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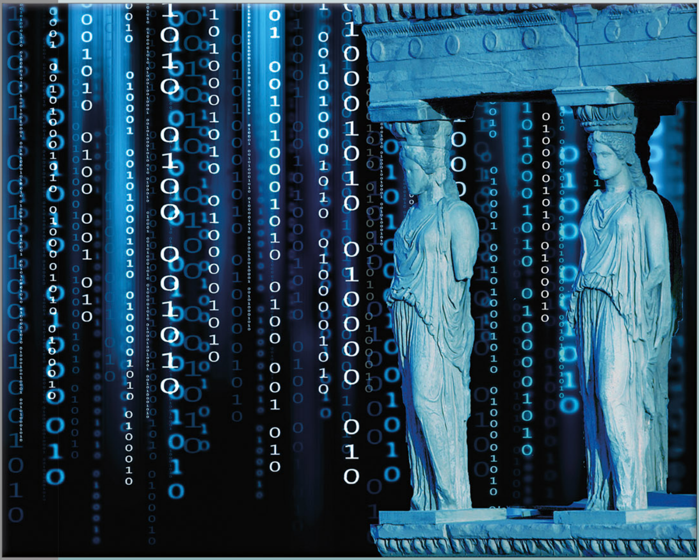
Informatics Empowers Healthcare Transformation



Editors: John Mantas
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IOS Press

INFORMATICS EMPOWERS HEALTHCARE TRANSFORMATION

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Preface

The current volume presents the accepted papers of the ICIMTH (International Conference on Informatics, Management, and Technology in Healthcare). The Organising Committee and the Scientific Programme Committee would like to present to the academic community the scientific outcomes of the ICIMTH 2017 Conference, held from 7 to 9 July 2017 in Athens, Greece.

The ICIMTH 2017 Conference is the 15th Annual Conference in this series of scientific events, gathering scientists from all continents as well as from the hosting country in the field of Biomedical and Health Informatics.

The Conference focuses on the empowerment of the Healthcare by the Biomedical Informatics applications in the whole spectrum from Clinical Informatics, Health Informatics to Public Health Informatics as applied in the Healthcare domain. Considering that management and organisational issues play an important role in the implementation phase of Biomedical Informatics applications, topics related to the above themes are also included as an integral part to the overall theme of the conference. We are treating the field of Biomedical Informatics in a very broad framework examining the research and applications outcomes of Informatics from cell to populations, including a number of Technologies such as Imaging, Sensors, and Biomedical Equipment and Management and Organisational subjects, such as legal and social issues and setting research priorities in Health Informatics. In essence, Informatics empowers the Healthcare Transformation.

This volume incorporates only the full papers accepted for oral presentation. It should be noted that the proceedings are published in this series of the conference as an e-book with e-access for ease of use and browsing without losing any of the advantages of indexing and citation in the biggest scientific literature databases, such as Medline and Scopus that the series of Studies in Health Technology and Informatics (SHTI) of IOS Press provides.

At the time of the deadline we had 97 submissions, from which after reviewing we have accepted 65 as full papers to be included in the volume proceedings.

The Editors would like to thank the Members of the Scientific Programme Committee, the Organising Committee, and all Reviewers, who have done a thorough and objective refereeing of the scientific work to produce a high quality publishing achievement and a successful scientific event.

Athens, 9.06.2017
The Editors,
John Mantas, Arie Hasman, Parisis Gallos, and Mowafa S. Househ

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On Informatics Diagnostics and Informatics Therapeutics - Good Medical Informatics Research Is Needed Here*

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Abstract. In the era of digitization some new procedures play an increasing role for diagnosis as well as for therapy: informatics diagnostics and informatics therapeutics. Challenges for such procedures are described. It is discussed, when research on such diagnostics and therapeutics can be regarded as good research. Examples are mentioned for informatics diagnostics and informatics therapeutics, which are based on health-enabling technologies.

Keywords. informatics diagnostics, informatics therapeutics, research, medical informatics, health informatics, biomedical and health informatics.

Introduction

The honour of giving an invited talk at ICIMTH 2017 gives me the opportunity to present some thoughts and to put them for discussion. Even as somebody, working now for about four decades in the field of medical informatics – please feel free to call this discipline also biomedical informatics, health informatics, or biomedical and health informatics [1, 2] – I still have to continue to reflect on the question, how this field can *the best* contribute to good medicine and good health care and how it can *the best* add to the progress of science (see also e.g. [3, 4]).

In the era of digitization and in living in a time, we can with good reasons call the information age (e.g. [5, 6] with discussion in [7]), some rather new procedures or techniques play an increasing role for diagnosis as well as for therapy. We may call them informatics diagnostics and informatics therapeutics ([2], p. 606). Please let me reflect on these informatics diagnostics and informatics therapeutics and let me point out some challenges in this context. Before doing this I want to recall the meanings of both, medical informatics and medical informatics research.

These thoughts are by nature subjective. Readers of this text may with good reasons have different opinions. Debating on such thoughts may be helpful in order to put appropriate priorities on our individual research agendas or on how to appropriately contribute to the practise in our field.

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* Written version of a keynote lecture, given at the International Conference on Informatics, Management, and Technology in Healthcare (ICIMTH), held from July 7 to 9, 2017, in Athens, Greece.

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1. When is Research Good Medical Informatics Research?

Let me here recall some thoughts, presented in [8] (with discussion in [9]).

Medical informatics research is by no means easy to do. This is based on the nature of this field, which is "avant la lettre" interdisciplinary [10]. We can recognize this already, when looking at the definition of this field. As "discipline, concerned with the systematic organization, representation, and analysis of data, information and knowledge in biomedicine and health care" it "aims to contribute to high-quality, efficient health care and to quality of life on the one hand and to progress in science on the other" by "developing methods of its own and using those of the computer and information sciences in general" as well as "methods of other disciplines such as mathematics, biometry, economics, linguistics, and physics" ([8], p. 256-7).

Research in medical informatics has to have to components: On the one hand it is research on *methodology and technology* (with strong roots in computer science, which is in my country and in my language much more appropriately called 'Informatik') and on the other it is research with the *objective* to contribute to the progress in biomedicine and health care (with strong roots in these sciences).

Medical informatics research should ideally and preferably have both components:

It should be *relevant* to the objectives of medical informatics *and*

It should be *original*, with respect to (new) methodology and/or technology.

Such research is in my opinion good medical informatics research. Due to my experience, even if one of these two components is at the beginning not really fully developed, it may come up in the course of research projects, if the intention of medical informatics research remains present.

If some research only satisfies one of these components, then "one should critically reflect, whether this is truly research in medical informatics. It might also be either research in some other biomedical or health care field or in some other field of computer or information science, but not in medical informatics". It is however a grey zone. So it can also be medical informatics research. Last, but not least, if "projects do not satisfy any of these qualities, then one has to reflect on whether this is research at all" ([8], df_6 on p. 260).

2. On Informatics Diagnostics and Informatics Therapeutics as Important Contributions of Medical Informatics to Health Care and Prevention

2.1. Important Research Fields of Medical Informatics

Informatics diagnostics and informatics therapeutics have been mentioned in the context of suggesting in the year 2010 important future research fields. Let me at first quote all fields mentioned:

medical informatics contributions to good medicine and good health for the individual

1 seamless interactivity with automated data capture and storage for patient care …;

2 knowledge-based decision-support for diagnosis and therapy …;

3 patient-centered data analysis and mining …;

4 informatics diagnostics …;

5 informatics therapeutics …;

6 informatics capability-enhancing extensions …;

medical informatics contributions to good medical and health knowledge
7 systematization of medical/health knowledge …;
8 analysis of medical and health knowledge …;
9 identifying new disease patterns …;
10 modelling the virtual human …;

medical informatics contributions to well-organized health care
11 … concepts for … health data bank architectures and for its organizations …;
12 … concepts for patient-centered health information system architectures …;
13 automated, individualized health advice and education;

with all these research fields being related to
14 analysing, creating and/or extending theories, concepts, and methods;
15 systematic evaluation, from 'phase 1' lab experiments to 'phase 4' field tests;
16 establishing and exploring the use of 'living labs' …" ([2], p. 606-7).

2.2. Characterizing the Two Fields on Diagnostics and therapeutics

Informatics diagnostics and informatics therapeutics have been characterized as:
4 informatics diagnostics, where informatics tools (with corresponding methodology) form the major part of the diagnostic entity;
5 informatics therapeutics, where informatics tools (with corresponding methodology) form the major part of the therapeutic entity" ([2], p. 606).

Related procedures / techniques in the context are, e.g., pharmaceutical diagnostics and pharmaceutical therapeutics. By this definition, e.g., computer tomography may at least nowadays be regarded as informatics diagnostics, because informatics tools and, in particular, informatics methodology has become a (if not the) major part. Such new diagnostic and therapeutic procedures can be observed in various technology fields:

- medical devices (e.g. [11]),
- mobile devices (e.g. [12-14]),
- Internet (e.g. [15]), and
- ambient assistive devices (e.g. [16]).

In some of these fields, such diagnostics and therapeutics already started to boom.

2.3. Examples

Many research projects at PLRI focus on ambient assistive devices, which we call health-enabling technologies. Such diagnostics and therapeutics can well be used in the context of a person's home (recall [17] from ICIMTH 2016). Let me mention two examples, based on our research at PLRI: New informatics diagnostics could be developed in the GAL-NATARS study [18, 19] and new informatics therapeutics in the AGT-REHA project [20]. They are using health-enabling technologies [16] at a person's body or at a person's home. Through GAL-NATARS we did receive new insights on the behavior of geriatric fracture patients after discharge. With the AGT-REHA system we can now offer new therapeutic support on rehabilitation patients with shoulder problems. Details are in the mentioned references.

3. Challenges

With regard to pharmaceutical diagnostics and therapeutics there is a much longer tradition in knowing how to do research on such procedures / techniques and on how to introduce and approve new procedures. With regard to informatics diagnostics and therapeutics, among others, the following challenges have to be faced:

- For pharmaceutical diagnostics and therapeutics as well as for medical devices there exist regulations for their approval, use and evaluation. This is currently not the case (at least in this intensity) for informatics diagnostics and therapeutics. We can, e.g., rarely find randomized trials here (see e.g. [16]).
- Developing pharmaceuticals takes years, while informatics tools are developed in a much faster time. Regulations for evaluation and approval have to consider this.
- Tools used as informatics diagnostics and therapeutics, are often also used for other purposes, too. This is e.g. obvious, when considering smart homes (see e.g. [16]). Again, regulations for evaluation and approval should consider this.

4. Discussion

Are informatics diagnostics and informatics therapeutics of importance or are the just a nice, but small informatics niche? In my point of view (and certainly not only there), they are not. They will significantly influence health care and prevention, as it has been done and still is by, e.g., pharmaceutical diagnostics and pharmaceutical therapeutics. Therefore, from my point of view, research on informatics diagnostics and informatics therapeutics is important and has to be encouraged. It should, however, be research, fulfilling the mentioned criteria of good research in medical informatics.

In the context of the United Nation’s Sustainable Development Goals it is mentioned that the „spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies, as does scientific and technological innovation across areas as diverse as medicine and energy“ [21]. According to the World Health Organization, information and communication technologies for health, often addressed under the term eHealth, are „recognised as one of the most rapidly growing areas in health today“ [22].

As a person’s home is affected, this also leads to consequences, how homes are built and how they are equipped [23]. As biomedical and health informatics specialists are needed for developing, assessing and delivering tools and services for such informatics diagnostics and informatics therapeutics, it is also of importance to consider these issues in educational programs [24].

Let me finally mention that such informatics diagnostics and informatics therapeutics – fields 4 and 5 in section 3.1 – also quite strongly correlate with field 6, mentioned there: “informatics capability-enhancing extensions, both mental and physical, to overcome (e.g. age-related) functional deficits (both external or internal to the human body, serving as implanted, immersive or external assistants, and providing a person with extended memories, senses, and connectivity)” ([2], p. 606). This may lead to important changes beyond medicine and health care and will affect human life and society as a whole.

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Find Your Passion, Lead with Purpose: A Health Informaticians' Guide

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Abstract. Health Informatics is an ever evolving, changing and dynamic field that has become the disruptive innovation shaping the future of healthcare. Health informaticians face a number of challenges in the workplace such as gaining acceptance and recognition from other healthcare providers and overcoming the resistance of healthcare providers from using technology in clinical practice. Being a health informatician is not for the faint hearted, especially as resistance to the role of health informaticians continues from both healthcare providers and hospital administrators. As health informaticians move from behind the scenes to the front line of todays modern healthcare organization, more leadership training is needed for health informaticians in dealing with the changing demands of the healthcare industry and rapid changes in technology innovations. Waking up everyday with the same passion and purpose to lead others and drive change within healthcare organizations requires the health informatician to find the internal passion that will be transformed into external actions guiding the health informatician in how they lead, communicate, work, think, and treat others within the workplace. The purpose of this paper is to help health informaticiains tap into and develop their passion for the field of health informatics so that they can lead with purpose to improve how healthcare is practiced and delivered, making a lasting change in the overall healthcare system.

Keywords. Leadership, Passion, Purpose, Health Informatics.

Introduction

They say that the two most important days of your life are "the day you were born, and the day you know why" [1]. As health informaticians, much has and continues to be written about the field from a variety of perspectives ranging from bio-informatics, image processing, clinical informatics, consumer health informatics, to public health informatics and other new and emerging domains that are transforming the field and changing how healthcare is practiced. As technology becomes more pervasive in healthcare organizations around the world, the role of health informaticians is becoming more vital and more visible as change agents improving how healthcare decision are made and how healthcare is practiced. Without a doubt, health informaticians today are seen as "disruptive innovators" by using technology in a simpler and more radical way "to either create a new product or a new environment for using the product that didn't previously exist" [2].

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Currently, health informaticians are not computing scientists lurking in the background creating systems, rules, and technologies that are out of touch and irrelevant to healthcare providers, but rather, key healthcare providers are taking the lead within the health informatics domain by developing their own clinical systems and technologies and working with health informatics experts to create a healthcare milieu that is "contextually" data driven. Health informaticians working behind the scenes, detached from the healthcare environment is no longer a viable option as health informaticians move to the frontlines and become the change agents working alongside healthcare providers to improve how information and communication technologies are used in clinical practice.

We cannot deny the challenges that health informaticians face on a daily basis from healthcare provider resistance in using new technologies, rising technology procurement and implementation costs, usability issues, project delays, project failures, change management challenges, and the ability to follow and keep up with the ever changing technologies that are changing rapidly. But one thing remains true over the years, that health informatics is more about people than it is about technology. In 1951, more than 65 years ago, Dr. Playfair wrote about developing "a record-keeping system in general practice", where Playfair touches upon many of the issues and challenges that health informaticians face today. Playfair reports that [3]:

> *A one four-drawer cabinet alongside my desk holds over 3,000 of my own cards. Without rising from my chair I can get out a patient's card in two seconds….This system is based on accepted business filing methods....those of my colleagues who see it for the first time tend to think it cumbersome; this is because they are looking at a new method with a new apparatus before they understand or have worked it. However, [medical locums/residents] have very quickly grasped it and have welcomed its speed and simplicity....Some may doubt whether the cost is justified, but I continue to find it a most worthwhile expenditure*

Playfair found that the new system improved patient care, workflow, was easy to use, however, while facing resistance from colleagues on its utility and administrators relating to system costs, yet, Playfair remained passionate about the work and continued to develop the record-keeping system system. Playfair's investigation clearly shows that the field of health informatics is more about people than about the implementation and use of technology, which 65 years later, remains relevant. Playafair's passion and leadership is what made the system successful, and Playfair mostly, worked alone, but kept a sustained effort onwards until Playfair was successful irrespective of the resistance faced.

Many leadership styles have been proposed for healthcare managers and providers over the years, such as transformational leadership, collaborative leadership, shared leadership, distributed leadership, ethical leadership and so forth [4]. Finding what leads one to enter the field of health informatics is not a simple task to accomplish, because it is a diverse field that accommodates a variety of different disciplines and domains such as surgery, medicine, nursing, pharmacy, laboratory technology, sociology, psychology, information sciences, computer science, public health etc. Finding one's purpose for practicing health informatics is essential as health informaticians are playing a larger role in how healthcare is practiced today. Finding the passion to work in the field of health informatics and the purpose to continue doing so requires one to wake up daily and head to work collaborating with people that doubt the discipline, its intentions, and goals. Living with purpose and leading with passion is a challenge for the practicing health informatics professional. A health informatician must have the right passion for practicing health informatics, which will help him/her overcome the aforementioned challenges. In this paper, I will provide direction for health informatics researchers and practitioners on how to find their purpose for the practice of health informatics so that they may lead from the inside-out and lead with purpose regardless of the personal or work challenges they may face.

1. Finding Your Passion, Lead with Purpose

In the late 19th century, Samuel Pierpont Langley wanted to be the first person to build an airplane [5]. He was highly connected, had ample funding and media coverage, hired the best scientific minds of the day, and had government support to build the first airplane. At the same time, just a few hundred miles away, in Dayton Ohio, Orville and Wilbur Wright, had little money, little education, little media coverage and no government support, and they also wanted to build the first airplane. History remembers the Wright brother's success and little mention is made of Samuel Langley. Sinek attributes the success of the Wright brothers to their dedicated passion for wanting to build the first airplane and change the course of history [5]. Sinek attributes Samuel Langley's failure as a result of his intentions to be rich and famous for building the first airplane. The day the Wright brothers were successful in achieving their goal, Langley quit pursuing his.

As a health informatics educator, I always welcome the incumbent graduate or undergraduate class with the above mentioned story. When I am finished, I ask them, "Why are you studying health informatics?" Most graduate and undergraduate students respond by noting their interest in improving job prospects, enhancing or changing their careers, or making more money. Rarely, if ever, do any of the students say: "I want to be remembered for making healthcare safe for everyone", "I believe in creating tools that can change how medicine is practiced" or "I want to be the first to eliminate human error in healthcare". Then I continue, based on my experience and say that: "one day, you will make more money, buy a bigger home, get your promotion, buy the nice car, travel, and then what? What will make you come to work the next day?" Because many health informatics students are focused on the results and not driven by their passions for practicing health informatics, they will face difficulties leading within the field.

In order to discover your own "Why" or passion, you will need "to identify your core, lifelong strengths, values and passions – those pursuits that energize you and bring you joy"[1]. The Harvard Business Review (HBR) provides prompts that are found to be most effective for finding your passion: "1) What did you especially love doing when you were a child, before the world told you what you should or shouldn't like or do?; 2) Describe a moment and how it made you feel; 3) Tell us about two of your most challenging life experiences. How have they shaped you?"[1]. As for myself, as a practicing health informatics researcher and practitioner, it took me over fourteen years to love the field and become passionate about it. Since my first day at university, I wanted to be a Professor. I wanted to travel the world, earn a comfortable living, and be a respected member of society. Once I achieved most of my goals, I felt empty, and thought of changing careers, until I asked myself, "what I loved doing as a child and how I felt about it, while thinking about challenging life experiences". I found out, through my life experiences, that as a child and in my early teens, I always enjoyed helping others and always wanted to help improve people's lives; in short, "I am passionate about helping people believe in themselves". Today, I develop confidence in my students, so that they believe in themselves, making them better health informatics researchers and practitioners. I always inspire them by saying: "All of you have greatness within you, my job is to help you find it."

2. Conclusion

As health informaticians, you will need to find your passion for the discipline. Once you find your passion, you will begin leading others with purpose and clear direction and become self-aware, have great relationship building skills, drive and determination, resilience and grit, confidence, creativity, organizational capability, flexibility, innovation, and vision with a goal orientation [6]. Other health informaticians, healthcare providers, and managers will see your passion and will subscribe to it and provide you with the resources to achieve your goals. As a result, you will find that your strong passion will lead to improved healthcare outcomes.

Acknowledgements

I would like to thank the College of Public Health and Health Informatics Students at KSAU-HS for helping me find my passion. A very special thanks to Dr. Majid Al-Salamah, a great leader that is passionate about public health and health informatics. I would also like to thank Prof. Raghib Abu-Saris for his great wisdom and encouragement in writing this paper. Also, a special thanks to students at King Saud University.

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Chapter I

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Pitfalls of Ontology in Medicine

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Abstract. Much research has been done in the last few decades in clinical research, medicine, life sciences, etc. leading to an exponential increase in the generation of data. Managing this vast information not only requires integration of the data, but also a means to analyze, relate, and retrieve it. Ontology, in the field of medicine, describes the concepts of medical terminologies and the relation between them, thus, enabling the sharing of medical knowledge. Ontology-based analyses are associated with a risk that errors in modeling may deteriorate the results' quality. Identifying flawed practices or anomalies in ontologies is a crucial issue to be addressed by researchers. In this paper, we review the negative sides of ontology in the field of medicine. Our study results show that ontologies are perceived as a mere tool to represent medical knowledge, thus relying more on the computer science-based understanding of medical terms. While this approach may be sufficient for data entry systems, in which the users merely need to browse the hierarchy and select relevant terms, it may not suffice the real-world scenario of dealing with complex patient records, which are not only grammatically complex, but also are sometimes documented in many native languages. In conclusion, more research is required in identifying poor practices and anomalies in the development of ontologies by computer scientists within the field of medicine.

Keywords. Ontology, Medicine, Pitfalls, Knowledge, Integration

Introduction

Advancements in medical research have led to an exponential increase in the generation of data. Managing this vast information not only requires integration of the data, but also a means to analyze, relate, and retrieve it. The field of medicine has a rapidly growing vocabulary, with a range of complex scientific names and concepts. For example, in many countries, the same drug is known by different names. Thus, greater the variation in terminologies in healthcare, more difficult it is to analyze the information, thus increasing the risk of potential errors. Most of the medical terminologies can be organized as a complex hierarchy in which the most general term is placed on the top, whereas the terms become more specific down the hierarchy. Each term corresponds to a complex concept which is related to other concepts in many ways.

Ontology is the "hierarchal structuring of knowledge about concepts by sub-classing them according to their properties and qualities" [1]. Ontology, in the field of medicine, describes the concepts of medical terminologies and the relation between them. Since concepts are very important for sharing data and representation of knowledge, ontology

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enables the sharing of medical knowledge. The spectrum of ontology includes various concepts such as terminologies and thesauri. While terminologies are a set of designations that belong to a particular language, thesauri also include the relations between them. Therefore, ontology implies a broader scope of information which encompasses relationships which are more in numbers and highly specific in their function [2]. The advantages of ontology-based analysis are associated with a risk that errors in modeling may deteriorate the results' quality, a prime issue which has been highlighted by many studies. Gherasim et al. [3] identified four denominations associated with ontological errors: (1) "taxonomic errors", (2) "design anomalies" or "deficiencies", (3) "anti-patterns", and (4) "pitfalls" or "worst practices". The purpose of this paper is to provide insight about the possible pitfalls of ontology especially in the field of medicine. The results of this work would provide a more detailed perspective on the current research around ontology in medicine.

1. Methods

Papers relating to the pitfalls of ontology in medicine were identified from Google Scholar, PubMed (up to 2017), and World Wide Web (blogs, news, and magazine articles). The following key terms were searched as headings or text words in the titles and abstracts: "ontology", "medicine", "pitfalls", and "issues". In order to reveal additional papers, references in the literature were also searched and relevant papers were further analyzed. Every article was searched with a primary focus on the limitations and negative experiences relating to ontology in medicine; the relevant information was extracted, analyzed, and included in the review.

2. Results

A total of seven relevant papers were found relating to the pitfalls of using ontology in medicine.

2.1. Balance of Natural Language and Ontology

Ontology could be a solution to the problems in medical terminology only if the terms are understood in the right way. In the example of SNOMED-RT, which is a reference terminology i.e., "a set of concepts and relationships that provides a common reference point for comparison and aggregation of data about the entire health care process, recorded by multiple different individuals, systems, or institutions", Ceusters et al. [4] highlight multiple problems such as linguistic problems (ambiguous meanings in preferred terms, a grammatical construction in terms, mismatch between formal meaning and concept) and ontological problems (errors in the algorithm, poor modeling, merging diverse terminologies into one larger system). The study concludes that designing too many medical ontologies without keeping ontological or linguistic constraints in mind could hamper their use in advanced natural language-understanding applications [4].

2.2. Relation to human languages

In a domain like biomedicine, only a minor portion of the scientifically relevant facts could be adequately represented by formal ontologies, when these are conceived as representations of entity types. The attempt to encode default or probabilistic knowledge using these ontologies is prone to produce unintended, erroneous models. Schulz et al. [5] highlight the benefits of formal ontology in better capturing domain knowledge. The authors identify two major issues to be addressed: 1) representation of background knowledge and 2) relation of ontology to human languages [5].

2.3. Inconsistent knowledge representation

Despite their advantages, ontologies in the field of biomedicine have not been utilized to their full potential. Maiga and Williams [6] attribute the reasons as 1) lack of knowledge of user requirements for biomedical data integration systems since the subjective knowledge changes with time, place, and cultural environment; and 2) absence of general framework to evaluate their suitability for specific applications. This emphasizes the difficulties in incorporating specific properties to be used in ranking ontologies since their selection could depend on personal preference and requirements. To bridge this gap, the authors developed a flexible framework for improved user evaluation of ontologies in biomedical systems [6].

The National Cancer Institute (NCI) Thesaurus, a description logic-based terminology, is a part of the US National Cancer Institute Bioinformatics caCORE distribution. It has been created to be used by NCI's researchers and the whole cancer community. It is designed to serve several purposes such as annotation, search, and retrieval of data, automated indexing, retrieving bibliography information, and linkage to heterogeneous resources [7]. Ceusters and Smith [8] present the evaluation of NCI Thesaurus for its compliance with the principles of good practice in terminology and ontology design. The authors used the online version of Thesaurus and its OWL representation (version 04.08b, released on August 2, 2004), and measured each based on the requirements mentioned in the relevant ISO terminology standards and the ontological principles mentioned in the recent literature. Many mistakes and inconsistencies were observed with respect to the underlying knowledge representation system, term formation principles used, and missing or incorrectly assigned formal and verbal definitions. The study concludes that the version 04.08b of the NCI Thesaurus has the same broad range of problems as seen in other biomedical terminologies. The authors recommend a more principled approach to test the Thesaurus for internal consistency, as well as, its similarity to that part which it is designed to represent [8].

In another study by Kumar and Smith [9], NCI thesaurus was shown to have similar problems regarding suitability for characterizing entities in colon cancer ontology [7,9].

2.4. Common pitfalls in Gene Ontology

Gene Ontology (GO) describes the "universe" of possible functions of a gene, but not specifically of a particular gene. An annotation or a statement of connection is used in ontology to link a type of gene product with biological process, molecular function, or the type of cellular component. A positive (or negative) annotation implies that the function specified exists (or does not exist). Gaudet & Dessimoz [10] discuss the major pitfalls of Gene Ontology such as 1) wrongly assuming the absence of annotation indicates absence of function; 2) "NOT" or "co-localizes with" are important qualifiers in gene annotation as they could change the meaning of annotations, such errors go unnoticed since only a small number of annotations have qualifiers; 3) different types of annotations for different species, e.g., model species have much more experiment-based annotations; 4) experiment-based annotations have more difference if derived from different articles than if in the same paper; 5) more positive annotations than negative could result in misleading accuracy; 6) large variations in the number of annotations could be introduced by inter-ontology links and annotation extensions; also, the latter may not be fully implemented. For the above-mentioned pitfalls, and others mentioned in the paper, the authors suggest remedies and best practices [10].

3. Discussion and Conclusion

Our review provided insights into the negative sides of ontology in medicine. In healthcare systems, ontology is perceived as a mere tool to represent medical knowledge, thus relying more on the computer science-based understanding of the medical terms. While this approach may be sufficient for data entry systems, in which the users merely need to browse the hierarchy and select relevant terms, it may not suffice the real-world scenario of dealing with complex patient records, which are not only grammatically complex, but also are sometimes documented in many native languages [4]. Evaluation of biomedical ontologies is of prime importance for better results from these systems. The development of an effective research methodology in biomedicine is challenging due to the lack of commonly agreed criteria for evaluation of research results [11].

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CrowdHEALTH: Holistic Health Records and Big Data Analytics for Health Policy Making and Personalized Health

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Abstract. Today's rich digital information environment is characterized by the multitude of data sources providing information that has not yet reached its full potential in eHealth. The aim of the presented approach, namely CrowdHEALTH, is to introduce a new paradigm of Holistic Health Records (HHRs) that include all health determinants. HHRs are transformed into HHRs clusters capturing the clinical, social and human context of population segments and as a result collective knowledge for different factors. The proposed approach also seamlessly integrates big data technologies across the complete data path, providing of Data as a Service (DaaS) to the health ecosystem stakeholders, as well as to policy makers towards a "health in all policies" approach. Cross-domain co-creation of policies is feasible through a rich toolkit, being provided on top of the DaaS, incorporating mechanisms for causal and risk analysis, and for the compilation of predictions.

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Keywords. Big data, health promotion, disease prevention, health analytics, public health policy making

Introduction

The explosion of ICT services led to several devices and platforms providing additional data (e.g. monitoring blood pressure, heart rate, sugar levels, etc). However, these data and the respective services operate independently, and due to this inadequate integration, it is getting increasingly common for important events to be missed (e.g. early indications of spatiotemporal development of diseases). On the other hand, the multitude of data sources highlights a unique opportunity: data to be exploited for effective and targeted policy making, development of personalised medicine, prevention of diseases and health promotion in general. Additional factors are health determinants and should also be considered, as highlighted by the WHO [1], including the physical, social and economic environment, genetics, and relationships with friends and family. Additionally, today's health records (EHRs and PHRs) *are far from being what the citizens consider as of value to their health*. This is consistent with the beliefs of 80% of the public regarding health as more than being disease-free [2] and includes a *variety of everyday aspects, such as the environment, the fit lifestyle, the nutrition, the mental and emotional health*. Capturing and linking this information with other data in EHRs and PHRs would be of benefit for learning about outcomes of prevention strategies, health policies, diseases, and efficiency of clinical pathways. HITECH and PPACA consider the incorporation of this information into EHRs and the meaningful adoption of such enhanced records of major importance [3]: Records would become placeholders of all types of *multi-* information*: data from multiple sources, incorporating multi-discipline knowledge, facilitating multi-stakeholder collaboration, capturing multi-morbidity cases. Furthermore, *collective community knowledge* could play a significant dual goal: (i) collect, fuse and analyse information from different entities to extract valuable information for the provision of actionable insights, (ii) provide the ground for targeted health policy making [4]. The impact is apparent: 46% of the respondents in [5] highlighted that information sharing has changed their overall approach towards healthy life. Another survey [6] shows the need and value for sharing health information with others and communities: 70% tracked a health indicator for themselves / for someone else and 34% of those share their health tracking records or notes with another person or group. With respect to data sharing concerns, the acceptance of online platforms (e.g. PatientsLikeMe [7]) and in general health-oriented social networks (as a venue for sharing ideas, debating treatment options, etc) showcases that these concerns are increasingly limited. Thus, the challenge is not only how to *utilize the data from different sources*, but also how to c*ombine it to exploit the community knowledge benefits*. To this end, management of big data is key, which provides significant added-value when combined with eHealth tools (e.g. causal analysis, evidence-based evaluation of strategies, risk stratification, etc). In this paper, we present CrowdHEALTH as an *integrated platform that incorporates big data management mechanisms addressing the complete data path: from acquisition, cleaning, to data integration, modelling, analysis, information extraction and interpretation*. The goal of CrowdHEALTH is to enable proactive and personalized disease prevention and health promotion, while providing decision support to authorities for policy creation, through the exploitation of collective knowledge and intelligence, following paradigms such as [8] that emerges from multiple information sources and its combination with situational awareness artefacts.

1. Holistic Health Records

CrowdHEALTH explores mechanisms that can be clustered across three main areas: (i) extended health records, (ii) collective health knowledge (i.e. clustered records), both produced and exploited by (iii) big data techniques. As highlighted by CISCO [9]: “Humans evolve because they communicate, creating knowledge out of data and wisdom based on experience”. Our hypothesis is that the “extended” health records can be exploited to a greater degree if they can evolve by following the human communication paradigm. This metaphor means enhancing records with technologies to exploit the knowledge and experience derived from other records (i.e. from patients in the same medical, social and environmental situations). Thus, we propose the evolution of health records in two stages: (i) towards *Holistic Health Records - HHRs* providing a complete view of the citizen including all health determinants, (ii) towards *HHRs Clusters* to extract collective knowledge. As depicted in the following figure, an HHR contains *several components*: (a) the personal component containing health, social and lifestyle data (such as nutrition or physical activities) collected by either the citizen, her family, friends, etc., (b) the social component containing social care data collected from social care providers, (c) the medical device component containing health data from medical devices (e.g. home care systems or wearables), (d) the healthcare component containing data (e.g. clinical data, diagnoses, medication, etc) obtained by healthcare providers (e.g. primary care systems) and (e) laboratory medical data.

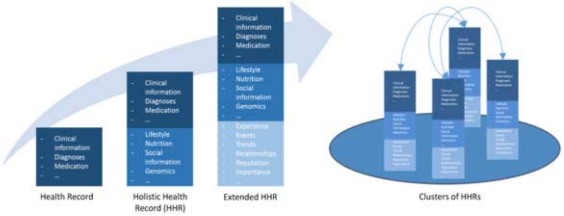

Figure 1. Holistic Health Records and Clusters of Records.

The HHRs clusters act as living entities, including properties such as experience (i.e. medication experiences of patients), relationship with other HHRs (i.e. relationships with friends and family, and “classification” of relationships as for example patients with the same disease), reputation, events and trends that affect the citizen or similar citizens. The latter means that HHRs could form networks in an automated way based on a variety of criteria (such as lifestyle choices or disease symptoms) and exchange information as experiences. Note that we are not proposing yet another social health platform for information sharing amongst individuals but the realization of HHRs clusters allowing records to form communities, share information, identify trends that impact patients.

2. Efficient health services through big data analytics

As depicted in the following figure, the overall architecture of CrowdHEALTH platform consists of three main pillars: Data & structures, Health analytics, and Policies. In the context of *Data & structures*, *Plug'n'Play* enables the integration of unknown sources to avoid the manual and ad-hoc integration of these sources. As it is important that the collected data emerge from reliable sources to ensure information "fresh-ness" and appropriateness, *Sources Reliability* enable adaptive selection of sources based on the corresponding availability patterns and volatility levels. A *FHIR-compliant API* enables connectivity and communication, ensuring meaningful interpretation of the acquired data and the feasibility of their incorporation into HHRs. *Data Anonymization* facilitates adherence to privacy requirements, while *Data Quality Assessment* techniques are performed to ensure that different sources' data that are fed in the constructed HHRs actually originate from the expected sources and are of the required quality. Regarding HHRs, the *HHR Manager* provides the new structures as a basis for the compilation of the HHR. *Context Analysis* enables the identification of cluster similarities based on the context obtained from the compiled HHRs. The HHR clusters are defined through the *Clustering and Classification* mechanism that captures correlations among similar HHRs. The HHRs and HHR clusters are stored into the *Data Store*, along with the data derived from the quality tools, which are made interoperable through the *Interoperability Layer* in order to address heterogeneity of health data. These data are aggregated into HHRs through different data models and query languages. *Real-time big data analytics* are performed on the stored data (i.e. HHRs, clusters, historical citizen, health analytics results) enabling correlations and extraction of situational factors between biosignals, physical activities, medical data patterns, clinical assessment and laboratory exams. The big data approach is able to process millions of events per second allowing the exploitation of (often critical) medical data from different sources as things happen.

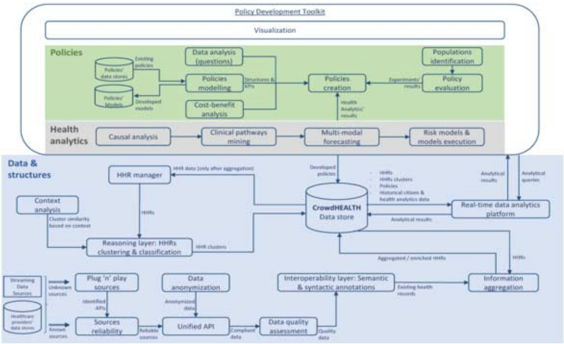

Figure 2. CrowdHEALTH Conceptual Architecture.

In the context of the *Health Analytics*, analytics techniques are utilized for carrying out *Risk Models & Models Execution*, *Causal Analysis*, *Multimodal Forecasting*, and *Clinical Pathway Mining*, upon all the gathered data. Regarding *Risk Models & Models Execution*, class-specific care plans and policies are compiled according to data-driven models. *Causal Analysis* allows for the identification of the properties that affect the performance of policies and care plans. *Clinical Pathway Mining* supports data analysis to identify similarities or differences in treatment among groups of patients, indicate major effective factors that affect several treatments and establish a supporting framework for improving the treatment of patients with different diseases. *Multimodal Forecasting* estimates the applicability and effectiveness of health policies, their variations and combinations to particular population segments taking into consideration social information and spatiotemporal properties. In the *Policies* pillar, *Policies Creation* obtains the modelled policies and the *Cost-benefit Analysis* outcomes, and in combination with the health analytics results proposes policies that are *Evaluated* based on the experiments on *Identified Populations*. With regards to the first input, health and disease prevention policies are analyzed, while the integrated health policy making paradigm is refined and updated with data analytics outcomes and experiences. Regarding the second input, an evidence based framework produces guides and identifies indicators in the development of public health policies, combined with leveraged knowledge from existing public health policies. All the information is provided to different entities in the ecosystem (e.g. healthcare providers, policy makers, care professionals, nutrition experts, etc) via a *Visualization* environment that enables stakeholders to interact with the platform through analytical queries, while manipulating the results and visualizing them in an adaptive way. Visualization is part of a *Policy Development Toolkit* that exploits created policies, and health analytics results to advance the processes of policies co-creation and evaluation.

3. Conclusions

The health data from multiple information sources constitute a computable collection of fine-grained longitudinal phenotypic profiles that may facilitate knowledge discovery and cohort-wide investigations on an unprecedented scale, which is the prerequisite for patient-centered care [10]. To this end, in this paper we propose a complete approach for capturing all health determinants in new structures, the HHRs, while creating groupings of them (i.e. clusters) to provide the ground for collective knowledge and provision of insight for different population segments according to various criteria (e.g. location, occupation, medication status, emerging risks, etc). This opens opportunities for disease prevention, personalised medicine, and may lead to reduction in readmission rates [11]. The proposed approach is under evaluation through scenarios with heterogeneous data sources / devices, data to be included in HHRs, target groups (e.g. chronic diseases or youth obesity), and environments (care centers, social networks, public environments, living labs, etc). Exploiting 2 million records and 700.000 streams of everyday activities, while engaging 200.000 users, the platform is expected to exploit the current 7.5 million measurements from 1 million people with additional 200.000 / year being also analysed.

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Characteristics of the Highest Users of Emergency Services in Veterans Affairs Hospitals: Homeless and Non-Homeless

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Abstract. Efforts are underway to understand recent increases in emergency department (ED) use and to offer case management to those patients identified as high utilizers. Homeless Veterans are thought to use EDs for non-emergent conditions. This study identifies the highest users of ED services in the Department of Veterans Affairs and provides descriptive analyses of these Veterans, the diagnoses for which they were seen in the ED, and differences based on their homeless status. Homeless Veterans were more likely than non-homeless Veterans to have >10 visits in the 2014 calendar year (12% vs. <1%). Homeless versus non-homeless Veterans with >10 visits were more often male, <age 60, and non-married. Non-homeless Veterans with >10 ED visits were often treated for chest and abdominal pain, and back problems, whereas homeless Veterans were frequently treated for mental health/substance use. Tailored case management approaches may be needed to better link homeless Veterans with high ED use to appropriate outpatient care.

Keywords. Homeless Veterans, Emergency Department, High Utilizers

Introduction

The use of emergency and urgent care services is rising in the US. The consequences of using the emergency department (ED) for non-emergent conditions translate to over-crowding of EDs, perceived lower quality of care, decrease in access to those who really need the ED, and an overall increase in costs to the health care system. High utilization of EDs has negative effects on patients and health care workers, resulting in frustration with the health care system in general. Efforts are underway to better understand the use of the ED for non-emergent conditions, and to offer patients identified as high utilizers of the ED (also called super-utilizers) customized case management in an attempt to decrease ED use and encourage ambulatory and primary care visits. To date, these high utilizer programs have had mixed success in diverting patients from using the ED as a usual source of care to more traditional primary and ambulatory care venues [1,2]. A key preliminary step is to characterize those patients

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who are the highest users of the ED in terms of their demographics, co-morbidities, and appropriateness of ED use.One group that might be well suited for high utilizer programs is homeless Veterans. Prior studies have documented high ED use among homeless patients, and homelessness is more common among Veterans than in civilian populations. Compared to their non-homeless counterparts, Veterans experiencing homelessness are thought to more frequently use EDs for non-emergent conditions. In order to tailor high utilizer programs for homeless Veterans, there is a need to better understand the prevalence of high ED use, characteristics of high utilizers, and common reasons for ED use among homeless and non-homeless Veterans. This study aimed to examine differences between homeless and non-homeless Veterans in the 1) frequency of ED use in one calendar year, and 2) sociodemographic characteristics and clinical diagnoses among those identified as the highest ED utilizers.

1. Methods

1.1. Administrative data related to ED and urgent care use in VA hospitals

The US Department of Veterans Affairs (VA) serves nearly 6 million unique Veterans through a network of 152 hospitals around the US. Many of these hospitals have emergency departments and urgent care clinics. Administrative data on ED and urgent care clinic use that were collected during routine clinic care from January 1 to December 31, 2014 were extracted from the VA corporate data warehouse using Veterans Informatics and Computing Infrastructure (VINCI), a secure research portal [3].

1.2. Data analysis

Descriptive statistics were used to analyze demographic and ED/urgent care visits for the 12-month study period. Primary *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes are entered into the electronic medical record by providers at the time of care. All ICD-9-CM codes were assigned to a category using Clinical Classifications Software (CCS) that was developed for the Healthcare Cost and Utilization Project (HCUP), a Federal-State-Industry partnership sponsored by the Agency for Healthcare Research and Quality [4]. Those Veterans who had administrative evidence of homelessness at the ED/urgent care visit were identified as previously described [5], using ICD-9-CM codes for lack of housing (V60.0) and for housing instability (V60.1 Inadequate housing, V60.89 Other specified housing or economic circumstances, and V60.9 Unspecified housing or economic circumstances). The number of ED/urgent care visits per Veteran were grouped and the highest users were defined as those having >10 visits in a 12-month period (11 and above). Details of visits of these highest utilizers were examined and stratified by their housing status (homeless or non-homeless) at the time of the ED/urgent care visit.

2. Results

2.1. Number of ED/Urgent care visits by Veterans in 2014

A total of 1,018,741 unique Veterans accounted for nearly 2 million ED/urgent care visits during the calendar year 2014. Veterans had a mean of 2 ED/urgent care visits (median 1, range 1-237). Homeless Veterans had higher numbers of visits as compared to non-homeless (Table 1). A greater percentage of homeless Veterans (948, 12.4%) had >10 ED/urgent care visits during the study period than non-homeless Veterans (<1%).

Table 1. Emergency Department and Urgent Care Visits in VA Hospitals, January 1 to December 31, 2014.

	Total (N=1,018,741)	Non-Homeless (N=1,011,107)	Homeless or With Housing Instability (N=7,634)
Average Number of ED/Urgent Care Visits (Median, Range)	2 (1, 1 – 237)	1 (1, 1 – 131)	5 (4, 1 - 237)
ED/Urgent Care Visits	N (%)	N (%)	N (%)
1	571,162 (56.1)	569,657(56.3)	1,505 (19.7)
2	219,095 (21.5)	217,842 (21.5)	1,253 (16.4)
3-10	220,947 (21.7)	217,019 (21.5)	3,928 (51.5)
11 and higher	7,537 (0.74)	6,589 (0.65)	948 (12.4)

2.2. Sociodemographic characteristics of those with >10 ED/urgent care visits

Veterans with >10 ED/urgent care visits were predominantly male (92.2%). More than half of high utilizers were non-Hispanic White (56.3%), over age 60 (53.6%), and separated, divorced, or widowed (52.5%). Most (84.1%) never saw active combat during their military service. Compared to non-homeless Veterans, those with experiences of homelessness or housing instability were more frequently male (96.1% vs 91.6%), and younger (36.2% vs. 56.1% over age 60), but less frequently married (6.0% vs. 30.0%).

Table 2. Most Frequent Diagnoses of Veterans with >10 ED/Urgent Care Visits in VA Hospitals, January 1 to December 31, 2014.

Non-Homeless (N=1,011,107)			Homeless or With Housing Instability (N=7,634)		
ICD Code	Description	N (%)	ICD Code	Description	N (%)
786.5	Unspecified Chest Pain	1,539 (23.4)	V60.0	Lack of Housing	413 (43.6)
789	Abdominal Pain	1,459 (22.1)	303.9	Alcohol Dependence	293 (30.9)
724.2	Lumbago	1,389 (21.1)	311	Depressive Disorder	273 (28.8)
496	Chronic Airway Obstruction	1,041 (15.8)	305	Alcohol Abuse	266 (28.1)
599	Urinary Tract Infection	961 (14.6)	V62.84	Suicidal Ideation	263 (27.7)
465.9	Acute Upper Respiratory Infection	807 (12.2)	724.2	Lumbago	212 (22.4)
682.9	Cellulitis and Abscess	755 (11.5)	786.5	Chest Pain	207 (21.8)
786.09	Dyspnea / Respiratory Abnormality	742 (11.3)	303	Alcohol Intoxication	164 (17.3)
784	Headache	730 (11.1)	729.5	Pain in Limb	164 (17.3)
786.59	Other Chest Pain	728 (11.1)	789	Abdominal Pain	154 (16.2)

2.3. Frequent diagnoses of those with >10 ED/urgent care visits in a 12-month period

Of non-homeless Veterans with >10 ED/urgent care visits, 23% were treated for diseases related to the chest pain, 22% for abdominal pain, and 21% for back problems (Table 2). Of the homeless Veterans with >10 ED/urgent care visits, more than one-quarter were seen for alcohol dependence (31%), depressive disorder (29%), and alcohol abuse (28%).

3. Discussion

To our knowledge, this is the first study to characterize the highest utilizers of the ED in US Department of Veterans Affairs hospitals. One in nine homeless ED/urgent care patients were identified as high utilizers, many of whom received care for mental health/substance use issues that could potentially be addressed in outpatient settings. It will be important, once high users are identified to initiate regular case management to understand the reasons behind frequent ED use and to establish longitudinal primary care relationships. We acknowledge several limitations of this study. As only one calendar year of data were analyzed, no trends could be established. Future studies should include data from several years of ED and urgent care usage. There are inherent limitations to the reliability and completeness of administrative ICD coding of diagnoses of ED and urgent care visits. As we determined administrative evidence of homelessness only on the date of the ED/urgent care visit, it is possible that we underestimated the prevalence of homelessness among this group of Veterans. Correlating administrative evidence of homelessness in a time period prior to the ED/urgent care visit would be important to have a better estimate of the prevalence of homelessness among Veterans. Further detailed characterization of homeless Veterans who are the highest users of the ED is essential to understand their patterns of use and to inform tailored programs to mitigate inappropriate high utilization.

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Assessing Dental Information Requirements of Electronic Health Records of Zahedan Dental School

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Abstract. Due to the various beneficiaries of Electronic Health Records (EHR), the information requirements of each group should be taken into account while designing the EHR. In line with the priority of implementing electronic health records in the province of Sistan and Baluchestanin Iran, this study aims to assess the dental information requirements of EHR at Zahedan Dental School. This cross-sectional study was performed in 2014.The study population comprised 6565 faculty members, residents of dental school and staff in Health Information Management of Zahedan Hospitals. The data collection instrument was a questionnaire which comprised six sets of data and 67 informative elements that were prioritized based on the average of scores. Data were analyzed by using descriptive statistics, SPSS. All the elements, except two ones including marital and employment status which were considered as the second priority with average scores below 7, other proposed elements such as clinical findings, final diagnosis, oral health status, drug sensitivity, main complaint, patient's full name, required X-rays, medical record number, and the discharge recommendations of an average above 7 were regarded as the first priority of the respondents. In conclusion, it is recommended that these findings should be considered in the design of electronic health records system at Zahedan Dental School.

Keywords. Electronic health records, information Requirements, Dentistry

Introduction

In recent years, the use of computer technology created a huge improvement of healthcare; including formation and maintenance of patients' medical record electronically, quick access to reliable information, and sharing of information [1]. The outlook of paper records, as the proper communicative tool between healthcare

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providers, is poor in processing data informatively as well as timely [2]. According to the definition provided by ISO, EHR is a reservoir for storing data digitally and transmitting securely, by which these data are accessible by multiple users at the same time [3]. The utilization of electronic health records in dental services has offered several advantages such as compliance rate rising with set parameters, and continuity of care as well as easier, and more efficient clinical audits [4]. Also, using this system resulted in increased clinical revenues, reduced costs related to the facilities used for keeping records on paper [5]. The role of dental service, as an important part of healthcare systems, is unavoidable for the prevention of oral diseases and can explicitly facilitate clinical audit process through correct, comprehensive and structured data [6]. Analysis of information requirements is one of the early stages in the life cycle of information systems (SDLC) [7]. Acharya et al. reported that most respondents in this study deemed patient's dental information necessary for synchronizing or providing effective medical care. An integrated EHR can facilitate this holistic approach to patient care [8]. Considering the priority of implementing electronic health records in the province of Sistan and Baluchestanin Iran, the purpose of this work was to assess the dental information requirements of EHR at Zahedan Dental School in this province.

1. Methods

This cross-sectional study was carried out in 2014. The study population comprised 65 faculty members and residents of dental school, and staff in Health Information Management of Zahedan Medical University Hospitals that were selected by convenience sampling. According to relevant literatures, the questionnaire was designed. The content validity and reliability of the questionnaire were assessed by expert’s opinions and test-retest method (Spearman's rank correlation coefficient was used to evaluate the reliability of the questionnaire, which showed a coefficient of 81%), respectively. The first part was related to demographic data of respondents, while the second part was related to the information needs of dental electronic records in six sections that included 67 items. Respondents were asked to rate each item based on importance and on a scale of 1 to 10. After collecting the questionnaires, the data were analyzed by SPSS software. For data analysis, descriptive statistics, mean and frequency were utilized. The data with an average of 1 to 3.99 were excluded (third priority). The data that gained an average of 4 to 6.99 were presented as a set of proposal (second priority). Finally, data with an average of 7 to 10 were considered as the first priority of dental electronic health records.

2. Results

Thirty three health information management personnel and 32 dentists participated in this study. Generally, this population included 23 males (35%) and 42 females (65%). Moreover, most people were between 31-35 years of age. According to the data, in sections of identifying information needs, the highest mean was related to the element patient'sfull name. On the contrary, employment and marital statushad the lowest mean. In the section of clinical information needs, drug allergies element had the highest mean while the element of vital signs, refusal of treatment, and charts had the lowest mean. In the health status section, oral health status element was of utmost importance while the element of etiology had the least importance (Table 1). Among the others informational elements related to the treatment plan section, the final diagnosis and clinical findings had the highest mean. Among the informational elements related to the treatment measures, the element of required X-rays had the highest. In the section of follow-up, the element of recommendations after discharge had the highest mean (Table 2).

Table 1. Mean and standard deviation of information requirements: Identifying information, Clinical Information, Health status

Identifying information			**Clinical Information**			**Health status**		
	Mean	**SD**[a]		**Mean**	**SD**		**Mean**	**SD**
patient's full name	8.85	1.68	Main complaints	8.38	1.92	Systemic Detection	8.60	1.73
Father's name	7.50	2.72	Medicinal History	8.63	1.87	Dental diagnosis	8.52	1.70
Date of birth	8.09	2.75	Medical History	8.80	1.75	Etiology	7.55	2.36
sex	7.98	2.62	Dental History	8.64	1.83	Electronic consent	7.95	2.16
Marital status	6.55	2.82	Family history	7.75	2.10	Oral Health Status	8.98	1.71
Employment status	6.40	2.52	Pulp tests	7.90	2.21	Periodontal status	7.27	1.84
Name of Medical Center	7.06	2.97	Periapical Tests	8.01	2.10			
Admission date	8.30	2.58	Findings and Results	8.24	2.08			
Address and telephone number of the patient	8.06	1.85	Diagnosis code	8.55	2.01			
Therapist addresses and phone numbers	7.56	2.50	Vital signs	7.73	2.70			
Relatives in cases of emergency	7.52	2.41	Submit refusal of treatment	7.73	2.20			
Medical record number	8.50	2.66	Charts and dental chart	7.73	1.75			
Lab Name	7.13	2.76	Intraoral images	8.38	2.05			
Person or insurer organization	7.21	2.83	Extra-oral images	7.90	2.02			
insurance type	7.70	2.56	Drug allergies	8.96	1.72			
insurance number	8.47	2.56						

[a] Standard deviation

3. Discussion

Heid et al. reported the required inputs in patient's files, which were identified as the main data elements, were as follows: the patient's identity Information, the therapist identity information, clinical observations, date of admission, prescribed medications, and the patient's immune status [9]. In this study, the demographic and identifying data with an average of 7.68, clinical data with an average of 8.22, and treatment plan data with an average of 7.99 were responded by individuals, therefore according to the statistics, registration of these data in dental EHR is required.In terms of required inputs in patients' EHR, periodontal status and legal consent at any level has been mentioned as the necessary entries in the patients' dental electronic records [10]. Also, such data are considered as the first priorities of information needs in EHR. In general, according to the results, with the exception of two elements of marital status and employment status in identity section, the rest of the elements in other sections were regarded as the first priority of the respondents and therefore, should be considered in the set of information needs related to dental health electronic records of Zahedan

Dental School. Meanwhile, it is suggested that in designing dental electronic record besides attention to a set of information needs, the knowledge of experts in this area should be used for design, implementation and use of electronic health records.

Table 2. Mean and standard deviation of information requirements: Treatment plan, Treatment measures, Follow up

Treatment plan			**Treatment measures**			**Follow up**		
	Mean	**SD**		**Mean**	**SD**		**Mean**	**SD**
Examinations	8.10	2.15	Prevention measures	8.04	1.91	Recommendations after discharge	8.38	2.09
Clinical Findings	9.03	1.08	Endodontic	7.86	2.09	Clinical Alert	7.36	2.91
Evaluation of paraclinical tests	8.15	1.98	Reconstructive	8.09	2.05	Next appointments arrangement	8.35	1.91
The final diagnosis	9.03	1.64	Prosthesis	7.90	1.81			
The proposed treatment plan	8.10	2.18	Disease and periodontal surgery	8.26	1.76			
Required time for treatment	7.61	2.21	Implant	7.87	1.58			
Measures taken	8.15	2.18	Orthodontic	7.47	2.01			
The number of ampoule used for numbness	7.26	2.56	Pediatric-related treatment	8	2.09			
Type of numbness techniques	7.50	2.53	Required X-rays	8.55	1.75			
Prophylactic medication	7.83	2.10	Tooth Extraction	8.13	2.02			
Instructions before and after treatment	8.10	2.27	Surgery	8.41	1.95			
Referral for counseling	8.07	1.97	Plaque Removal	7.36	2.45			
Referral to a specialist	7.43	2.21						
Referral Results	7.95	2.01						
Electronic Signature dentist	7.35	2.31						

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Exploring Oral Cancer Patients' Preference in Medical Decision Making and Quality of Life

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Abstract. Little is known about the clinical effects of shared medical decision making (SMDM) associated with quality of life about oral cancer? To understand patients who occurred potential cause of SMDM and extended to explore the interrelated components of quality of life for providing patients with potential adaptation of early assessment. All consenting patients completed the SMDM questionnaire and 36-Item Short Form (SF-36). Regression analyses were conducted to find predictors of quality of life among oral cancer patients. The proposed model predicted 57.4% of the variance in patients' SF-36 Mental Component scores. Patient mental component summary scores were associated with smoking habit (β=-0.3449, p=0.022), autonomy (β=-0.226, p=0.018) and Control preference (β=-0.388, p=0.007). The proposed model predicted 42.6% of the variance in patients' SF-36 Physical component scores. Patient physical component summary scores were associated with higher education (β=0.288, p=0.007), employment status (β=-0.225, p=0.033), involvement perceived (β=-0.606, P=0.011) and Risk communication (β=-0.558, p=0.019). Future research is necessary to determine whether oral cancer patients would benefit from early screening and intervention to address shared medical decision making.

Keywords. Shared Medical Decision Making (SMDM), SF-36,Oral Cancer

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Introduction

Evidence based patient involvement seems based on a strong liberal individualist interpretation of patient autonomy. [1, 2] Recently, many patients expressed their opinion and expect to participate in medical decision-making. [3, 4, 5, 6] In the present study, this trend reflects the more researchers participate in this topic: Cassileth et al. [7] survey of 256 of a university hospital cancer patients and found that the proportion of patients to participate in decision. Strull et al. [8] investigated three different clinics in 210 hypertensive patients in the decision-making role to play: doctors accounted for 78% of key decision makers. Mazur and Hickam [9] University Hospital is sampling 467 general outpatients and to investigate the "Who do you like to make a decision?" Was found willing to share decision-making accounted for 68.1%. Charles et al. [10] the literature review of the past authoritarian model, joint decision-making model, patients with different patterns, and further development of the medical decision-making model. This study was to understand patients who occurred potential cause of shared medical decision making and extended to explore the related factors of quality of life for providing patients with psychological adjustment of early assessment.

1. Methods

We conducted an observational cross-sectional study to examine the prevalence of SMDM among oral cancer patients and the association of SMDM with health related quality of life. In addition, we used the SMDM Questionnaire [11] to assess the current involvements of study participants, and SF-36 health-related quality of life. Figure1 shows the research framework. Responses were analyzed using descriptive statistics, univariate analysis of variance, Pearson correlation analysis and independent samples t-tests. Approval for the study was received from the institutional review boards at Chung Shan Medical University Hospital. Informed consent was obtained from participants prior to in-person interviews.

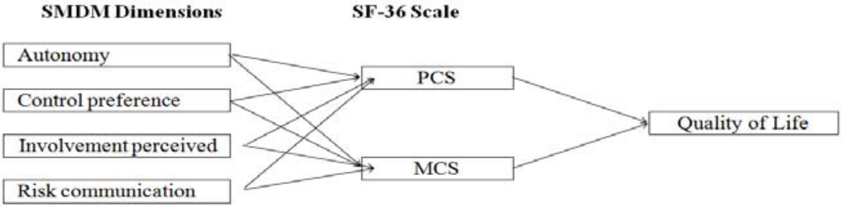

Figure 1. Conceptual Framework

2. Results

This study adopts a cross-sectional study design, from November 2014 to September 2015. Of the 64 invited participants, most respondents were married (90.5%), and graduated from college (31.7%). This analysis can be show that most of the patients were over 40 years of age. In Table 1, these variables explained 57.4% of the variability in the Mental Component summary scores of the SF-36 (R^2=0.574). In addition, using a linear regression model, we analyze the socio-demographic and medical-related variables correlated with the physical component summary (PCS) and mental component summary (MCS) in SF-36 for these patients. Further, we explored the relation between patients' psychological symptoms and Mental Component and Physical Component summary scores.

Table 1. Predictors of SF-36 Mental and Physical Component summary scores

	Mental Component Summary score (R Square = 57.4%)		**Physical Component Summary score (R Square = 42.6%)**	
	Beta	*p*	*Beta*	*p*
Older age	0.021	0.927	0.024	0.378
Sex	0.056	0.701	-0.012	0.832
Higher education	0.288	0.007*	-0.021	0.655
Employment status	-0.225	0.033*	-0.025	0.447
Smoking history	0.169	0.218	-0.344	0.022*
Alcohol consumption	-0.117	0.157	-0.192	0.471
Autonomy	-0.191	0.374	-0.226	0.018*
Control preference	0.143	0.580	-0.388	0.007*
Involvement perceived	-0.606	0.011*	0.404	0.388
Risk communication	-0.558	0.019*	-0.219	0.285

The proposed model predicted 57.4% of the variance in patients' SF-36 Mental Component scores. Patient mental component summary scores were associated with smoking habit (β=-0.3449, p=0.022), autonomy (β=-0.226, p=0.018) and Control preference (β=-0.388, p=0.007). In summation, the proposed model predicted 42.6% of the variance in patients' SF-36 Physical component scores. Patient physical component summary scores were associated with higher education (β=0.288, p=0.007), employment status (β=-0.225, p=0.033), involvement perceived (β=-0.606, p=0.011) and Risk communication (β=-0.558, p=0.019).The patients' health-related quality of life, as measured by the SF-36, is presented in Table 2.The average of the Physical Componentis less than normal on Taiwan's average can be found from the average in all areas and most are very different from U.S. standards. Also in the gender and age-adjusted norm in Taiwan compared to the results of the analysis showed that age and gender will affect the role-playing were limited, and the development of social function, as well as mental health part.

Table 2. Health-related quality of life outcomes

Domains of SF-36	**U.S. Norms**	**Mean (SD)**	**Taiwan Norms**
Physical Function	90.24	67.3(22.3)	89.50
Role Limitations-Physical	83.65	33.7(31.4)	89.21
Bodily Pain	84.84	58.3(12.7)	80.24
General Health	69.25	56.5(24.6)	70.22
Vitality	68.27	45.7(19.1)	60.64
Social Function	86.81	54.4(17.4)	85.15
RoleLimitations-Emotional	79.40	38.6(32.8)	88.63
Mental Health	73.01	56.9(17.0)	74.27
Physical Component	52.00	48.7(30.4)	51.85
Mental Component	50.00	57.5(15.5)	51.55

3. Discussions

For oral cancer patients, providing the necessary information, in an easily accessible way, in enabling patients to understand related treatment, thereby reducing anxiety, improving knowledge, and supporting involvement in SMDM. Other benefits of patient education include improved adherence to treatment regimens, better alignment of care with patients' goals and values, and transition to self-management. Indeed, education and support in the medical decision-making process can be provided by physician's aids and elicit patients' values regarding these choices. To our knowledge, this is the first study to investigate the individualregarding quality of life using the SF-36 and SMDMQ for oral cancer patients. The goal of this project is to afford the patient the opportunity to have a reasonable quality of life and to providing thechance for a cure in the future. The main limitation of the current study is the sample size, which increases the type II error risk. Future research is necessary to determine whether oral cancer patients would benefit from early screening and intervention to address shared decision making.

Conflict of Interest

The authors declare that there is no conflict of interests.

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Big Data, Big Problems: A Healthcare Perspective

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Abstract. Much has been written on the benefits of big data for healthcare such as improving patient outcomes, public health surveillance, and healthcare policy decisions. Over the past five years, Big Data, and the data sciences field in general, has been hyped as the "Holy Grail" for the healthcare industry promising a more efficient healthcare system with the promise of improved healthcare outcomes. However, more recently, healthcare researchers are exposing the potential and harmful effects Big Data can have on patient care associating it with increased medical costs, patient mortality, and misguided decision making by clinicians and healthcare policy makers. In this paper, we review the current Big Data trends with a specific focus on the inadvertent negative impacts that Big Data could have on healthcare, in general, and specifically, as it relates to patient and clinical care. Our study results show that although Big Data is built up to be as a the "Holy Grail" for healthcare, small data techniques using traditional statistical methods are, in many cases, more accurate and can lead to more improved healthcare outcomes than Big Data methods. In sum, Big Data for healthcare may cause more problems for the healthcare industry than solutions, and in short, when it comes to the use of data in healthcare, "size isn't everything."

Keywords. Big Data, Healthcare, Challenges, Opportunities, Costs.

Introduction

Over the past five years, Big Data has been used as a buzzword promising to revolutionize everything from business to sports to healthcare. Although, in 1997 NASA scientists were first to use the term "Big Data", there exists no standard definition for the term [1]. In keeping up with the advancement of technology, the large amount of information being produced, and the multiple definitions for the term Big Data, Barder and Stuart developed a comprehensive and modern definition for Big Data where they define it as: "a term describing the storage and analysis of large and or complex data sets using a series of techniques including, but not limited to: NoSQL, MapReduce and machine learning" [2].

In healthcare, Big Data is a popular term used to improve patient outcomes and delivery of care. Much has been said about how Big Data will revolutionize the healthcare industry, and yet, with every fad, there are those that are on the Big Data

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bandwagon, while other scientists are questioning its actual impact on clinicians, patients, and the overall quality and cost of care. The purpose of this paper, is to provide insight about the possible pitfalls and dangers around the use of Big Data concepts within the healthcare industry. The result of this work will provide a more somber perspective to the current research around Big Data in healthcare.

1. Methods

The methods used for identifying papers relating to the negative impacts of Big Data on healthcare stemmed from three sources: Pubmed (1966-2016), Google Scholar, and the World Wide Web (e.g, blogs and news and magazine articles). The search strategy used the following key terms: “big data”, “health care”, “challenges” and “problems”, as main subject headings or text words in titles and abstracts. References from retrieved literature were also searched and relevant papers were retrieved for further analysis. Thematic analysis was conducted on the retrieved papers searching for the negative experiences relating to the use of Big Data in healthcare. Each article was retrieved, read, and searched for negative results in using Big data in healthcare. Any relevant information was retrieved from the article and placed in a word document, then analyzed, and relevant themes were identified.

2. Results

A total of six relevant themes were identified relating to the negative impacts and caveats of using big data in healthcare.

2.1. Big Data Failure

Google Flu Trends [3] was thought to be the most successful Big Data project because it was accurately predicting influenza related visits ahead of the Centre for Disease Control (CDS), which used traditional statistical models and approaches [3]. However, Google Flu trends began overstating the number influenza related physician visits by a factor of 2 in 2013 [3], leading to its demise in 2015. One explanation is that the prediction of increasing visits disseminated through Google and news outlets led to more searches on Influenza, which led to the increase in the number of visits predicted by Google trends [3]. Kugler notes that “Google researchers placed too much faith in Big Data, rather than partnering Big Data with traditional data collection and analysis” [3].

2.2. Understanding Context

Neff reports that when physicians were asked about Big Data use, one physician stated that “I don’t need more data, I need more resources” [4]. Also, understanding the healthcare in terms context rather than just numbers and text is also a hurdle for Big Data implementation. Neff reports: “a computer usually looks at one small aspect of the patient's problem but doesn't get the context. An expert doctor can understand the huge picture of what's going on with a patient. People in the different social worlds of health care…all think of data differently and do (or hope to do) varying work with that data" [4].

2.3. Medication Errors and Threats to Patient Safety

There are challenges that have been identified with the use of big data which can be harmful to patients leading to the possibility of increased medication errors and patient mortality. Wang and Kirshnan [5] discuss the challenges and limitations in the use of clinical big data. In their review, the authors conclude that Big Data modelling can "lead to biased statistical correlation or inference, sometimes known as false discovery. Clinical big data users face a large spectrum of challenges, including, but not limited to sample size, selection bias, interpretation problem, missing values, dependence problems, and data handling methodology". In their work, Frakt and Pizer study the promise and peril of big data in health care and note that "if we're not careful, big data in healthcare could cause harm" [6]. The authors also note that Big data at times can provide meaningless correlations. For example, they note that for every five million packages of x-ray contrast media provided to different healthcare facilities, almost six patients die from adverse events. When analyzing the data using big data techniques, the results show that "such deaths are highly correlated with electrical engineering doctorates awarded, precipitation in Nebraska, and per capita mozzarella cheese consumption, respectively [6].

2.4. Protecting Privacy

One major issue that was identified in the literature is the protection of individual data. Vayena, Salathe, Madoff, and Brownstein, discuss some of the ethical challenges of Big Data for its use in Public Health [7]. The authors discuss some of their privacy concerns relating to Big Data as: "They span a wide spectrum, ranging from risks to individual rights, such as privacy and concerns about autonomy, to individuals' obligations to contribute to the common good and the demands of transparency and trust" [7]. Neff notes that "If data from just a few pieces of less-protected demographic information can re-identify someone, imagine what adding genetic information or disease conditions could mean for privacy risks in large-scale shared and pooled data [4].

2.5. Healthcare Data Quality and Interoperability

Another major stumbling block for Big Data are issues relating to data quality and interoperability. Sukumar, Natarajan and Ferrel note that data quality is questionable within healthcare, compared to other industries, which can undermine the the use of Big Data in healthcare [8]. Another major issue that is often overlooked when discussing Big Data is the need for capturing all the points of interaction between the patient and the healthcare system. In the United States, Canada, and much of the world, there is a limited number of operational national health information exchanges [9]. However, there are movements towards increased information exchange that would allow Big Data systems to access all the data relating to one patient or patient group.

2.6. Research and Establishing Evidence

Another issue is that Big Data techniques have an observational nature in which no causality can be established, as confounding variables cannot be averted. Since Big Data is composed of heterogeneous and very diverse data, even if it was generated from one institution, baseline characteristics of patients cannot be controlled. Therefore, generalizability of Big Data results is questionable [10,11].

3. Discussion and Conclusion

Our study provided insights into the "dark side" of using Big Data in healthcare. Although we do not totally discount the potential beneficial impacts that Big Data can have in healthcare, we believe that healthcare may not be ready for Big Data implementation due to a variety of reasons ranging from a lack of interest from physicians, a healthcare culture not accustomed to using data, threats to patient safety, healthcare data quality issues, privacy related issues, and Big Data failures.

There are a few limitations in the study that are worth mentioning. First, a clear bias of this research was to search for negative results relating to the use of Big Data in healthcare. This is mitigated by other literature sources not included in this study that exclusively focus on the benefits and virtues of big data for healthcare. Furthermore, the results of this data are not generalizable to areas outside of healthcare. Also, many sources were missed and could not be included in the study. Future studies should examine the possible benefits of Big Data for healthcare by providing more research evidence on the impacts Big Data can have on overall patient care.

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Decisional Conflict in Work-Related Hand Trauma Patients

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Abstract. Often, clinical decision making of reconstructive procedure is coupled and their concurrent resolution by interacting stakeholders is required. This study was to give new insight into the tradeoff method to elicit the utility function first and then the probability weighting function, to determine if and how stakeholder engagement can contribute to managing decisional conflict processes. The proposed methodology is illustrated through three subjects (physician, patient and family member). We found that significant evidence of probability weighting both at the aggregate level and at the individual subject level. The pattern of probability weights is consistent with an inverse shaped probability weighting function: Small probabilities are overweighed and intermediate and large probabilities are underweight. In addition, the degree of upper subadditivity exceeds the degree of lower subadditivity. Finally, the proposed procedure can reduce clinical risk by considering stakeholders' behavior attribute and providing physicians the effective support need for quality decision making.

Keywords. Decision Conflict, Work-related Hand Trauma, Stakeholder

Introduction

Making a decision is one of the most critical events encountered by patients with work-

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related hand trauma who want to address their unmet needs through different treatment regimens or programs. [1] This is especially important given the fact that evidence-based medicine fails to identify one treatment as clearly superior because each of the alternatives is associated with benefits and risks. [2] Decisional conflict is the uncertainty about which course of action to take when choice among competing options involves risk, loss, regret, or challenge of personal life values. [3] However, very few studies have investigated the process and outcomes of decision conflict for work-related hand trauma patients. It is common that patients, families and physicians must make decisions throughout the course of the work-related hand trauma. For example, the difficulty of the decision dilemma can be complicated by variables associated with the specifics of the choice situation. [4] In order to consider the stakeholder's attitudes towards risk and to reach a preferred treatment, this study was to give new insight into the trade-off method to determine if and how stakeholder engagement can contribute to improved decisional conflict.

1. Methods

In order to consider the stakeholder's attitudes towards risk and to reach a preferred treatment, the two-stage elicitation procedure was used for prioritization. First, we elicited the utility function for nine treatment scenarios and then used as inputs in the second stage to elicit the probability weights. In this study, we apply Abdellaoui's [5] the trade-off method to elicit the utility function and the probability weighting function. The trade-off method determines a standard sequence of outcomes, which are equally spaced in terms of utility. The first step consists of the selection of two reference outcomes R and r with $R \succ r$ and a starting outcomex_0. Then each subject is asked to specify x_1 such that he is indifferent between [*p, R; 1-p,*x_0] and [*p, r; 1-p,*x_1], with $R \succ x_0$ and $r \succ x_1$ to ensure that the two choices are comonotonic. [6-8] After x_1 has been elicited, the individual is asked to specify the number x_2 such that he is indifferent between [*p, R; 1-p,*x_1] and [*p, r; 1-p,*x_2]. If $r \succ x_2$ and rank-dependent expected utility theory holds, then the first indifference yields

$$[p,R;1-p,x_0] \sim [p,r;1-p,x_1] \Leftrightarrow w(p)u(R)+[1-w(p)]u(x_0)=w(p)u(R)+[1-w(p)]u(x_1) \quad (1)$$

$$\Leftrightarrow w(p)[u(R)-u(r)=[1-w(p)[u(x_1)-u(x_0)]$$

it similarly, the second indifference yields

$$[p,R;1-p,x_1] \sim [p,r;1-p,x_2]=[1-w(p)[u(x_2)-u(x_1)] \qquad (2)$$

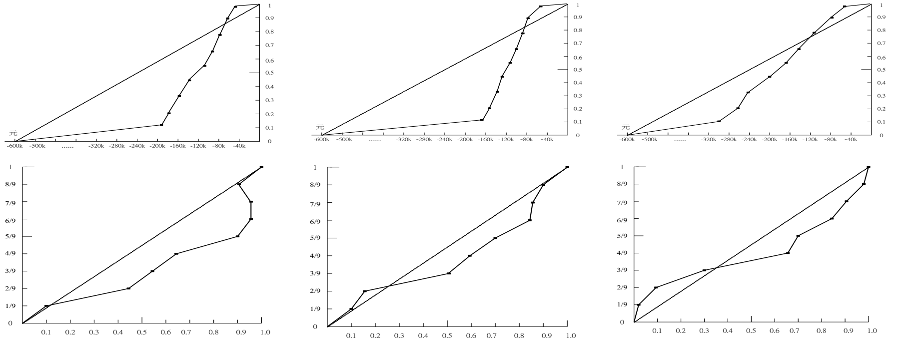
Combining (1) and (2) gives$\mathrm{u}(x_2)-\mathrm{u}(x_1)=\mathrm{u}(x_1)-\mathrm{u}(x_0)$.Given the uniqueness properties of the utility function *u*, the scale and the origin of the function can be chosen arbitrarily. [9] We used the scaling $u(x_0)=0$ and $u(x_k)=1$, from which it follows that for all 1 less than or equal to j less than or equal to k :$u(x_j)=j/k$. The probability p was held constant throughout the elicitation of the standard sequence. This ensured that the elicited utilities were not distorted by probability weighting. Equations (1) and (2) show that the terms *w(p)* and *1-w(p)* cancel out if p is held constant. As mentioned above, Abdellaoui [5] used the trade-off method to elicit first the utility function and then the probability weighting function with the elicited utilities as inputs. Under rank-dependent expected utility theory and the chosen scaling, this indifference determine the weight of probability p'as$w(p')=j/k$. Over the two stages, five questions were asked to elicit the shape of the utility function and the probability weight function. Further, this study adopted the questionnaires of decisional conflict, which have nine scenarios, for risk assessment. Each treatment scenario included a set of questions that were designed to elucidate stakeholder opinions and concerns. Each question consisted of an outright choice between two prospects. All the assessed quantities, outcomes, and probabilities were obtained through a series of choice questions. The applicability of the proposed methodology is illustrated through three subjects (physician, patient and family member). For stakeholder's perspective, data was aggregated at the individual analysis, depending on the utility and the probability weight function.

2. Results

Based on the result of assessing x_i and p_i, the utility functions and probability functions were elicited for three subjects. Figure 1 displays the result of the utility functions and probability functions.

Table 1. The results of the utility and probability weight and SEU

Scenarios	Physician			Patient			Family member		
	Utility	Probability	SEU	Utility	Probability	SEU	Utility	Probability	SEU
1	0.98	0.12	0.1176	0.98	0.17	0.1666	0.98	0.24	0.2352
2	0.88	0.06	0.0528	0.76	0.06	0.0456	0.89	0.16	0.1424
3	0.11	0.06	0.0063	0.13	0.06	0.0078	0.45	0.16	0.0720
4	0.99	0.39	0.3861	0.99	0.45	0.4455	0.99	0.42	0.4158
5	0.96	0.17	0.1632	0.92	0.27	0.2484	0.95	0.33	0.3135
6	0.66	0.21	0.1386	0.61	0.30	0.1830	0.83	0.36	0.2988
7	0.02	0.17	0.0034	0.02	0.27	0.0054	0.03	0.33	0.0099
8	0.03	0.14	0.0042	0.04	0.24	0.0096	0.05	0.28	0.0014
9	0.06	0.13	0.0078	0.13	0.21	0.0273	0.11	0.25	0.0275



(a)Physician (b)Patient (c)Family member

Figure 1. The utility functions and probability functions of three subjects

In order to verify the data on reliability, we used the χ^2 test: *p*-value=0.22 in first experimental session and p-value=0.09 in a second experimental session. It shows the indifference. According to the expected loss value of experiment estimates, we can obtain the $u(x_i)$, $w(p_i)$ and SEU (Subjective Expected Utility). Figure 1 displays the inverse *y* axle from *x* axle by use the equidistant projection. Table 1 shows the partial result of the utility, probability weight and SEU for patient case. The chi square test for independence showed no difference between individual. We found that significant evidence of probability weights is consistent with an inverse S-shaped probability weighting function: small probabilities are overweighed and intermediate and large probabilities are underweighted.

3. Discussions

According to the review of the related risk experiences, it can know the potential incident well by investigating into the risk cognition of stakeholders more in detail. Based on the result of this study, we found that the risk measurement of the proposed model be able to elicit the real risk attitude of each stakeholder will be helpful in managing the clinical decisional conflict. The proposed procedure can reduce clinical risk about by considering stakeholders' decision positions and behavior attribute and providing physicians the effective support need for quality decision making. This study used the real clinical case collected from the Chung Shan Medical University Hospital. Using the proposed methodology to deal with different scenarios is one of our future research topics. It not only can realize the more accurate potential risk incident by utilizing the non-parameter method, but also achieve the purpose of shift risk and control losses.

Conflict of Interest

The authors declare that there is no conflict of interests.

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Evaluation of an Integrated Health Information System (HIS) in a Public Hospital in Cyprus: A Pilot Study

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Abstract. Health information systems can improve the quality of services in healthcare. Evaluation of health information systems in hospitals is a very complex process, and it is more effective when different aspects are considered. The present work aims to develop an evaluation framework of an integrated HIS in order to improve the quality of healthcare services provided in Cyprus. Qualitative and quantitative methods were used, that measured three aspects of the system: technology, human factor and organization. Preliminary results showed that while participants seem to agree with the potential benefits of the integrated HIS, safety of data within the HIS is seen as a problem. Qualitatively, the study pointed to 3 factors that might improve the current integrated HIS: increasing interdisciplinary cooperation, training of staff, and upgrading the infrastructure. Further studies will provide a comprehensive picture for Cyprus, so that appropriate measures can be proposed and put in action.

Keywords. Health Information Systems, Evaluation Framework, Cyprus

Introduction

Health Information Systems (HIS) are used to process, gather and share information within the organization with the scope to improve management, reduce errors and support healthcare professionals [1], thereby providing more efficient and effective delivery and quality of health services [2-5]. HIS incorporates an umbrella of subsystems including international classification of diseases, patient administration, electronic health records and radiology, etc. [6]. The efficiency or effectiveness of the subsystems might be affected by sociological, cultural and financial factors, leading to the failure of the system partly or as a whole [7], with significant financial implications, and resulting in decreased provision of healthcare to patients [8]. Demand for safe, efficient and effective health care, as well as, the cost-effectiveness is now a challenge for every healthcare organization [9,10], and therefore not only implementation of HIS is of utmost importance, but their proper operation and continuous evaluation is mandatory.

Evaluation of HIS is a very complex process, and more holistic approaches include a combination of different elements, such as the human factor, technology and

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organization [4, 9-12], which result in a more effective appraisal. In Cyprus, there are only two public hospitals using integrated HIS, but no evaluation has ever been done, except for an assessment to ensure the safety and effectiveness of medical devices [12].

The objective of the present work is the development of an evaluation framework of the integrated HIS in Cyprus, having as a final goal the improvement of the quality of healthcare services provided. The framework includes the following factors: technology (examining the quality of information, system quality and safety), human factor (regarding the acceptance and usability of the system), and organization (relating to the structure and environment of the HIS) (Figure 1).

Figure 1. Evaluation framework

1. Methods

The target population of the present pilot study works in one of the public hospitals in Cyprus that use the integrated HIS [12]. Participants in the present study fulfilled the following criteria: 1) worked in a hospitaland usedintegrated HIS and 2) is a Doctor, a Nurse or other allied health professional, and 3) worked directly with patients.

Both qualitative and quantitative methods were applied, with a tool/questionnaire adapted from Ochieng et al. [13] and Viitanen et al. [14]. The questionnaire consisted of 43 questions using the Likert scale (Cronbach –A= 0.862), and 3 open questions, evaluating all aspects of the system, namely, technology, human factor and organization. The questionnaire was translated to the Greek language through bilingual translation in both directions.

Permission to conduct the research was obtained from the Cyprus National Bioethics Committee, the Office of the Commissioner for Personal Data Protection, and the Ministry of Health. Throughout the study, anonymity and confidentiality of the data of participants werestrictly maintained.

2. Results

Twenty individuals (25% male and 75% female) working at the Nicosia General Hospital participated in the pilot study. Nurses comprised the majority of the participants (70%), followed by doctors (25%) and other health professionals (5%). The age distribution (in years) of the participants varied between 30 to 39 (50%), less than 30 (25%), 40-49 (20%) and more than 50 (5%). Regarding years of working experience, only about 15% of the participants had less than one year, between 1-5 years (30%), more than 10 years (30%), 5-10 years (25%).

Questions measured the following aspects of the system: acceptance, usage, quality of information, system quality, safety, structure and environment, using the Likert scale, and the data was presented as mean percentage of the total sum of scores within the categories divided by the number of the questions.

Our preliminary results showed that while participants seem to agree with the potential benefits of the integrated HIS, the item safety, under the umbrella of technology, received very low scores. 45% of the participants stated that the system was not reliable and stable, and that information data disappeared (35%). Items within organization and human factors showed a relatively positive outcome, although 95% of the participants complained of system problems and crashes. Table 1 presents the mean in percentage for each of the factors evaluated.

Table 1. Mean percentage of the total sum of scores for each factor.

Factors	Mean (%)
Acceptance	70.6
Usage	72.6
Quality of Information	76.7
System Quality	74.2
Safety	36.5
Structure	75.4
Environment	70.4

In the qualitative part of the study, emphasis was put on the need of “better cooperation between healthcare professionals”, “healthcare professionals requiring more training on integrated HIS” and “the need forupgrading the integrated HIS”.

3. Discussion and Conclusions

The present pilot study represents the first ever study conducted in Cyprus towards the development of a comprehensive evaluation framework of the integrated HIS.

Preliminary results agreed those reported on a national research in Finland [14] and Japan [13], with the exception of the safety factor. Under the umbrella of technology, this latter factor could be influenced by the current infrastructure or even by the user itself.

The qualitative part of the study pointed to 3 factors that might help improvethe system: a) the need for training of healthcare professionals on the use of integrated HIS [1]. According to several studies [2,11,15], training of healthcare professionals is a key and crucial factor for a successful HIS; b) The need for better cooperation and communication between stakeholders [11,15-17], and c) the need for technical upgrading of the integrated HIS, which impacts on the quality of services provided [18].

4. Limitations and Future Work

As a pilot study, the sample is very limited and does not represent the overall population utilizing the integrated HIS at the hospitals in Cyprus. Further examination will take place within the context of the project, that should clarify which parameters can be improved, and to which extent, so that the appropriate strategies and solutions can be developed and put to action.

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GIS Mapping and Monitoring of Health Problems Among the Elderly

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Abstract. The electronic survey in conjunction with GIS in the current study aims at presenting the needs and health problems of the elderly in individual Open Elderly Care Centres in Greece. The online GIS survey enables the continuous monitoring and developing of the health problems of the elderly and helps them in their early care by the healthcare units. GIS survey123 is a customizable tool, which can be used to conduct research that is then published on an Android, iOS, and web platform. The ArcGIS software was used for the geographic mapping of data collected from a wide range of sources, so that health care professionals can investigate the factors associated with the onset of the diseases. Also, direct geographic mapping aims at identifying health problems of the elderly in Greece and transferring information to health care professionals in order to impose proper control measures in a very small period of time.

Keywords. Geographic Information Systems, electronic survey, open care centres

Introduction

The aim of this study is to investigate the health problems of the elderly in Greece. In order to achieve our goal, an online questionnaire has been designed with the survey123 of ArcGIS software. Similar researches have been carried out in Europe and elsewhere [1-3]. In Europe, a long term research is carried out having the title Survey on Health, Ageing and Retirement in Europe (SHARE), the first results of which were published during 2005 [4]. SHARE started with eleven countries across Europe, but gradually the number of countries included in the survey, exceeded sixteen countries. Similar surveys are Health and Retirement Study (HRS) in the U.S.A. and Longitudinal Study of Ageing (ELSA) in the United Kingdom [5,6]. Moreover, surveys similar to the HRS are carried out in Russian Federation and other Asiatic and African countries [7]. According to Carone and Costello [6], the significance of such surveys lies in the fact that they could affect the economic policy of the European Union, since the

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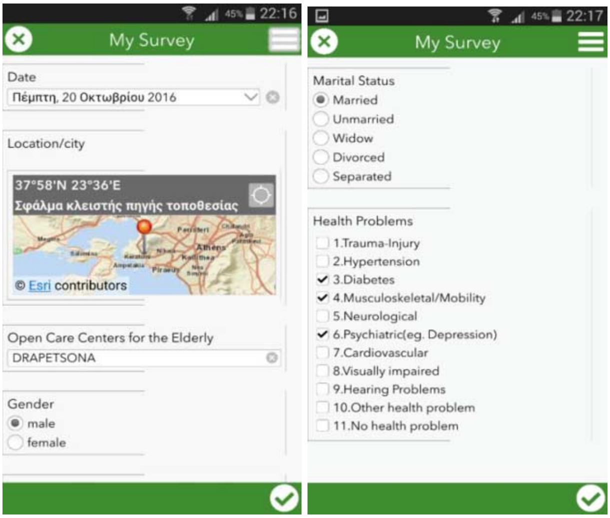
provided data could be used for important reforms concerning sustainable pension systems. Such surveys could also be used to understand the uncertainty of economic and demographic changes and could provide a valuable tool to assess the quality of life and health of elderly and how they affected by several social and economic factors.

The GIS survey123 is a more useful and customizable tool, which can be used to conduct research that is then published on an Android, iOS, and web platform. Data are stored in the esri cloud providing to the health care providers to directly process the results, since it is possible to analyse the results using graphical and mapped analyses. Information is then linked to the geographic location of the respondent and thus can relate the health problems of the elderly with local and social factors [1,3].

1. Methods

Survey123 of ArcGIS software was used in conjunction with a proper questionnaire (see Figure 1), which consists of 4 sections with 27 questions in total. The first section refers to the demographic characteristics of the respondents. The second section explores the relationships between the elderly and their families. The third section explores health care and finally in the fourth section the emotional and economic problems of the elderly are investigated [5]. Data were collected from 4 Open Elderly Care Centres of the Municipalities of Keratsini-Drapetsona, Galatsi, Neo Heraklion of Attica and Rhodes. A total of 294 questionnaires were answered at these Open Elderly Care Centers. Statistical data were then processed using the SPSS statistical software and the survey123. The ArcGIS software was used for the geographic mapping of data [4]. Regarding the gender distribution of the participants, 43.3% of them were men and 56.7% of them were women. Generally the age group of 70-80 years represents the relative majority of the participants with a percentage of 40.8%.



Date
Πέμπτη, 20 Οκτωβρίου 2016

Location/city
37°58'N 23°36'E
Σφάλμα κλειστής πηγής τοποθεσίας

Open Care Centers for the Elderly
DRAPETSONA

Gender
● male
○ female

Marital Status
● Married
○ Unmarried
○ Widow
○ Divorced
○ Separated

Health Problems
☐ 1.Trauma-Injury
☐ 2.Hypertension
☑ 3.Diabetes
☑ 4.Musculoskeletal/Mobility
☐ 5.Neurological
☑ 6.Psychiatric(eg. Depression)
☐ 7.Cardiovascular
☐ 8.Visually impaired
☐ 9.Hearing Problems
☐ 10.Other health problem
☐ 11.No health problem

Figure 1. Survey123 screen shots.

2. Results

Interactive maps and graphs have been created illustrating the health problems by geographic location of the respondents shown in Table 1 and Figure 2. The results of the research and statistical data will be processed and presented after the completed statistical analysis of the rest 603 questionnaires that were distributed in Greece (and not only at the above mentioned Open Care Centres for the Elderly). The most common health problems are hypertension with 94 cases, diabetes with 79 cases, vision problems with 76 cases, and cardiovascular problems with 72 cases, followed by musculoskeletal / mobility disabilities with 66 cases, other healthy problems with 61 cases, hearing problems with 54 cases, trauma – injuries with 42 cases, psychiatric problems with 27 cases, and finally, neurological problems with 26 cases.

Table1. Health problems sorted by research area.

	Region				TOTAL	%
	Rhodes	Neo Iraklio Attica	Galatsi Attica	Drapetsona		
Trauma-Injury	8	14	15	5	42	3,03
Hypertension	15	28	36	15	94	31,97
Diabetes	14	30	23	12	79	26,87
Musculoskeletal / Mobility	14	16	28	8	66	22,44
Neurological	2	13	4	7	26	8,84
Psychiatric (eg. depression)	2	6	9	10	27	9,18
Cardiovascular	5	17	32	18	72	24,48
Vision problems	9	21	30	16	76	25,85
Hearing problems	8	9	24	13	54	18,36
Other health problems	3	3	46	9	61	20,74
No health problem	5	4	16	7	32	10,88
Total	85	161	263	120	629	
Participants per region	53	61	116	64	294	
Positive answers per participant	1,60	2,64	2,27	1,88		

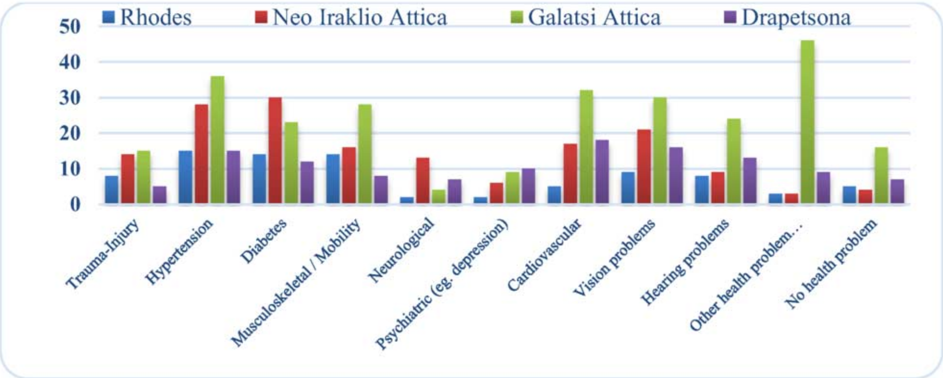


Figure 2. Health Problems sorted by research area.

3. Discussion and Conclusion

GIS in conjunction with an online survey can help researchers to obtain an immediate focus on capturing the health problems of members of Open Care Centres for the Elderly and presenting them online according to their geographic location. Researchers will be facilitated by the portability of the online tablet and smartphone questionnaire to collect dissimilar data from a wide range of sources, store them and obtain immediate results to monitor and focus on the reasons that may be related to the transmission of a disease. GIS has helped the health care industry to manage resources and personnel as well as helped other consumer service enterprises. Given that the role of GIS will have greater importance due to its abilities to integrate a wide range of data sources and to make complex data more quickly and easily understood, the use of GIS for business function--marketing, sales, and facility and materials management will continue to grow. Thus, creating a means to illustrate socio-economic indicators that affect the health of the elderly, according to their geographical position, will provide health service providers a key instrument to make informed decisions in managing and resolving the problems faced by the elderly.

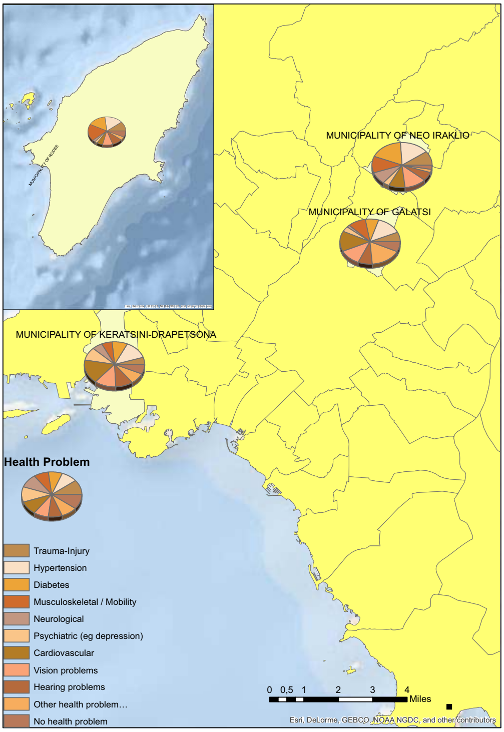


Figure 3. Map of Health Problems

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Geographic Mapping of Use and Knowledge of the Existence of Projects or ICT-Based Devices in Dementia Care

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Abstract. The purpose of this study is to investigate the knowledge and use of Information and Communication Technologies (ICT) from community-based patients, while the results were visualized on maps by using Geographic Information Systems (GIS). Of the 779 participants, 37.4% of the patients responded that they were aware of the availability of ICTs available for dementia, with only 9.2% responding that they were using individual devices. It was apparent that 94.7% of those with a university education had knowledge of ICT and 47.4% of them did use, unlike patients with lower levels of education. In conclusion, based on a small sample of the Greek population, the knowledge and use of ICTs is still on a limited scale and mainly concerns patients with high socio-economic status.

Keywords. Dementia Care, Information and Communications Technology, Geographic Information Systems.

Introduction

Caring for someone with dementia can be a complex task. Some consequences of the disease symptoms can prove to be dangerous for the safety of patients and the whole family: delusions, hallucinations, impaired visuospatial perception, reduction or complete loss of smell, reduced sense of touch, hearing impaired, limited crisis capacity and appropriate reaction to extraordinary circumstances, memory problems, disorientation and wandering, abnormal gait and balance, affect of environmental hazards, orthostatic hypotension and risk of falls [1,2]. ICT-based devices have proven to contribute to the creation of appropriate individualized Ambient Assisted Living in which the elderly can live comfortably, safety and health, by extending their living in the community and optimizing the quality of life of the same and his family [3,4]. Moreover, their widespread deployment and implementation is estimated to lead to cost

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containment by states, since effective patient management and retention in the community will reduce the cost of medical and nursing care, and delay or prevent their entry into nursing homes [5]. ICTs can include telemedicine services, smart home, smoke-water detectors, night motion detectors, fall detectors, geo-fence, voice warning, mobile tracking devices, drug reminder devices or reminder devices of other daily activities, cognitive stimulation devices, etc [6-9]. Of course, the use of technology in dementia, is not only confined to patient management and safety, but also extends to the development of maps depicting geocodified health data, where clinical and administrative information can be disseminated with visually and geographically, easily understood. The enormous potential of GIS seems to play a crucial role in determining where and when to intervene in improving quality of care, increasing accessibility of services, meeting not only users, but also the needs of the research community [10]. The purpose of this study is to investigate the knowledge and use of ICTs in the care and management of dementia, in patients with dementia in a Greek population. Research questions that were defined: (1) what is the relationship of patients with ICTs and how to adopt them? (2) How is ICT knowledge and use determined on the basis of demographic characteristics, such as educational level and financial status? (3) what were the differences in the above questions in different geographic areas?

1. Methods

The present study is a part of a cross-sectional study was conducted from 2014 to 2016 and from which the data originated. The initial study was designed to examine demographic, social, economic and medical, factors, in general the profile of dementia patients living in the community and using secondary care services. We used a simple questionnaire of demographic, social, economic and clinical data, supplemented by questions related to the "knowledge" and "use" of ICT. The sample of the survey, consisted of patients aged 61 years and over, was collected by external neurological clinics of four public hospitals in the 6th Health Region. For the statistical processing of the data, the SPSS ver. 21.0 (Statistical Package for Social Sciences) was used. The ArcGIS software has been used for the spatial visualization of the results and correlations in geographic maps.

2. Results

The study included 779 participants with a mean age of 77.7 years, with dementia diagnosis, from Pyrgos, Kalamata, Tripolis and Patras General Hospitals, from rural (30.3%) and urban areas (57%). The majority of patients were female (58.8%). High and higher education had only 2.1% and 2.4% of patients, respectively. In addition, the majority of patient, 42.2%, had an annual personal income of between 6.000 and 12.000 Euros. According to the results, 37.4% of the patients responded that they were aware of the existence of ICTs that are available for dementia, whereas only 9.2% of patients replied that they were using individual devices, smoke - water detection devices, GPS tracking devices, and fall detection devices (fig. 1).

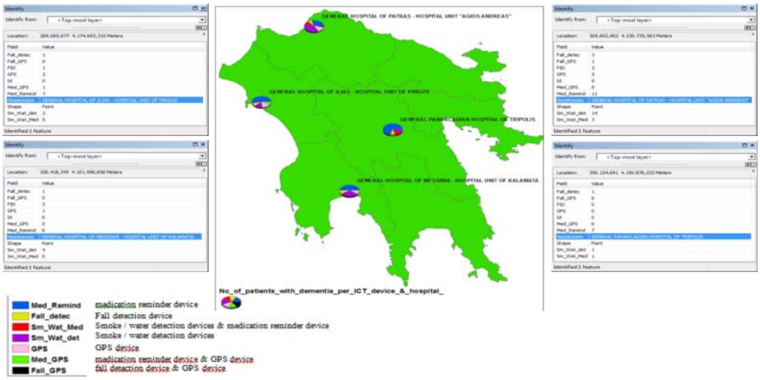

Figure 1. Number of patients with dementia by type of device (ICT) and per hospital

Investigating the profile of patients with knowledge and used ICTs, the following were exacerbated: in all patients with no education, only 9.9% had knowledge, and only 0.8% did use ICTs, in all patients with basic education (elementary school) 20.8% had knowledge, and only 1.5% did use ICTs. Among patients with secondary education (high school), 60% had knowledge and 16% were using ICTs, whereas patients with the higher education, 94.7% had knowledge and 47.4% used individual ICT devices. For each hospital separately: 27.7% of the patients from the General Hospital of Pyrgos, 23.2% from the General Hospital of Kalamata, 24.2% from the General Hospital of Tripoli and 48.9% from the General Hospital of Patras, were aware of the existence of pilot programs. For each hospital separately: 11.6% of the patients from the General Hospital of Pyrgos, 8.5% from the General Hospital of Kalamata, 8.3% from the General Hospital of Tripoli and 9.1% from the General Hospital of Patras, used individual devices.

3. Discussion

Our analysis showed that the use of ICTs has a very small share in dementia care. Older patients, but also their carers, most of whom are also elderly (spouses / companions), are obviously not familiar with technology [11]. Previous studies, on the contrary, have shown that people with mild to moderate dementia are able to handle simple electronic devices and can benefit [12]. A second reason for not adopting technology is, the privacy concerns. Studies have shown that elderly persons and their caregivers are receptive, with some concerns about violation of privacy, to the use of technology to monitor the elderly in their homes [13]. According to our results, the high level of education and high income were related to the knowledge of the existence of pilot programs and individual ICT devices, but also by their use, to facilitate the daily life and autonomy of patients with dementia and to promote their safety. This is confirmed by other studies [14]. The lack of information, financial resources but also moral dilemmas about the use of ICTs is likely to contribute to their limited dissemination, something that should act as an incentive for policy makers, as health and social care systems will be confronted with ever-increasing costs for the care of chronic patients, in an aging population.

4. Conclusions

In a sample of Greek population, it seems that knowledge and use of ICT is still on a limited scale, and mainly concerns patients with a high level of education. The relationship between the educational level and the knowledge and use of ICT appeared to be directly proportional, where the patients, with highest and upper levels of education, showed the highest rates. Correspondingly, the relationship between the financial status and the knowledge and use of ICTs also appeared to be directly proportional, where the patients with highest income levels showed the highest rates. The finding that socioeconomic status and dementia affects the use of devices by the elderly suggests the importance of keeping costs low and designing devices that are easy to use.

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The Artificial Pancreas: Reducing Safety Risk via Intra-Peritoneal Insulin Delivery

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Abstract. The Artificial Pancreas is a medical device, currently in development, that aims to provide automatic regulation of blood glucose (BG) levels in ambulatory type 1 diabetes mellitus sufferers. The most popular approach utilises subcutaneous (SC) continuous glucose monitoring (CGM) combined with SC insulin injection controlled by a Model Predictive Control (MPC) algorithm. From a safety risk perspective problematic elements include the performance robustness of the CGM and the need for a pre-meal insulin bolus to provide satisfactory post prandial BG regulation. This contribution presents preliminary in silico studies which indicate that the use of an alternative approach to insulin delivery - intra-peritoneal (IP) infusion - could provide a similar level of BG regulation (as obtained with SC delivery), without the need for the pre-meal bolus. This simplified control architecture would remove the patient safety risk related to the administration (or not) of pre-meal bolus.

Keywords. Artificial pancreas, intra-peritoneal insulin delivery, model predictive control, pre-meal bolus.

Introduction

Research into developing an artificial pancreas device that could automatically regulate blood glucose (BG) levels, in ambulatory patients with type 1 diabetes, began in the 1960's with significant progress being made since 2003, due to improvements related to subcutaneous continuous glucose monitoring (CGM) [1]. The most popular choice for insulin delivery remains the subcutaneous (SC) injection route because of the availability of a range of certified external insulin pumps [2]. The time lags introduced by this approach - a patient's peak insulin effect absorption time for a rapid-acting insulin analog, is of the order of 60+ minutes, plus there is a 10-15 minute time-lag associated with the CGM - make automatic controlled regulation of BG an extremely difficult control problem [3]. Intra- and inter-patient variability only increases the difficulty. BG regulation around mealtimes is especially problematic with it being accepted, in both SC-based intensive insulin therapy and SC automatic-control based therapy, that the administration of a pre-meal insulin bolus is a requirement to counteract the subsequent meal-related rise in blood glucose levels [4]. Most AP

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research groups/consortia use Model Predictive Control (MPC), wherein model-based optimization is used to predict future controlled responses and to also provide a meal-informed bolus calculation [5], though Medtronic, the medical device firm, are also pursuing both fuzzy-logic and Proportional-Integral-Derivative (PID) Control-based solutions [6]. The research consortia who utilize the SC(sensing)/SC (delivery) approach have already carried out initial home-based studies of AP devices with remote tele-monitoring of the operating device being a basic safety requirement [7,8]. The patient safety risk related to the failure of wireless connectivity, between sensor and actuator as well as tele-monitoring, of these home-based wearable AP systems has been shown to be fairly low with trials using a mobile phone-based AP system indicating that more than 97% of the total data transmission took less than 5 minutes [7]. Safety concerns do still persist about other elements of an SC/SC AP system though. The U.S. Food and Drug Administration (FDA) currently consider CGM systems to be 'not reliable enough to allow usage under daily life conditions' and 'algorithms developed to calculate appropriate insulin infusion do not allow optimal coverage of insulin requirements after meals, during the night, or after physical exercise', [9]. Also, there are safety concerns relating to the 'AP wearing' patients ability to, in the long-term, successfully administer a pre-meal insulin bolus (either at the correct time or at all) as well as concerns that a bolus could be administered yet, for some reason, no meal is taken, [10,11]. The last situation raises the possibility of a severe hypoglycaemic event which could be life-threatening. There are on-going attempts to reduce the difficulty of the SC-based control problem by reducing the time lag associated with insulin absorption. For example the use of intra-dermal insulin infusion using micro-needle sets [12] has been shown to decrease the associated peak insulin effect absorption time, while at the same time reducing the pain the patient currently experiences when attaching the CGM and the insulin set to their body. Alternative approaches to insulin delivery are also possible with the most practical alternative being intra-peritoneal (IP) insulin infusion, wherein the insulin is delivered directly into the peritoneum (the body cavity). The insulin peak effect time for IP infusion is of the order of 20 minutes [13] with pump-based IP insulin infusion being used successfully in Europe as part of intensive insulin therapy, for over 25 years [14]. There has also been recent research to address the possible use of IP insulin infusion as a viable option for AP device development [15,16]. IP insulin delivery with the associated reduction in reduction in insulin peak-effect time promises improved BG regulation performance over that currently achieved via SC delivery. This contribution compares, via an *in-silico* study, the performance of a SC-based AP with that of an IP-based AP. The intention is to examine if it is feasible to remove the pre-meal insulin bolus in the IP-based AP system while maintaining a similar BG regulation performance as that achieved by the SC-based AP, with the pre-meal bolus. The removal of the pre-meal bolus would remove all the patient safety risk associated with (a) the failure to administer a bolus and (b) incorrect administration including incorrect calculation of the bolus and incorrect timing of the delivery of the bolus. Most critically the administration of a bolus while no meal was then consumed, which could lead to severe hypoglycaemia.

1. The *In-Silico* Study: Controlled SC versus Controlled IP insulin delivery

The diabetic patient model used for the *in silico* study was Hovorka's model [16], The BG measurement in both SC and IP insulin delivery–based AP systems was SC–based using a continuous glucose monitor (CGM) modelled as a first-order lag with time constant 12.5 minutes. A time constant of 55 minutes was chosen to represent the SC delivered insulin absorption characteristics (peak time) while a time constant of 20 minutes was chosen to represent the IP delivered insulin absorption characteristics. The meal protocol for patient's food intake was breakfast at 7:30 am with 45 grams of glucose, lunch at 11:30 am with 75 grams of glucose, and dinner at 5:30 pm with 85 grams of glucose. A simulation time of four days was used with the controlled results shown in figure 1 being from the fourth day. Breakfast is taken at 4330 minutes, lunch at 4570 minutes and dinner at 4930 minutes. The control algorithm used in both AP systems was MPC with the choice of the same weighting on the control action as well as hard and soft constraints. The prediction horizons used in each MPC were different with them being chosen to reflect the different insulin absorption dynamics for the SC- and IP-based AP systems. Full details can be found in [11]. The control objective was to try and maintain BG levels within the normoglycaemic range which in this work is considered to be between 4 $^{mmol}/_{L}$ and 8 $^{mmol}/_{L}$.

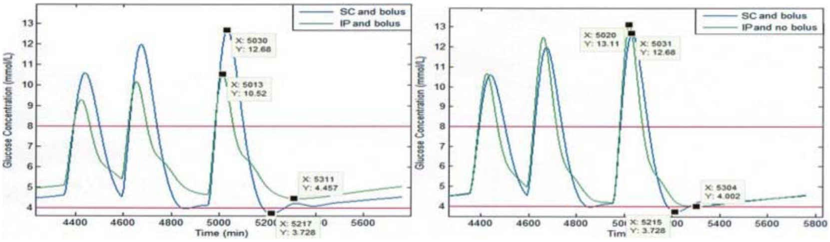

Figure 1. (a) SC-based AP and IP-vased AP: Feedback MPC and feedforward insulin bolus. (b) SC-based AP - Feedback MPC and feedforward insulin bolus, IP-based AP Feedback MPC only.

The BG regulation performance was assessed by considering the amount of time during the day that the BG of the virtual patient spent outside the normoglyceamic range. Both the percentage of time spent in the hyperglycaemic (BG > 8 $^{mmol}/_{L}$) range and hypoglycaemic (BG < 4 $^{mmol}/_{L}$) range was determined and tabulated, see Table 1.

For the nominal 70 kg virtual type 1 diabetes patient the performance of IP-insulin MPC controlled infusion, both with and without an administered pre-meal bolus, was compared with SC-insulin MPC controlled infusion with the pre-meal bolus. These preliminary results are encouraging with the IP-based AP showing an improved BG regulation, over the SC-based AP, both with (Figure 1(a)) and without (Figure 1(b)) the pre-meal bolus. For the nominal 70 kg patient, with a fixed insulin sensitivity, it would seem that AP control architecture could be simplified to remove the pre-meal bolus (the so-called feedforward control) yet still maintain a satisfactory BG regulation, based upon the % time spent in the hypo-, hyper- and normo-glycaemic zones, see Table 1.

Table 1. AP Performance Comparison – % time in the Hypo-, Hyper- and Normo- glycaemic zones.

	SC-based AP (Bolus)	IP-based AP (Bolus)	IP-based AP (No Bolus)
Hypoglycaemia	8.8%	0%	0%
Hyperglycaemia	23.75%	15.5%	19%
Normoglycaemia	67.45%	84.5%	81%

2. Discussion

This work indicates that by using an IP-based AP the need for a pre-meal bolus could be negated, while still maintaining satisfactorily BG regulation performance. The removal of the pre-meal bolus would remove all the patient safety risk associated with its administration, namely mis-timing, incorrect calculation and the possibility of the meal not being taken [10]. Unfortunately there would be an increase in safety risk associated with the use of IP-based insulin delivery over an SC-based approach though overall the patient safety risk will be reduced. The most common way of delivering insulin intra-peritoneally is via an implantable pump, which is surgically placed into the subcutaneous layer [14,15], with a catheter delivering insulin into the peritoneal cavity from the implanted pump. The main risks are infection and catheter occlusion though there are well developed procedures to both recognize and mitigate possible occurrences [14]. An alternative approach to IP-insulin delivery has been developed by Hoffman La Roche. In their 'Accu-Chek DiaPort' system an external pump delivers insulin into the peritoneal cavity via a 'port' structure (which is surgically inserted just beneath the skin) and a catheter [11]. Its use would reduce IP-related patient safety risk currently associated with the use of an implantable pump.

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Telehealth and the Re-Design of Emergency Medical Services

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Abstract. As patient numbers continue to rise Emergency Department's (ED's) are struggling to not only control patient wait times but also to maintain the quality of patient care. Improving patient flow through the ED has been a priority for many years with techniques such as Lean Six–Sigma being implemented specifically to help alleviate the problem. The Institute for Healthcare Improvement recently stated that the best opportunities to improving patient flow relate to the front-end of the ED, namely triage. This contribution examines the use of Telehealth initiatives at the front-end of the ED, specifically tele-consultation, to reduce patient loading, provide timelier healthcare (with improved patient outcomes) and reduce costs.

Keywords. Emergency Department, Pre-hospital Triage, Tele-consultation.

Introduction

Emergency Departments (ED's) are for many people the most easily accessed source of immediate, unscheduled care, both primary and emergency. As the numbers of admitted patients continue to increase ED's face major problems with regard to patient overcrowding, waiting times and safety - for example during January 2017 in A&E (Accident & Emergency) departments in England only 82% of patients were seen then admitted or discharged within a 4 hour timeframe - much lower than the designated NHS (National Health Service) minimum of 95% [1]. It has been recognised for many years [2] that speed of service, patient safety and cost of care in the ED have to be improved with quality improvement techniques, such as Lean and Six–Sigma, being applied specifically to help alleviate the problems of extended patient wait times [3]. Recently The Institute for Healthcare Improvement (IHI), stated that, 'Some of the best opportunities to improve ED (patient) flow relate to front-end and back-end flow', [4], with 'front-end' referring to triage and data gathering activities in the ED while 'back-end' refers to access, the use of specialists as well as 'getting patients to where they need to be'. Telehealth is an enabling technological approach that offers many possibilities for not only helping improve both front-end and back-end patient flow within the ED but also the quality of care. Telehealth refers to the electronic and telecommunication-based expansion of health care services, which include telemedicine and electronic health record (EHR) systems. It has already played a major role, usually via teleconsultation, in the rapid diagnosis and treatment of serious time-

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critical conditions such as myocardial infarction, stroke [5] and trauma. This contribution discusses the use of Telehealth for the re-design of emergency medical services (EMS) with the emphasis being on the use of tele-consultation either for prehospital triage or for triage within the ED. Three initiatives were chosen from the literature to illustrate how telehealth can enable more timely triage activities for both emergency and non-emergency patients.

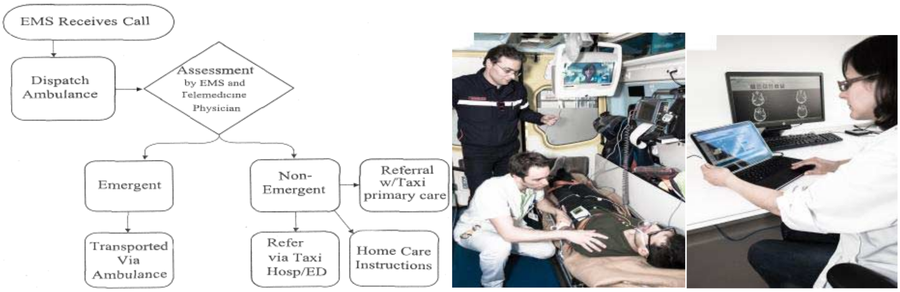
1. Telehealth Applications: Prehospital Triage via Tele-consultation

Three applications of telehealth to triage, both prehospital and within the ED, are described with tele-consultation being the common theme.

Providing patient access to remote specialists in underserved communities: Initial telemedicine-based applications relating to emergency medicine were motivated by the need to provide more timely diagnosis and care to patients in underserved communities – communities with small hospitals which do not support full-time emergency medicine teams. The Western Australia (WA) Emergency Telehealth Service (ETS) is a prominent example of this type of telehealth initiative [6] comprising over 70 regional and remote hospital ED's across the state. The ETS makes specialist emergency medicine physicians available, via videoconferencing, to support regional hospital-based clinicians with the diagnosis and treatment of acute emergency patients. The Cumbria and Lancashire Telestroke Network, - a tele-consultation service that remotely connects a team of 15 stroke consultants who provide 'out-of-hours' advice from their homes to hospital sites across Cumbria and Lancashire is another example of such a service [7].

Pre-ambulance triage, via tele-consultation with probable primary care patients: The Houston Fire Department initiated the Emergency Telehealth and Navigation (ETHAN) programme in 2014 [8]. ETHAN combines tele-consultation, social services and alternative transportation to reduce the numbers of primary-care related patients being transported directly to the ED via ambulance, or in this particular case via fire-engine. As well as reducing ED patient loading the cost savings, through the elimination of unnecessary ambulance journey's to the ED, are substantial (~$2500 per trip). Responding to patient initiated calls all EMS units carry Tablets so the patient can be connected to a hospital-based emergency physician via secure teleconferencing software. The tele-consultation involves synchronous communication via video conferencing and the measurement of vital signs on scene by the field crew with the physician making a preliminary diagnosis as well as outlining treatment options to the patient. The physician, in consultation with the patient, then makes the final decision regarding patient disposition if the patient condition is determined to be non-urgent and of a primary care nature. Figure 1(a) outlines the possible outcomes including referral via taxi transportation (rather than ambulance/fire engine) to the ED, referral via taxi transportation to a primary care facility or a homecare instruction (with follow-up).

Ambulance-based Triage: Tele-consultation using remote specialists in underserved communities takes place after the acute emergency patient is transported to the hospital. It is recognised that if prehospital triage and care of the acute emergency patient can be carried out within the ambulance, during transportation to the ED, then patient outcomes especially with time-critical conditions such as myocardial infarction and a stroke could be positively affected. One such study, into the safety, feasibility and reliability of an ambulance-based telemedicine triage system, was carried out in Brussels [9]. A prototype 3G telemedicine system (PreSSUB 3.0) was used to provide real-time bidirectional audio-video communication between the patient in the ambulance and the remote physician, see Figure 1(b). A preliminary prehospital diagnosis was formulated in 90.2% of cases with satisfactory agreement with in-hospital diagnoses. Failures resulted mainly from limited mobile connectivity. Other functionalities included the automated transmission of patient vitals as well as pre-notification of the ED team using SMS. Figure 1(c) shows the remote physician examining real-time patient data obtained from the ambulance.



(a) **(b)** **(c)**

Figure 1. (a) Pre-ambulance Triage of Probable Primary Care Patients, adapted from [8], Ambulance-based prehospital triage showing (b) Tele-consultation with remote physician [9], and (c) The remote physician examining transmitted real-time patient data [9].

The three applications highlight how Telehealth can make a positive contribution to EMS. The ETHAN programme is a nice standalone initiative that conceivably could be used to complement either of the other two described Telehealth applications in the re-design of the EMS. Providing patient access to specialists via in-hospital tele-consultation is a well-established service, especially for stroke victims in rural areas, that is also being applied successfully in urban areas not only to access remote specialist care but also to provide a degree of flexibility in ED staffing arrangements [10]. Ambulance-based triage can potentially provide the most timely diagnosis and care, though the initial financial outlay, to convert and equipment a number of ambulances is higher than the other described Telehealth initiatives [9].

2. Discussion and Conclusions

The three reviewed telehealth initiatives have made a substantial difference to not only delivering timely specialist care but also, in the case of ETHAN, intercepting primary care patients and providing them with a number of primary care options as an alternative to being transported to the ED. ETHAN has reduced ED loading as well as saving a substantial amount of money for each ambulance trip not taken. Though all these initiatives relate specifically to the ‘front-end’ of the ED there is also the potential to apply Telehealth initiatives throughout EMS. Though research has shown that tele-consultation is as safe and effective a method as face-to-face consultation between the patient and the physician [11] there are a number of challenges that need to be overcome. Technical challenges, relating to connectivity and the transmission of real-time data and video images still remain, though the expectation is that these will be re-solved with the introduction of 5G in 2020. Other challenges are financial and relate not only to the initial investment that a tele-consultation system may need. Current payment models in user-pays healthcare systems are currently affecting the expansion of Telehealth initiatives. The lack of re-imbursement for non-ED transports is currently a barrier to the expansion of the ETHAN programme - Medicare currently only provides reimbursement when a patient is transported to the ED [9]. The proposed U.S. 'CONNECT for Health Act of 2017' aims to 'remove roadblocks to telemedicine expansion by giving providers the freedom to experiment with telehealth in alternative payment models' [12]. Another challenge is the lack of awareness, and perhaps understanding, relating to how Telehealth can improve EMS. Northumbria NHS Trust provides healthcare for over half a million people across a mainly rural area in the North-East of England. Northumbria NHS Trust decided to centralise emergency care by building a specialist emergency hospital while downgrading the four A&E departments within the region to 'walk-in' facilities [13]. The centralising of Emergency Care within a rural area seems a retrograde step as this increases patient journey times as well as reducing access. There was substantial public and medical professional criticism of this strategy, for example, see [14,15]. Even if specialist care is now available 24/7 at the new facility the Telehealth initiatives reviewed here, especially the fairly low cost tele-consultation initiatives in both Western Australia and Cumbria and Lancashire, could have instead been applied to improve quality of care across the region (providing tele-consultation 24/7) while maintaining the lower travel times and improved patient access to the original four A&E departments.

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CFD Modelling of Local Hemodynamics in Intracranial Aneurysms Harboring Arterial Branches

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Abstract. The main cause of non-traumatic subarachnoid haemorrhage is an intracranial aneurysm's rupture. The choice of treatment approach is exceptionally difficult in cases of aneurysms with additional branches on the aneurysm's dome or neck. The impact of the arterial branches on local hemodynamics is still unclear and controversial question. At the same time, up-to-date methods of image processing and mathematical modeling provide a way to investigate the hemodynamic environment of aneurysms. The paper discusses hemodynamic aspects of aneurysms harboring arterial branch through the use of patient-specific 3D models and computational fluid dynamics (CFD) methods. The analysis showed that the presence of the arterial branches has a great influence on flow streamlines and wall shear stress, particularly for side wall aneurysm.

Keywords. CFD modeling, intracranial aneurysm, hemodynamics.

Introduction

According to different authors the prevalence rate of unruptured cerebral aneurysm is about 3 to 5% [1]. Aneurysm rupture results in non-traumatic subarachnoid haemorrhage that carries high rates of mortality and disability [2]. Making a decision of surgical management is a particularly major challenge for patient with so-called complex aneurysm (CA). Up to the present day no formal definition exists on what CA are, but branches arising from the aneurysm itself are one of the commonly recognized features of CA [3,4]. There are only a few research works dedicated to investigation of this kind of CA. It is still unclear, if the arterial branch presents difficulties only for surgical access or it has a significant influence over local hemodynamics too. However the computational fluid dynamics (CFD) methods offer a wide range of possibilities to simulate hemodynamic changes in aneurysm [5]. To this end the purpose of this study was to assess the hemodynamics of CA with arterial branches by means of CFD simulations.

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1. Methods

1.1. Patients Data and Image Acquisition

CT angiography images of three patients with saccular cerebral aneurysm harboring a branch were utilized to generate three-dimensional models. The aneurysms were located on different vessels of the circle of Willis, their morphological characteristics are listed in table 1.

Table 1. Initial morphometric data of aneurysms

Morphological characteristics	Patient 1 Woman, 87 years	Patient 2 Man, 60 years	Patient 3 Woman, 55 years
Parent vessel	Internal carotid artery (ICA)	Anterior communicating artery (ACA)	Middle cerebral artery (MCA)
Dome height, mm	9	20	8
Dome width, mm	6	12	9
Neck width, mm	4.6	7	5
Aspect ratio	1.95	2.86	1.6

1.2. Computational Modeling

The anatomy of aneurysms was segmented and reconstructed with the software suite “Gamma Multivox D2” (Gammamed-Soft, Ltd, Russia). Three-dimensional geometric models were smoothed, and parametric conversion was performed. Virtual “removal” of branches was made for each model for further comparison study. In addition, models of patients 2 and 3 were resized to assess the influence of large size on hemodynamics. A total of 10 realistic models of aneurysm were used in this study (figure 1).

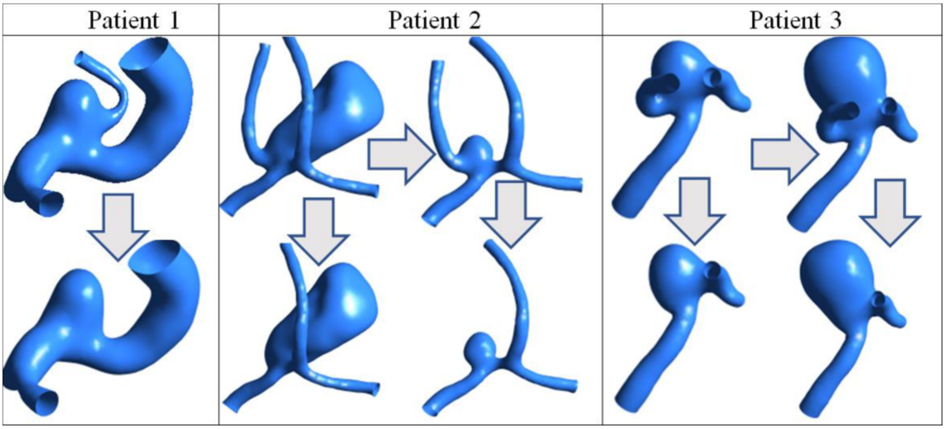

Figure 1. 3D models of aneurysms. The bottom row contains models after branch removal.

The following CFD simulations were carried out by means of ANSYS CFX v17.2 (ANSYS Inc., USA). Vessel walls were assumed to be rigid. Blood was modeled as an incompressible and Newtonian fluid with constant density 1060 kg/m3 and viscosity 0.0039 Pa*s. The inlet pulsatile flows were defined from doppler ultrasonography of healthy human. The peak systolic velocity for ICA, ACA and ACM were 100, 85 and 60 cm/s respectively. Beyond that we computed all 10 models with raised velocity (Vps=150 cm/s) to assess hemodynamic changes in conditions of pathological states.

The results are presented in terms of velocity profile, pressure and wall shear stress (WSS) distribution. Moreover, a new visualization technique was proposed that may improve interpretation of WSS distribution.

2. Results

CFD modelling showed mixed results. Analysis of the flow streamlines after branch removal showed lack of considerable changes in direction and force of stream for Patient 1. Conversely, for models of Patient 2 virtual removing of branch caused significant reduction of blood flow intensity in aneurysm sac (figure 2). As a consequence of this, WSS reduction was indicated. This effect was found for the small aneurysm as well as for the giant one. One of possible explanations of the discrepancy between two wall-side aneurysms could be the difference in the ratio of branches diameter to neck diameter. The ratio between sectional area of branch and sectional area of neck was equaled to 6.5 for Patient 1; only a small part of stream was directed to the branch. For Patient 2 this ratio was half as much.

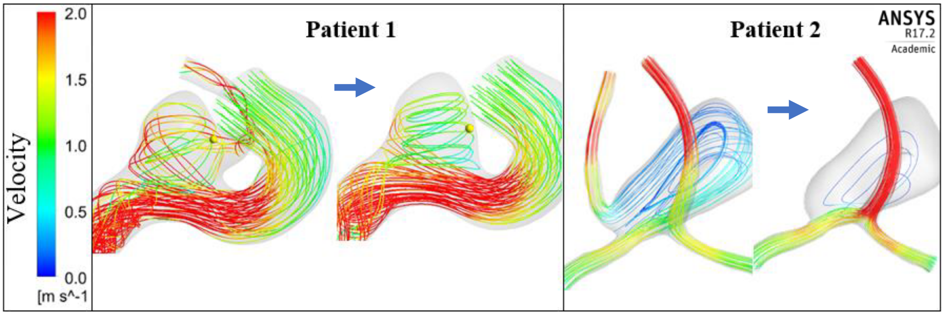

Figure 2. Comparison of velocity streamlines for patient 1 and 2 with and without arterial branch.

The branch removal on models for Patient 3 had not influence on local hemodynamics. We suppose that the bifurcation position of the aneurysm could be the cause: the dome of aneurysm was under the jet impact whether the arterial branch was present or not.

It is interesting to note that WSS growth rate was much higher for simulations with raised velocity (Figure 3). It means that in situations of angiospasm or hypertensive crisis not only values of WSS increase, but also the WSS variance in the area of jet. In other words, the values of WSS increased 3 times on the small area in comparison with other parts of aneurysm. The revealed trend can explain the fact that aneurysm rupture occurs at a time of elevation in blood pressure [6].

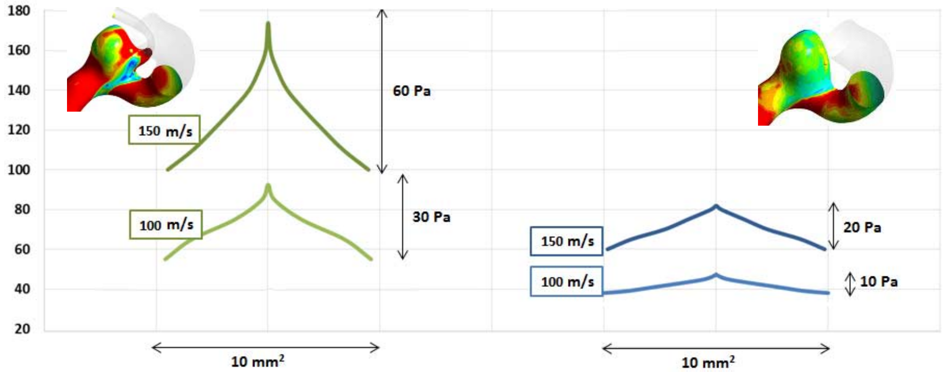

Figure 3. Comparison of WSS gradient near the area of jet for models with and without branch.

3. Discussion

In the light of this analysis we can suppose that presence of arterial branches on the dome or neck of aneurysm has a considerable impact on local hemodynamics. The nature of this impact depends on morphological characteristics and mostly on the relative position of aneurysm towards the parent vessel (side wall or bifurcation location). The bifurcation aneurysm was quite insensitive to branch removal: we found no significant changes of hemodynamics parameters. The variation of velocity profile and WSS of side wall aneurysm was much greater, the explanation of this requires the consideration of local and system factors [7]. It should be noted that a number of simplifying assumptions was made: we assumed rigid walls and Newtonian fluid. Also this study has a significant limitation due to the small number of patients. Overcoming this limitations and further studies would help surgeons to understand the hemodynamic changes induced by surgical treatment and to predict intra- and postoperative complications.

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Totally Connected Healthcare with TV White Spaces

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Abstract. Recent technological advances in electronics, wireless communications and low cost medical sensors generated a plethora of Wearable Medical Devices (WMDs), which are capable of generating considerably large amounts of new, unstructured real-time data. This contribution outlines how this data can be propagated to a healthcare system through the internet, using long distance Radio Access Networks (RANs) and proposes a novel communication system architecture employing White Space Devices (WSD) to provide seamless connectivity to its users. Initial findings indicate that the proposed communication system can facilitate broadband services over a large geographical area taking advantage of the freely available TV White Spaces (TVWS).

Keywords. Wearable Medical Devices, Body Area Networks, TVWS

Introduction

Future communications envisage a plethora of wireless, connected, sometimes ‘smart’ devices that will communicate in real time with each other. This is referred to as the ‘Internet of Things’. These devices are expected to be part of our daily lives, interfacing not only with humans, but also with other devices known as machine to machine communications [1]. IoT enabled medical devices are expected to form a smart environment that is characterized by polymorphic requirements in terms of latency, throughput, reliability, speed, power, security, etc. generating enormous amounts of new, unstructured real-time data. 5G is expected to provide connectivity to such devices including a wide range of Wearable Medical Devices (WMD) [2]. When considering broadband connections, one might think the fastest the better. Nevertheless, some of these devices / users might not necessarily require a ‘gigabit experience’ but lower data-rates to maintain longer battery life and reliability. WMD requirements, are application specific but there are a common set of constraints in size, power and functionality since they are all going to be carried by humans. The location of the WMD, data rate, frequency and regulatory standards all influence the design complexity and power dissipation of telemetry links. The design of antenna is very demanding with the major challenges being miniaturization, low-power consumption to aid the energy efficiency of the MD (especially in the case of Implanted Medical Devices). Patch antennas are generally used because of their flexibility in design,

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conformability and shape [4]. For those that they do need the high data-rate experience, delivering higher capacities and speeds requires better cell densification and access to new, broader carriers in new spectrum. So how can 5G network address all these devices singlehanded? For the time being and perhaps for the next few years, part of the capacity growth can be gradually addressed by the ageing 3G/4G based systems, but by 2020, 5G technologies will have to be operational. Nokia [4] and Ericsson [5] introduced a number of new services and use cases that will drive the technology such as mobile broadband, mobile media, IoT, etc. Based on these use-cases, it has been deduced that 5G networks will be have to somehow fulfill the 5 major parameters and these are: throughput, capacity, number of devices, cost, latency and reliability. This contribution proposes a novel long-range communication system architecture which is using unlicensed frequencies (470-700MHz) to provide internet connectivity to WMDs. The approach to identifying the challenges included a digital library search, as well as review of the main standard applicable to TVWS which is IEEE 802.22. The authors picked a representative sample from the results, based on their experience. The literature used the keywords “wearable + medical + device + IoT” and “wearable + medical device + TV white spaces”. The papers were reviewed by the authors for examples or discussion on the interaction between security design features.

1. Wearable Medical Devices – Operation parameters and requirements

Advances in electronics, sensors and IoT technology, has inspired the design of new medical devices, shaping the new generation of Body Area Networks (BAN) and healthcare. Wearable Medical Devices (WMDs) and Implanted Medical Devices (IMDs) can be considered part of the BAN and expected to generate data, communicate it, aggregate it, and analyze it providing constant health monitoring for the patients. This enables the healthcare system to sustain detailed long-term health records of patients and help the doctors make the correct diagnosis. Current wireless technologies used for connecting various medical sensors are: Bluetooth, ZigBee, WiFi, RFID, IEEE 802.15.6, etc [6]. As the number of applications increases, existing wireless technologies will not be able to cope with the fast-evolving sensors. For example, the data-rates supported by the current standards might not be able to cope with future sensors which will generate larger volumes of data. Furthermore, security is already an issue for some of the standards such as RFID and ZigBee [7][8]. This means that great caution must be taken when using them in a healthcare environment.

2. Current and future Mobile Networks – Providing services to WMDs

Remote monitoring for large numbers of patients will require high bandwidth, reliable communication links, large coverage area and high quality of service when deploying future mobile communication systems. Today, the main wireless cellular mobile network technologies that can be used to provide substantial coverage and data-rates for wireless medical devices are 3G: WCDMA, CDMA2000, EVDO and 4G: Long Term Evolution (LTE). Nevertheless, these types of wireless networks cannot provide direct connectivity to WMDs and IMDs devices since these are usually low power, high frequency devices usually operating in the Industrial Scientific Medical (ISM) bands. Furthermore, it will be expensive for the patient to keep all devices connected transmitting through these networks. Future 5G systems will bring in paradigm shift in remote patient monitoring and tracking but probably at a high cost. It is expected that it will form the new technology of choice for applications that require very high capacity as well as very low latency. Nevertheless, 5G networks is promising high bandwidth (1gbps per user) and coverage for its users with sub-1ms latency needed to support the time-critical applications in emergency applications such as healthcare.

3. TV White Spaces for Connecting Wearable Medical Devices?

WMDs and IMDs are considered highly demanding due to the nature of the data exchanged, depending on the mission and safety critical process control data. They therefore require robust, low latency, reliable and highly available wireless links while interference must be mitigated in an interference-prone radio-busy radio environment. What we are proposing here is a communication system architecture that will connect all WMDs and IMDs to the healthcare system in a secure way while guaranteeing the polymorphic requirements of each application. As part of this system, a device – called Body Sensor Managing Device (BSMD) is introduced to locally communicate with the WMDs and IMDs through the BAN, while it will transmit the data to the internet through unlicensed TV White Space (TVWS) spectrum employing the IEEE 802.22 communication standard also known as WiFar (see fig.1). Users carrying their BSMD equipment, are expected to move through the 802.22 cellular network and connect to the closest base-station to achieve internet access. [9-11] The IEEE802.22 cellular network, to avoid causing / receiving interference to the incumbent devices (see fig 1), sensing-assisted spectrum databases (SASDs) are used where they offer an efficient solution for certain scenarios, eliminating the need for wireless network operations and management in a complex, interference-prone local or indoor environment when used in the context of self-configuration [12]. Since healthcare has very strict operational requirements it is imperative to employ dynamic spectrum management, relying on the information collected and managed by such databases in order to ensure incumbent protection, co-existence and interference management as well as fine-grained adaptation to available spectrum.

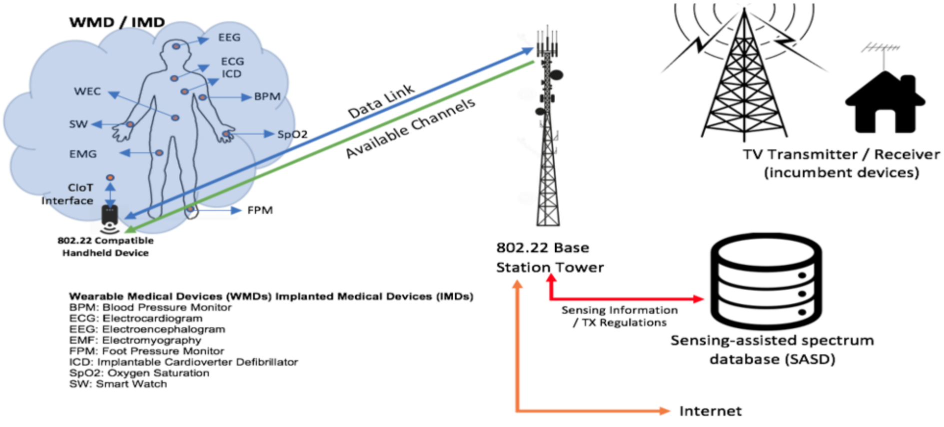

Figure 1. Proposed architecture connecting WMDs and IMDs to the internet using WiFar (IEEE 802.22)

4. Discussion

Medical sensors in/on human body will become vital part of our lives and in some cases mandatory (possibly by our life insurance). In order to provide seamless connectivity in large geographical areas, a novel type of network is proposed where all these sensors communicate with our BSMD through the BAN and all data generated is transferred in real time using the freely available TVWS spectrum using IEEE802.22 cellular type of network. Our proposed system requires substantial work in a number of research topics in order to become operational. First topic is the convergence of the numerous lightweight networking protocols that the current WMDs are using. Furthermore, the antenna design for our BSMD device must be designed to address the issue of propagation losses especially in highly populated cities. BSMD should also ensure that it establishes low-power communication with the sensors forming the BAN in order to extend their lifetime. Finally, it is important that the system's performance is tested for availability, reliability and throughput to assess the capability of our system architecture to support critical medical devices. Our proposed architecture can be used as a reference point for future work and for redefining the way WMDs operate as well as pave the road for a new fully connected and highly integrated healthcare system that will process the data generated by the WMDs and IMDs and transmitted by our BSMD device.

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Usability in Mobile Electronic Data Collection Tools: Form Developers' Views

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Abstract. Mobile Electronic Data Collection Tools (MEDCTs) are created by form developers to collect data. Usability being one of the top quality attributes is of great concern to developers of any interactive applications. However, little is known about the form developers' understanding of usability, how they measure usability and their limitations in designing for usability. We conducted an empirical study where we aimed at getting the developers' views on usability by interviewing 8 form developers. These are creators of forms used for data collection. We found that developers knew about usability, but it was not their main focus during form development. Challenges included constraining deadlines, software limitations and the insufficient communication with the field users to establish the usability needs. Furthermore, the methods used to evaluate the usability of created forms varied amongst developers and these included in-house evaluations and feedback from piloting sessions with end users.

Keywords. Electronic Data Collection, usability, form developers, mobile forms

Introduction

Advancement in mobile computing has led to increased reliance on mobile devices for Electronic Data Capture (EDC) in place of paper-based data collection [1]. Mobile Electronic Data Collection Tools (MEDCTs) consist of mobile devices like phones and tablets (hardware) together with a number of different possible programs (software), also known as form creation software [2,3]. To collect data, form developers have to create a data collection form by using form creation software like Open Data Kit (ODK), OpenMRS, etc, which may be open source or proprietary. The form developers do not need to have any prior software programming training in order to create a mobile form [3].

MEDCTs collect various types of data like textual, numerical and multiple choice questions among others. Depending on the type of mobile device, other types of data can be collected for example location coordinates using GPS, pictures and video recordings. In addition, to improve the data accuracy and completeness of the tool, certain validation constraints and skip logics are also implemented during form creation [3]. MEDCTs provide an array of tools for designing electronic forms, however, the

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usability of these forms relies on the capabilities provided by the software developers, and this should be of great concern [4]. Usability may be defined as “how easy user interfaces are to use” [5].

Often times, the source of usability challenges during data collection is unclear. In some instances the challenges in usability are attributed to the operating system. In others to the limitations in the form creation software, or coding mistakes in the forms made by the designer, or even to the nature of the mobile device being used to collect data [6]. Apart from the software challenges, usability challenges may also be as a result of the data collectors being unfamiliar with the mobile device and yet the training time is very limited [7]. Some of these data collectors may be field staff from rural populations and may get discouraged after trying to learn the technology [8].

It is important to note that variations in form design can lead to different usability experiences, for example an increase or decrease in interaction speeds, errors and or user satisfaction during data collection [9]. And yet to our knowledge, there has been no study to explore the role form developers who create mobile forms play in the usability of MEDCTs.

In this paper, we present results from an empirical study on the views of form developers who use different form creation software to create mobile forms that are used in community and health facility settings. The aim of the study was to explore the form developers’ understanding, implementation and evaluation of usability during the development of mobile data collection forms.

1. Methods

A total of 8 interviews were conducted in December 2016. The participants were purposively selected and had developed mobile forms using OSS for low resource settings for a period of more than 5 years. They included 2 monitoring and evaluation specialists working on m-health projects, 1 systems analyst, 1 Health and Management Information Systems coordinator, 3 form designers and programmers working for an HIV clinic and a health care software development company respectively and 1 project implementer working for a Health Information Systems organization. The projects and organizations from where they were selected included; Pace Uganda Limited, Omnitech Uganda Limited, Millennium Promise Uganda and the Monitoring and Evaluation Technical Support (METS) Program under the Ministry of Health in Uganda. Others included the Academic Model Providing Access to Healthcare (AMPATH) clinic in Eldoret, Kenya, Health Information Systems Programme (HISP) Uganda and Interactive Health Solutions (IHS), Karachi, Pakistan.

The interviews were semi-structured based on a set of thematic questions which included experiences, limitations and challenges in form design, use and type of guidelines during form development and the understanding of usability and its implementation in the design of forms. The interviews lasted approximately 25-30 minutes. Seven interviews were direct interviews while one was done via Skype. All the interviews were recorded using a voice recorder, and transcribed. We used the qualitative content analysis method [10,11] and manually derived the sub categories and categories based on the codes derived after transcribing the interviews.

2. Results

Table 1. Results depicting the content areas, codes, sub categories and categories from the study.

Content areas	Codes	Sub categories	Categories
The form developers	Form developers consist of programmers and form designers.	Two types of form developers	Form development and software
	Form developers use OSS form creation software like ODK, DHIS2, OpenMRS, etc	Software have different capabilities and limitations	
Designing mobile forms for usability	The pressure of beating unrealistic deadlines is high	Challenges in achieving usability	Design and usability
	The length of the questionnaires is sometimes very long		
	There are limitations in some software		
	Intermediary users are the project managers or implementers	Different types of users have varying usability needs	Users and usability needs
	Field users: those who collect clinical data (clinicians / field workers)		
	Intermediary users' needs, and not the field users' more practical needs are recorded when creating forms		
Methods of evaluating a mobile form	Form developers first filling forms before roll out	Usability evaluation is not standard	Usability evaluation
	Taking note of number of errors and interruptions during piloting		
	Implementing validation constraints and skip logic		
	In-house testing by about 10-20 members of staff before roll out		
	No use of design guidelines or checklist to create forms		

The mobile form developers knew what a usable form looked like but implementing usability in mobile forms was a challenge. This was due to unrealistic deadlines that were always coupled with the numerous questions in the questionnaires that had to be worked on. Some mobile form developers also did not have the expertise to improve on the designs of the forms and therefore were limited to the capabilities of the form creation software. Programmers on the other hand were able to add some features which would improve on the usability of the forms.

Designing mobile forms to meet the user needs for the different types of users in many cases seemed futile. The intermediary uses often defined the user needs because there was hardly any communication with the field users since these were usually deployed shortly before project roll out. So the practical usability needs from the field users were hardly captured during the initial design of the mobile forms.

There are no known design guidelines for evaluating the usability of mobile forms. Therefore mobile form developers each found a way of evaluating their mobile forms. Some developers relied on the feedback from the training and piloting sessions, most of which was not centred on usability but on functionality. Others performed in-house testing with about 10-20 staff members who were involved on a particular project before roll out. While others individually filled the mobile form first in order to address any usability challenges before roll out.

3. Discussion and Conclusion

The form developers had basic knowledge on what a usable form should look like or contain, but often times did not implement it mainly due to constraining deadlines, software limitations and unclear user needs. Lastly there was no standard way of measuring usability of the forms as each form developer did it differently, ranging from in-house testing to the feedback given after user trainings and pilot testing of the forms.

Some of the limitations we had in this study included the differences in expertise of the mobile form developers and the settings in which they worked. Those who were programmers could write some code to improve on the usability of the forms, unlike the non programmers. Furthermore, some were developing mobile forms on a commercial basis while others were employed by a particular organization. So their experiences differed a great deal and therefore generalizing the findings was challenging due to the differences in settings and exposure.

In conclusion designing for usability is a threesome involving the developers, the software and the users. It is not enough for the developers to know about usability, they need to implement it in their products. Therefore, more research is needed to operationalize usability evaluation in MEDCTs so that developers have a standard against which they can measure their products. Secondly, whenever possible, mobile form development should include end users, as it was evident that there exists a communication gap between the users and the developers. The traditional system development approach is used more than the agile approach due to time and resource constraints. On the contrary, agile development assumes several design iterations and involves user groups besides product owners and stakeholders. This may contribute to better usability in MEDCTs.

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Cybersecurity and the Medical Device Product Development Lifecycle

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Abstract. Protecting connected medical devices from evolving cyber related threats, requires a continuous lifecycle approach whereby cybersecurity is integrated within the product development lifecycle and both complements and re-enforces the safety risk management processes therein. This contribution reviews the guidance relating to medical device cybersecurity within the product development lifecycle.

Keywords. Cybersecurity, Medical devices, Life-cycle, Risk Management.

Introduction

The first decade of the 21st century has brought about significant changes in the medical device landscape. The ever-increasing connectivity of software-controlled medical devices has created much concern about cyber- related vulnerabilities [1] which has only heightened with the recent ransomware attack on the U.K.'s National Health Service (NHS) [2]. Cybersecurity concerns are especially prevalent with regard to connected implantable medical devices (IMDs), where the associated safety risks if a cyber-attack is successful are extremely high. The range of cyber-attacks that medical device companies and healthcare organizations are trying to defend against, include; malicious software introduced into the device or system, device operation disrupted by blocking the flow of operation, false information sent to operators to initiate inappropriate actions by medical staff and unauthorized changes made to embedded software or unauthorized commands issued to devices [3]. Additionally the economics relating to medical device cybersecurity normally involves a complex system of payments between the multiple stakeholders—including manufacturers, providers, and patients. The U.S. Food and Drug Administration (FDA) released guidance for the management of cybersecurity in medical devices [4] in October 2014. It recommends that manufacturers "consider cybersecurity risks as part of the design and development of a medical device, and submit documentation about the risks identified and controls in place to mitigate those risks." Thus the FDA is indicating that manufacturers consider the possibility throughout the total product lifecycle of a device, therefore refocusing medical device development to include security, in addition to safety, as a key element. Specifically the guidance recommends the following:

- Identification of assets, threats, and vulnerabilities;

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- Assessment of the impact of threats and vulnerabilities on device functionality and end users/patients;
- Assessment of the likelihood of a threat and of a vulnerability being exploited;
- Determination of risk levels and suitable mitigation strategies; and
- Assessment of residual risk and risk acceptance criteria.

The guidance also identifies "core functions" of cybersecurity activities from the National Institute of Standards and Technology (NIST) cybersecurity framework [3]. A 2016 US security framework adoption study reported that 70% of the surveyed organizations see the NIST Cybersecurity Framework as best practice for computer security.

1. The Medical Device Product Development Lifecycle

There are a number of different product development lifecycles used to design and develop medical devices with development usually containing the following steps; specification, design, development, testing manufacturing and subsequent to regulatory approval, product launch and post-market monitoring. Figure 1 shows parts of the FDA's product development pathway particular to medical devices where the 'invention + prototyping', 'pre-clinical' and 'post-market monitoring' phases encompass most of the recognised product development activities [5].

Figure 1. The medical device development pathway, adapted from [5]. The interaction between the regulatory process with the pathway, which accommodates the iterative and cyclical nature of medical device design and development, is not indicated.

It is possible for medical device manufacturers to apply a variety of security development lifecycles. For example the British Standards Institution (BSI) recommends that manufacturers consider following the good practice outlined in security standards developed for industrial automation and control system security; IEC 62443-4-1:Product Development Requirements and IEC 62443-4-2: Technical Security Requirements [6]. Basic safety standards for functional safety, utilized across other domains, now address cybersecurity throughout system lifecycles and recommend approaches to secure products, systems and networks. They also reference IEC 62443. The majority of research into security and privacy has centered on threats to the telemetry interface [1] though security experts have begun advocating that a more holistic approach to securing increasingly complex and connected medical devices be taken [7]. Despite the challenges, the importance of ongoing security evaluation throughout the life-cycle of the medical device is now accepted. Figure 2 illustrates dedicated security activities superimposed over the software design lifecycle [8]. Comprehensive threat assessment, carried out after the requirements stage, is the most fundamentally important activity. The use of static analysis tools, as part of the software security lifecycle, are highly recommended by software safety standards because they enforce strict coding standards, such as MISRA-C, to prevent defects as well as finding any defects that do occur before unit testing. Static analysis also provides automated documentation to support testing, coding standard and quality/robustness evidence [8].

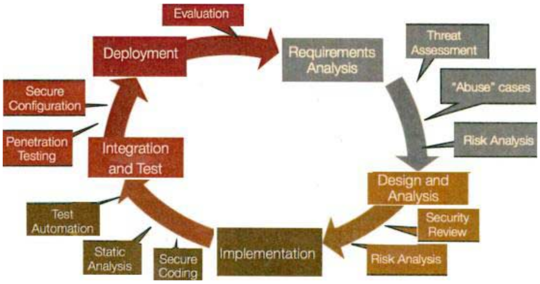

Figure 2. Security standards superimposed over the software design lifecycle, adapted from [8].

2. Cybersecurity Risk Management

FDA's Postmarket Guidance [9] recommends manufacturers implement a process for assessing cybersecurity risk to the device's clinical performance by considering:

- Exploitability of the cybersecurity vulnerability; and
- Severity of the health impact to patients if the vulnerability were to be exploited.

The FDA does recommend that a cybersecurity vulnerability assessment tool, such as the Common Vulnerability Scoring System, be used for assessing how exploitable a particular vulnerability is. However, estimating the probability of a cyber-attack is problematic given the absence of data on the probability of the occurrence of harm. This difficulty also applies to software failure and other situations such as sabotage or tampering with a medical device. The approach recommended in EN ISO 14971 [10] is to use either the worst possible case outcome or set a default value for the probability as one, indicating that worst-case scenarios drive the cyber-protection level of the device. For assessing the severity impact to health, the FDA suggests the approach based on qualitative severity levels as described in EN ISO 14971. Cybersecurity priorities do differ depending upon how the medical device is deployed. Confidentiality is a priority for hospital systems, preventing data breaches, or ransomware (which impacts the availability of systems if made unusable by encryption, such as in the NHS attack [2]). Protection of the patient is a priority where they are exposed to medical devices (including implantable devices) as part of their care. In [11] the authors' discussed specific cybersecurity mitigations applied to IMD's, such as authentication strategies, and their possible impact on the safety of the patient and the need for the designers to take this in account. The Association for the Advancement of Medical Instrumentation (AAMI) appreciate that medical device security can become a patient safety issue, such as in IMD authentication, and should be treated as such during risk management related activities within the product development lifecycle [11]. The AAMI indicate that the controls or countermeasures employed for security mitigation be assessed for their impact on safety functionality in order that new hazards are not introduced [12]. To provide some degree of transparency with regard to the relationship between product development activities and cybersecurity, figure 3 illustrates product development activities, represented here as a V-model, and the corresponding software security lifecycle activities, indicated in red [13].

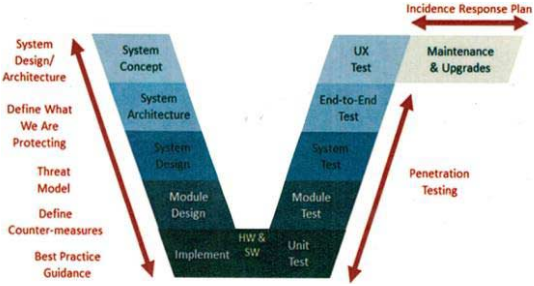

Figure 3. V-model based Product Development Lifecycle with complementary Security Risk related software orientated, actions indicated. Adapted from [13].

3. Discussion

Much of the medical devices cybersecurity guidance is recent and will evolve and develop as (a) the nature of cyber-attacks evolve and (b) the emergent properties, that is ‘vulnerabilities’, of existing and new medical devices, become known. It is now recognized among the different stakeholders that establishing cybersecurity has to be a collaborative effort throughout the product development lifecycle. Previously medical device risk management focused on functional safety, safety-related risk (to the exclusion of cybersecurity) or the protection of data. Multiple approaches are now actively addressing the lifecycle risks and potential harm from cybersecurity incidents.

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The Hazards of Data Mining in Healthcare

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Abstract. From the mid-1990s, data mining methods have been used to explore and find patterns and relationships in healthcare data. During the 1990s and early 2000's, data mining was a topic of great interest to healthcare researchers, as data mining showed some promise in the use of its predictive techniques to help model the healthcare system and improve the delivery of healthcare services. However, it was soon discovered that mining healthcare data had many challenges relating to the veracity of healthcare data and limitations around predictive modelling leading to failures of data mining projects. As the Big Data movement has gained momentum over the past few years, there has been a reemergence of interest in the use of data mining techniques and methods to analyze healthcare generated Big Data. Much has been written on the positive impacts of data mining on healthcare practice relating to issues of best practice, fraud detection, chronic disease management, and general healthcare decision making. Little has been written about the limitations and challenges of data mining use in healthcare. In this review paper, we explore some of the limitations and challenges in the use of data mining techniques in healthcare. Our results show that the limitations of data mining in healthcare include reliability of medical data, data sharing between healthcare organizations, inappropriate modelling leading to inaccurate predictions. We conclude that there are many pitfalls in the use of data mining in healthcare and more work is needed to show evidence of its utility in facilitating healthcare decision-making for healthcare providers, managers, and policy makers and more evidence is needed on data mining's overall impact on healthcare services and patient care.

Keywords. Data Mining, Knowledge Discovery, Healthcare, Artificial Intelligence

Introduction

Since the mid-1990's, knowledge discovery and data mining techniques have been used in the areas of marketing, investment, fraud detection, manufacturing, telecommunications, and healthcare [1]. Data mining is a "step in the [knowledge discovery] process that consists of applying data analysis and discovery algorithms that produce a particular enumeration of patterns (or models) over the data" [1]. The data mining process involves the ability to find interpretable patterns and association in data that can be used for a particular interest [2]. Within healthcare, data mining techniques have been used for chronic disease management, customer relationship management, fraud detection, identifying effective treatments, and best practices [3]. However, little has been written about the possible adverse impacts of data mining on healthcare

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practice. The purpose of this paper is to identify limitations and challenges of using data mining in healthcare.

1. Methods

Papers relating relating to the hazards of data mining in healthcare were identified from Google Scholar, PubMed (up to May 2017), and World Wide Web (blogs, news, and magazine articles). The following key terms were searched as headings or text words in titles and abstracts: “data mining”, “challenges”, and “issues”. All articles were searched focusing on the limitations and challenges relating to the use of data mining in healthcare. Furthermore, the relevant information from each article was extracted, analyzed, and included in the review.

2. Results

A variety of articles of relevant papers were found relating to the challenges around the use of data mining in healthcare. Below we summarize our findings into three themes relating to data reliability, data sharing, and data modelling.

2.1. Data Reliability

One major challenge that relates to building data mining models is the quality and the relevance of the data used in the healthcare data mining project [4]. Healthcare data is complex and collected from a variety of sources that include structured and unstructured healthcare data and “without quality data there is no useful results” [4]. Furthermore, there is minimal consistency across healthcare organizations in the use of metadata and healthcare standards which impact the quality of the data generated by healthcare information systems [5]. Complexity further occurs with how medicine is practiced across different hospitals impacting the creation of data and its ability to be reused for data mining projects [5]. Denaxas, Asselbergs, and Moore use an example of measuring blood pressure or white blood cell counts which can be recorded across different hospitals in different ways and under different contexts, depending how medicine is practiced within the respective hospital [5].

2.2. Data Sharing

Data sharing across healthcare organization is a major challenge for the data mining field. Healthcare organization have yet to setup a health information exchange for sharing health information, where patients may not be willing to disclose their healthcare data for use in data mining projects [4]. Privacy concerns across healthcare organizations also add to this difficulty of bringing together healthcare data from a variety of healthcare organizations [6]. Security of healthcare data is also a major concern, where the security of healthcare data within a healthcare organization have come into question with the increased number of security threats that have been occurring over the past few years [7].

2.3. Data Modelling

Patterns that are found in data mining outputs may be subject to random fluctuations thus making their verification and application difficult [8]. For example, data mining techniques used for predictive modelling are based on common hospital practices that may not necessarily follow best practice models, where such a model can recommend inappropriate medication orders that will be used and reinforce poor decision making within the healthcare organization and impact the delivery of patient care [9]. Also, data mining provides “no concrete answers” as data mining techniques only discover patterns in the data without explaining why these patterns exist, which is dependent on the specificity and sensitivity of the data mining tools impacting the predictive value of the information generated [10]. Also, scientists have challenged the real world value of data mining, where significant trends do not explain causation and without domain knowledge experts, the interpretation of data mining results by non-healthcare experts may lead to errors decision making [10].

3. Discussion and Conclusion

Our research study provides insight into the limitations and challenges relating to the use of data mining healthcare. We found that there are a variety of challenges in the use of data mining in healthcare that relate to data reliability, data sharing, and data modelling. With the growing in the number of data sources available today from the internet and transaction based systems (such as the Electronic Medical Record) more work on the use of data mining in healthcare is warranted. During our review, we did not find overwhelming evidence on the positive impacts of data mining in healthcare, although our scope was limited to data mining challenges and limitations.

We strongly recommend that data mining researchers ensure that they use large sets of data that are representative of the real world using the relevant domain knowledge experts to help understand and interpret the data generated from data mining results/outputs. Allowing technical (ie., computing science) experts with little or no healthcare background to develop data mining algorithms without user input from healthcare providers will lead to incorrect decision-making which can negatively impact patient care.

Furthermore, we recommend that more data mining experiments need to be conducted in healthcare. As there is an ever increasing number of data sources being generated from transactional systems, the internet and wireless medicine, more data mining projects can be implemented within the healthcare setting. As more healthcare organizations are becoming data driven, data mining, applied in the right manner, may provide insights into the data being collected within the healthcare organization, hence, improving how healthcare is delivered. Understanding and interpreting the data in the correct manner and with relevant content experts can help pave the way for future studies to explore and find the underlying reason behind a number of healthcare challenges being studied.

Overall, data mining has a variety of limitations that were only touched upon during this review. The work presented in this paper has a few limitations. Firstly, the literature search was biased towards finding limitations and challenges related to data mining in healthcare. As a result, studies that provide advantages to data mining in healthcare were not included in the results. Furthermore, the results pertaining to this study are not meant to be generalizable, but to rather question some of the applications of data mining in healthcare. Also, because we did not follow a comprehensive methodology in our search of the literature, many information sources may have been overlooked. Future work should take into consideration some of the issues raised within this review and conduct more studies on the limitations and challenges on the use of data mining methods in the analysis and interpretation of healthcare data, especially as it relates to patient care.

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Designing a Safety Reporting Smartphone Application to Improve Patient Safety After Total Hip Arthroplasty

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Abstract. This paper presents a safety reporting smartphone application which is expected to reduce the occurrence of postoperative adverse events after total hip arthroplasty (THA). A user-centered design approach was utilized to facilitate optimal user experience. Two main implemented functionalities capture patient pain levels and well-being, the two dimensions of patient status that are intuitive and commonly checked. For these and other functionalities, mobile technology could enable timely safety reporting and collection of patient data out of a hospital setting. The HCI expert, and healthcare professionals from the Haukeland University Hospital in Bergen have assessed the design with respect to the interaction flow, information content, and self-reporting functionalities. They have found it to be practical, intuitive, sufficient and simple for users. Patient self-reporting could help recognizing safety issues and adverse events.

Keywords. User-centered design, HCI, adverse events, self-reporting, patient empowerment

Introduction

Patient safety is a subject of concern for healthcare providers and the industry. In the field of arthroplasty, safety enhancing procedures are developed for both staff and patients. Information given to patients is mainly in the form of instructions concerning the perioperative treatment. Currently there are no technological solutions that could enable patients to report severe adverse events and prevent damages. There is evidence of cases when patients come to hospitals with significant postoperative injuries and long periods of sustained pain.

The outcome of adverse events has a negative impact on patient well-being, societal costs, as well as the reputation of healthcare. In Norway, from 2011 to 2015, 3,4 billion NOK was paid out in compensation costs related to the outcome of adverse events. The field of Orthopedics was responsible for 37% of the compensation claims [1]. Therefore, one could take advantage of mobile technology to prevent the occurrence of severe adverse events.

This research sees value of empowering patients not only through the general information, but also through capturing patient main data such as pain level, anxiety,

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mobility, progress, and quality of recovery. Similar efforts have been done by Nelson et al. [2] and Dine et al. [3].

The design described in this paper is based on the clinical practices in Norway which informs patients about the major course of recovery, risks, expected level of pain, mobility, and surgical area management [4].

A possible advantage of mobile technology is to facilitate for communication and interaction between patients and healthcare staff. Successful experiences have been seen in oncology [5] and heart disease [6] resulting in improving the quality of patient care.

A safety reporting smartphone application was created to prevent the occurrence of severe postoperative adverse events. This was done by enabling self-reporting throughout the whole course of rehabilitation.

1. Method

A user-centered design approach [7] was utilized in order to achieve an optimal result regarding user experience, as the framework extensively emphasizes requirements by addressing possible users in the design process, prototyping, and evaluation. The application requirements were gathered at an early stage in the development process through a field study and a literature search, combined with a discussion involving biomedical experts and a chief surgeon at the Haukeland University Hospital in Bergen, Norway.

Firstly, to evaluate the application's interaction flow and design, an expert review [8] was carried out with an experienced academic in Human-Computer Interaction.

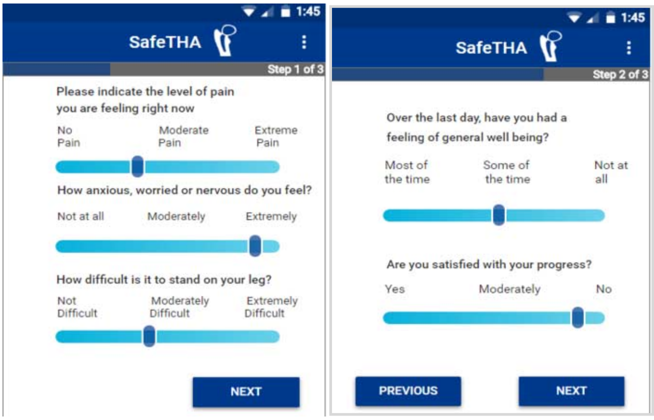
Secondly, SafeTHA's content and suitableness was discussed with a physician in an open interview. In addition, the physician tested the prototype by completing the self-reporting process.

Thirdly, a female nurse, 51 years of age, that has recently undergone total hip arthroplasty tested the application and provided feedback.

Lastly, a physiotherapist assessed the statements regarding mobility as well as the prototype.

2. Results and Discussion

The field research has influenced the content and functionalities of the application, which was designed primarily for Android devices by using a prototyping application named Axure RP Pro [9]. SafeTHA enables and aids patients, the primary user group, to self-report important factors and prevent postoperative adverse events such as pain, anxiety, mobility, as well as help with the progress, and quality of recovery. Additionally, it informs patients about recommended activity levels after surgery, risk factors and how to reduce them, manage the surgical area, and pain aspects.



Please indicate the level of pain you are feeling right now

How anxious, worried or nervous do you feel?

How difficult is it to stand on your leg?

Over the last day, have you had a feeling of general well being?

Are you satisfied with your progress?

Figure 1. Left: Self-reporting of pain, mobility, and anxiety (Screenshot).
Right: Self-reporting of quality of recovery and progress (Screenshot).

The first self-reporting screen, depicted in Figure 1 (left), enables the user to assess pain, anxiety, and mobility. The physiotherapist suggested that one could add several statements to mobility, e.g. "*do you have any problems getting in and out of bed*?", however the HCI expert advised against it. The expert highlighted the importance of making the self-reporting process as effortless as possible. The physician had a similar point of view; to lower the threshold of self-reporting. In addition, he suggested to add a help text to the pain and anxiety statements, as there could be a misconception regarding how they are interpreted in this self-reporting context. Figure 1 (right) illustrates the second self-reporting screen, which contains a quality of recovery statement and a statement regarding the patients' progress. One of the previous designs included a possibility of taking a picture of the surgical area, however the expert in HCI was against it and claimed that it would lead to low-quality data. Initially, the physician thought gathering pictures was a great idea, however it could increase the possibility of contamination and could lead to an increased risk of adverse events. Therefore, he suggested to add a statement concerning patient progress instead. Furthermore, the physician found the self-reporting statements to be satisfactory for gathering data, as well as useful and sufficient for preventing the occurrence of adverse events. As for reporting frequency, he recommended that patients could report daily the first postoperative week, followed by two times the second week, and once in week three and four respectively. The former patient thought the application was straight-forward, easy to navigate, and would be a simple way to carry out the self-reporting. Moreover, she proclaimed that by having health personnel monitor the patients' current status would be a "*great relief*". Mobile technology is widely available and makes it possible to access the general information about the patient context-independently. Most patients carry their smartphone everywhere, which could be highly valuable for self-reporting and capturing the data regarding discomfort and pain. The physician stated that the general information in SafeTHA was adequate, as it covers all the information that patients are concerned with after hospital discharge. The information given to patients vary greatly from hospital to hospital, but the essential information is captured within the current design. When a patient has completed the self-reporting, starting at day 1 after the surgery, a summary of the report in PDF format is sent to healthcare personnel, the second user group. Thereafter, if they notice any major differences such as pain level at day 6 is worse than at day 1, there is a possibility for a timely intervention via direct contact with the patient. A staff member has the opportunity to assess the patient situation and advise. An example of the self-reporting visualization regarding pain level can be viewed in Figure 2. The data filled in by the patient is on the scale from one (best) to ten (worst).

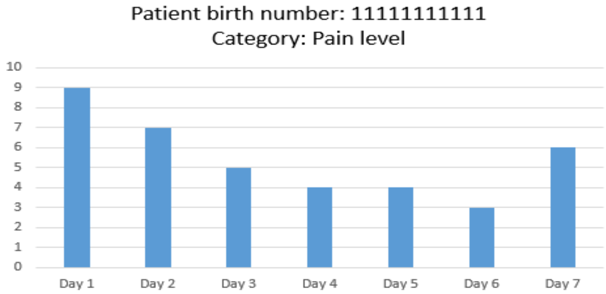


Figure 2. Example of pain level visualization (Screenshot).

The purpose of SafeTHA is to assist the detection of adverse events, however one cannot solely rely on the application. According to the physician, the application could also uncover how good healthcare is at providing services, not only limited to the surgical domain. Lastly, he added that self-reporting in general is highly relevant and of great importance.

3. Conclusion

The design has enabled a simple, straightforward way of self-reporting the patient's current state post-surgery. The findings indicate that the application is capable of capturing an early onset of adverse events. It affords an interaction between patients and healthcare staff in a simple, easy to follow manner. Evaluation has been carried out with an HCI expert and healthcare professionals. They have evaluated the interaction flow, content of information, as well as self-reporting, and found it to be practicable, intuitive and sufficient.

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The EVOTION Decision Support System: Utilizing It for Public Health Policy-Making in Hearing Loss

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Abstract. As Decision Support Systems start to play a significant role in decision making, especially in the field of public-health policy making, we present an initial attempt to formulate such a system in the concept of public health policy making for hearing loss related problems. Justification for the system's conceptual architecture and its key functionalities are presented. The introduction of the EVOTION DSS sets a key innovation and a basis for paradigm shift in policymaking, by incorporating relevant models, big data analytics and generic demographic data. Expected outcomes for this joint effort are discussed from a public-health point of view.

Keywords. Decision Support System, public health policy making, hearing loss

Introduction

Decision making is pivotal to public health policy. Public-health policy decision making (PHPDM) outcomes are being drafted, adopted, implemented, monitored and evaluated based on guidelines, methodologies, templates and extensive interaction and collaboration among governmental institutions, policy implementing authorities and non-governmental stakeholders. Therefore, the introduction of a Decision Support System (DSS) to PHPDM would offer profound opportunities, as it has already happened in the healthcare section. However, we have found that there is a lack of research focusing on the design, implementation and evaluation of DSS in PHPDM, especially in the field of the prevention and management of hearing loss (HL), which has been of very limited use. For that reason, we are re-introducing the DSS role in PHPDM, with the purpose of providing data retrieval and summarization functionalities for text-mining related tasks, aimed mainly at PHPD makers and clinicians.

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1. State-of-the-Art Analysis

There are some ontology-based approaches for collaborative modelling of public policies and for managing these across their entire life cycle (i.e. G2G collaboration [1]) which also provide support for SWOT (Strengths, Weaknesses, Opportunities, Threats)-based situational analysis in policy modelling and formation, development of an action plan, implementation and monitoring. However, such approaches exploit the capabilities of information and communication technologies, only to facilitate collaboration and synthesis required in public policy-making in general. They do not provide features so as to enable selections between alternative policy options based on generated evidence, resulting from automated big data acquisition and analysis.

On the other hand, several tools to support the decision-making process have been reported recently for public health policy making (PHPM): a probabilistic decision support algorithm [2]; a browser-based multi-data visualization tool for surveillance of public health impact of climate change [3]; a data mining, warehousing and ontology system [4]; and an agent-based model-driven system for information-fusion, data-mining and decision scenario generation [5]. However, none of the existing approaches provide an integrated platform, supporting the specification of PHPDM models based on analysis of evidence that can be generated in explicitly specified ways. Moreover, the monitoring of policies instilled by such models -which are also based on the automated and continuous analysis of evidence using big data techniques- is still unexplored in the PHPM concept.

The purpose of this paper is to describe the EVOTION DSS functionalities along with its foundational setup, being a part of an integrated platform that enables the collection and analysis of heterogeneous datasets related to HL. These datasets include hearing aid usage, physiological, cognitive, medical, personal, occupational, behavioural, life style, environmental and open web data to be imported into the DSS.

2. EVOTION DSS: Foundational Framework and Functionalities

The purpose of the EVOTION DSS is to provide data retrieval and summarization functionalities for text-mining related tasks, aimed mainly at PHPD makers and clinicians. They should in turn define and produce decision-related scenarios, based on information coming from the EVOTION platform, as well as from external/open sources. For that reason, the following interfaces are to be implemented, as part of the DSS:

- External Data / Document Upload Related Interfaces, which will allow the user to upload documents in pre-defined formats to the DSS Document Repository
- EVOTION Data Import Related Interfaces, which will allow the user to query data reports produced by the EVOTION platform components
- Information Extraction / Question Scenarios Related Interfaces, which will allow the user to select analysis type and definition of factors via pattern matching algorithms and to select questions (scenarios) to be run in order to produce decision-producing cases, and
- DSS Scenarios Reports Related Interfaces, which will allow the user to view DSS-produced reports

The reasoning behind the aforementioned interfaces and their related functionalities stems from the need to develop a text-mining (TM) based DSS, which mainly provides data retrieval/summarization functionalities. These functionalities can be extended to the modelling and simulation purposes required for PHPDM, therefore a common basis needs to be set up, as described below.

In determining multicausality for some chronic disease (such as HL) in epidemiology, a model called Rothman model or Rothman's Causal Pies is used among several other models [6]. The aforementioned model explains that chronic illness will arise when for a short or longer period of time all necessary components -called "component causes"- act upon (or inside) a patient. Amongst the component causes in every case, a component called “necessary cause” is present because without it, the disease does not occur. In the same context, EVOTION DSS is built from all component causes, gathering data from the EVOTION platform as well as several heterogeneous data sets (elements of the HL health problem), suggesting that each component cause is a necessary cause too, at the same time.

In the PHPDM procedure, having a DSS is considered an important asset because at the end of each decision modelling process, users simply want to see related information (as happens in the healthcare section). Prior to getting this information, the decision modelling process must deconstruct the health problem of interest (i.e. HL) to its most elementary parts. This procedure is nothing more than identifying each component cause, this time exactly located on the health problem itself. The produced modules should be suitable for IT processing, data analyzing and statistical modelling processes to be realized by a DSS.

Therefore, in the very beginning of the data deconstruction process, there is a need for setting cornerstones understandable and acceptable by everyone. As far as the EVOTION DSS is concerned, our basis is the International Classification Disease-10 (ICD10) coding system aimed at HL, as well as the International Classification of Functioning, Disability and Health (ICF).

Table 1. DSS Datasets.

ICD10 Procedure Coding System (ICD10-PCS)
2017 ICD-10-Clinical Modification (ICD10-CM) Table of Drugs Index
International Classification of Primary Care
Census trend defined by sex, race and age parameters
Educational attainment
Employment, incidence and prevalence of employment/unemployment rate according to sex, age parameters
Marital status
Gross Domestic Product (GDP) trends
Total healthcare costs and direct/indirect costs for HL patients
Incidence and prevalence of ICD-10 and ICF HL codes and their trends
Pricelist for appropriate codes of ICD-10-PCS and ICD-10-CM
Pricelist for hearing aids and their annual maintenance
Risk factors for HL patients
Literature review, Reports and Related Papers
Calculation of SWOT and other economic analysis parameters: Cost-effectiveness (Cost-utility and Cost-consequence analysis), Cost-of-illness, Cost-minimization, Cost-benefit, Budget-impact
Calculation of factors such as: Disability-Adjusted Life Years (DALY), Years of Life Lost (YLL), Years Lost due to Disability (YLD), Years of potential life lost (YPLL) or potential years of life lost (PYLL)
EVOTION clinical data outputs

The functionalities of the EVOTION DSS will help to deconstruct the HL problem and enable the identification, simulation, selection and monitoring of the effectiveness of possible and implemented interventions. The latter is related to the management of

HL and the overall inclusion and well-being of HL patients, in processes aimed at the formulation of related public health policies properly. In that concept, there is a need of defining (a) publicly available datasets, (b) EVOTION-platform produced datasets and (c) different international classification codebooks available in the healthcare domain, as component causes. These datasets (component causes) are presented in Table 1.

The analysis of these datasets via the DSS, will allow Public Health Authority Actors (PHAA), HL patients, clinicians, insurance companies and other stakeholders, to create different decision options by changing input parameters –real (modeling) or virtual ones (simulating)–, as well as to detect and avoid model uncertainties.

3. Conclusion

Although efforts to improve the evidential basis and the adoption of computing technologies and analytics methods never ceased to be made, those existing are all still largely underused in all stages of the public policy-making lifecycle. The introduction of the EVOTION DSS sets a key innovation and a basis for paradigm shift in policymaking, by incorporating: (a) the development of PHPDM and simulation models to enable the exploration of the effects of the decisions that they generate, (b) the use of big-data analysis of heterogeneous data sets related to HL, and (c) the use of generic demographic data available for the region that a policy is intended for.

By developing a versatile, flexible, validated and credible quantitative system for executing population HL-related models, by providing a framework for domain experts to collaborate on model design and validation, and by enabling a decision support process that allows health professionals to interact with these models, the EVOTION DSS is bound to set an unparalleled demonstration of decision support models for public health HL-related data, setting the foundations for future related systems.

Acknowledgements

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Residence as a Diagnostic and Therapeutic Area – A Smart Home Approach

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Abstract. The “research apartment Halberstadtstraße” (HSS) in Braunschweig, Germany, is the attempt to realize a personal living environment as a room for diagnostics and therapy with the support of health-enabling and ambient assistive technologies (HEAAT). As a research tool, the HSS will enable the efficient implementation of new HEAAT and help in evaluating these under controlled real-life conditions. This new research tool will therefore be the missing link between artificial laboratory and complete real-life conditions. For a defined period, selected subjects can live in the HSS and experience the benefit of such a “Smart Home”. The academic support in a real-life controlled living-environment enables continuous monitoring of behavior patterns and habits of healthy and ill persons, evaluation of new HEAAT, and conduction of requirements analysis and acceptance studies.

Keywords. Smart Home, Ambient Assisted Living, Behaviour Monitoring and Interpretation, Health-Enabling and Ambient Assisted Technologies

Introduction

The personal living environment as a room for diagnostics and therapy is an approach to make use of modern information and communications technology introduced to many modern residences around Germany for medical care. This approach benefits from previous research and development for smart homes and health-enabling and ambient assistive technologies (HEAAT). Haux et al. conclude in [1] that “*HEAAT remain an important field for future health care and for interdisciplinary research”*.[1,2]

Many academic papers in this topic prove this progress. Smart Home projects like CASAS [3,4], IRIS [5], COACH [6], HELPER [6] and BASIS [7,8] play a pioneering role due to their sophisticated research status. Reviews for employed Smart Home technologies prove versatile possibilities which exist to build up a Smart Home [9–12]. It is notable with all of these projects that the benefit for medical care could not yet be proven. Martin et al. showed in their review that currently there are no randomized controlled trials (RCTs), quasi-experimental studies, controlled before and after studies (CBAs) and interrupted time series analyses (ITS) for the use of Smart Home in medical care [13].

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The goal of the “research-apartment Halberstadtstraße” (HSS) located within the Heidberg district in Braunschweig is to contribute to establish home as a room for diagnostics and therapy for medical care. According to planning of this research-apartment the following research hypothesis were derived [14]:

- *Behavior* monitoring for specific disorders: Previous studies have shown that people with specific disorders profit most from health-enabling technologies. Because of the difficult transfer to everyday settings of affected people the evidence is often still absent. The HSS could provide this evidence.
- Sensor-based analysis of activities of daily living: Activities of daily living (ADL) are a key to measure health states of people. Within the controlled environment of the HSS, these ADLs can be measured over a longer period with different individuals. Especially the controlled equal conditions of the research apartment will provide new results through comparable evaluation.
- Practical determination of required sensor equipment: For detection of a specific disorder the required sensors cannot be determined without practical tests, because every individual and every disorder is different. The HSS enables these kind of tests and could permit identification of easily parameterizable sensors.
- Conduct studies on acceptance and demand: Participants do not need to imagine part of the use but can experience the use completely. Studies on acceptance and demand based on long term experiences in real everyday life might result in a more realistic, and therefore better data quality.

1. Methods

The first step in designing such an apartment was a complex requirement analysis on modifications and features of the residence with the help of expert discussions and literature reviews. The key requirements identified in this process were functional requirements for technical features of the residence. Additionally requirements like accessibility, disability friendliness, a non-stigmatizing environment and almost unnoticeable sensors were determined. With these requirements, plans for modification were specified. Conversion work was carried out in 2014 and 2015. In the beginning of 2016 the apartment was declared open and the first tenant moved in. Figure 1 shows the apartment’s floor plan including the color-coded sensor layout. A KNX building automation system and its corresponding sensors and actuators were used [15]. For data recording a mini PC with a teafile database and a DynDNS for remote access was set up. Data collection is performed by logging of data transfers on the KNX bus and storing these logs in teafiles. Stored data includes: Presence in apartment, time of tap use, time of departure, opening and closing of windows and exterior doors, room temperature, humidity and ambient light. Until now long term data of one subject over the curse of one year and three months is available.

2. Results

Using modern data mining methods like clustering, ADLs of the occupants can be derived. Further data analysis was made with sensor fusion and role-based and knowledge-based methods for data analysis. A simple presentation of this data is in the form of the course of the day over 24 hours (see Figure 2). Determination of differences between different daily routines indicates changes of ADLs and normal behavior. Furthermore, the time of presence, the amount of active hours per day, the separation of activities in kitchen and bath to determine eating and hygiene behavior, and also nightly activities and therefore conclusion on sleep quality can be calculated.

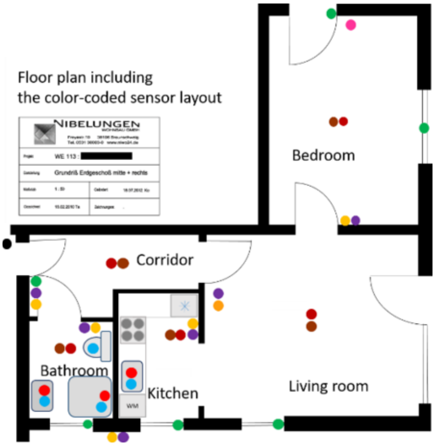

Figure 1. Floor plan of HSS in Braunschweig. Installed sensors are color-coded: dark red presence detector, brown ambient light, green door and window contacts, blue flow rate cold water, red flow rate hot water, purple temperature sensors, yellow humidity sensors.

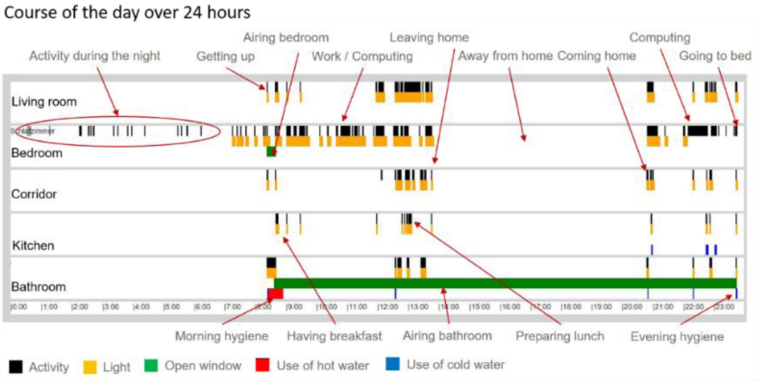

Figure 2. 24 hour plot of acquired data. Recognized activities are labeled. In addition, this diagram shows daily routine of the tenant.

3. Discussion

We built up a Smart Home to address the conclusion of [1] "*that a person's home and their interaction therein, have become important components in the health care provision, assessment, and management*". The road to achieve our goals with HSS remains long. Our limitation in methods is that we still work with data of a healthy 30-year-old man and for some analytics like the automated detection of broken sensors time is a critical factor. Our approach is comparable with the Smart Home Projects CASAS [3] and IRIS [5]. Thus we totally agree with the conclusion of these papers. More studies with high quality outcomes are required and to realize such studies we need the possibility to expand data collection with a higher number of residents. This will enable us to find the key aspects (e.g. minimal sensor set for maximized data outcome) and to generalize the whole setting to transfer it to different disorders and residents. Our next steps will be to go more into detailed data analysis and to start studies on acceptance and demand. In addition, provision of analyzed data from smart home for health care at home, in hospitals and for ambulant heath care professionals is a topic that we work on.

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Creating XML / PHP Interface for BAN Interoperability

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Abstract. Recent advances in medical and electronic technologies have introduced the use of Body Area Networks as a part of e-health, for constant and accurate monitoring of patients and the transmission as well as processing of the data to develop a holistic Electronic Health Record. The rising global population, different BAN manufacturers and a variety of medical systems pose the issue of interoperability between BANs and systems as well as the proper way to propagate medical data in an organized and efficient manner. In this paper, we describe BANs and propose the use of certain web technologies to address this issue.

Keywords. ehealth, BAN, XML

Introduction

Nowadays medical technologies and research on them are at their peak. Many products that monitor patients' health factors render constant patient "close monitoring"2 obsolete. That is because many of these products have biometric sensors which use the intake of values and compare them with risk factors to warn the patient or the physician about the current condition and the next steps that need to be taken by either party to avoid a severe situation. Moreover, the use of biometric sensors creates an extreme volume of data that must be manipulated to extract the information needed. As an example, the use of Electronic Medical Record (EMR), Electronic Health Record (EHR) and Personal Health Record (PHR) [1] posed the issue of data transfer between different systems and devices as well as the issue of manipulating those data to be available. Targeting this issue, we present a methodology of using Web Technologies to achieve a transfer of data in an organized manner that can be adopted by different system and Body Area Network (BAN) manufacturers. The purpose of this methodology is to offer interoperability for devices of different vendors so that data gathered by one system can be available to and translatable by a different manufacturer's system.

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[2] We use the term "close monitoring" to distinguish the proximity of the monitoring. For "close monitoring" we mean that a health professional must be physically close to the patient so he or she can take the patients' vital measurements and document them on a piece of paper

1. BANs

Advances in Internet of Things (IoT) and Information and Communication Technology (ICT) has enabled the need of integrating Body Area Networks (BANs) in healthcare. BANs are comprised of a plethora of heterogenous biometric sensors which are either Wearable Medical Devices (WMDs) or Implanted Medical Devices (IMDs) and are used for measuring changes in a patient's vital signs [2-4]. This large amount of data [5] is to be stored, processed and analyzed in order to provide constant health monitoring for patients individually to help keeping an updated and detailed PHR. With a detailed PHR patients can keep track of their health and can present their physician the data needed for further diagnosis or treatment. Wireless technology advancements have led to the emergence of WBANs (Wireless Body Area Networks). WBANs can be supported by the use of Wi-fi, Bluetooth, ZigBee (for personal area networks) [6,7], RFID (Radio Frequency Identification), IEEE 802.15.6 (WBAN standard) and more [8]. Since the number of BAN manufacturers is increasing, different technologies are at hand as so as in different medical systems that use BANs. Moreover, the number of people that are to use this kind of equipment is about to double until 2050 [9], leading to an immense increase of data to be processed and stored [5]. Therefore, the issue of interoperability of BANs [10] so that sensor data not to be isolated in a local system, is to be addressed.

2. BAN: deployment of an ECG sensor

What we are proposing is the design and implementation of an interface that uses Web Services to support the development of medical related applications on low cost devices. We created a web based interface that is commonly acceptable which can be used by Body Area Networks' (BANs) manufacturers and e-health programmers. This leads to an initial solution of the interoperability issue and the sharing of biometric and medical information, thus facilitating the establishment and usage of EHRs and PHRs. In order to do so, we propose the use of XML (eXtensible Markup Language) as the basis of a structured and light way of sending massive amounts of data through networks. This is because XML has been created for large scale electronic publishing and to facilitate the exchange of a wide variety of data in networks [11]. Since XML data structure is embedded with the data, the sharing of information is consistent. Moreover, the data are in plain text format, so there is independence of software or hardware [12]. To create the data structure, we take advantage of XSD (XML Schema Definition). Moreover, we use PHP (Hypertext Preprocessor) to simulate a server – side reception, processing and transmission of data to verify the proposed way and its functionality. With the use of an Arduino Uno microcontroller, a low-cost hardware platform which in our project acts as a server, we will be able to receive data from the biometric sensors attached to e-Health Arduino Shield and make them available by transmitting them using an XML format in a network of a plethora of connected devices.

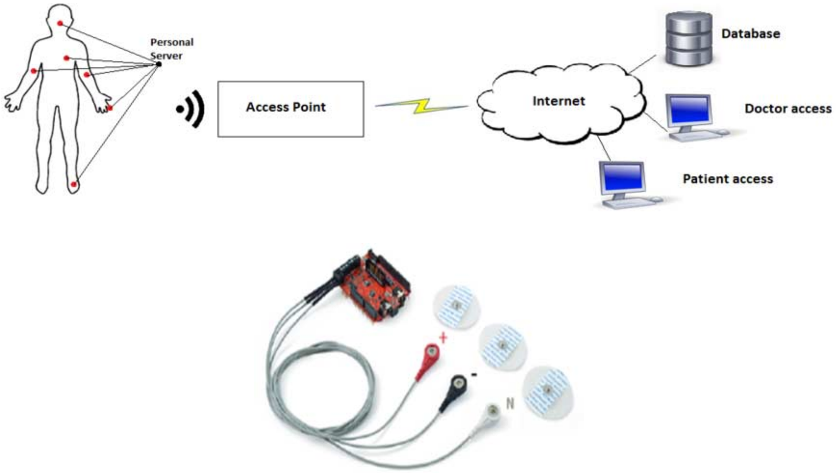

Figure 1. Connectivity of a WBAN and Personal Server.

As an example, we take the ECG sensor operation. The personal server [13] comprises of an Arduino Uno microcontroller, an e-health Arduino Shield and a Wi-Fi module. After uploading the compiled code on the microcontroller, it starts receiving data from the ECG sensor [13].

Figure 2. E-health Arduino Shield with ECG sensor leads connected on it.

The data collected are time and voltage values separated by a delimiter (here is the semicolon). By using PHP, the microcontroller acts as a server and while it receives data periodically, it uses XML variables (<time>, <ECG_voltage>) to organize them with tags. Following this, the server validates the labels and the format of data using the schema provided in XSD and then it makes them available to be stored in the server's memory. From now on, these data are available to be accessed via a user's GUI or by any other application that uses these data to build database records that can then be added to existing or create new Electronic Health Records. This enables every software engineer or programmer to take an existing interface and use it to fit the needs of their projects. As a result, more database systems can be updated to use a global format in order to overcome the previously mentioned issue of interoperability.

3. Discussion

Medical sensors and BANs play a vital role in modern medicine for creating and maintaining a detailed and accurate EHR. As global population grows and medical technologies advance, the amount of data to be stored and processed increases geometrically. In addition, different medical system and BAN technologies pose an issue of interoperability. With the use of the interface proposed, we manage to share data between different technologies of BANs seamlessly, without hardware or software dependencies. In the future, this can be used by programmers of medical software and systems to establish a standard way of interconnecting BANs and sharing the data received through networks to create, enhance or modify EHRs. Upon completion of this task, the interface proposed can be applied in a hospitalized environment in order to achieve a global interconnection of establishments so that patients' data are available to each physician in the world. This could also reinforce medical research of professionals or students in the field, by providing case studies with actual data.

Since this is an ongoing project, one of the great issues at hand is gathering raw data from each vendor's system and structuring them with our proposed scheme, since the amount of companies in the field is vast and procuring each device is somewhat troublesome.

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Associations Between Hearing Performance and Physiological Measures - An Overview and Outlook

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Abstract. The current paper summarises the research investigating associations between physiological data and hearing performance. An overview of state-of-the-art research and literature is given as well as promising directions for associations between physiological data and data regarding hearing loss and hearing performance. The physiological parameters included in this paper are: electrodermal activity, heart rate variability, blood pressure, blood oxygenation and respiratory rate. Furthermore, the environmental and behavioural measurements of physical activity and body mass index, alcohol consumption and smoking have been included. So far, only electrodermal activity and heart rate variability are physiological signals simultaneously associated with hearing loss or hearing performance. Initial findings suggest blood pressure and respiratory rate to be the most promising physiological measures that relate to hearing loss and hearing performance.

Keywords. hearing loss, hearing performance, sensors, wearables, physiological measures

Introduction

One of the fastest growing markets of this decade is that of the wearable healthcare devices (i.e. smartwatches and wristbands) [1]. Given the amount of data that such devices record, they make possible the collection of large heterogeneous datasets that combine data from wearables with observations and monitoring of people with a known health-related condition, e.g. hearing loss (HL). These data can help shape evidence-informed public health policies, which require data provided by and for technological, clinical, legislative and political actors.

The EVOTION project (http://h2020evotion.eu) funded under the Horizon 2020 programme of the European Union uses data collected from hearing aids (HA) and

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sensors included in a wearable (smartwatch) to assist in the formulation of evidence-informed public health decision models in HL related policy making.

To do so, it is crucial to establish a basis for associations between existing sensor technology, as they are included in wearables, and HL and hearing performance (HP). Therefore, for the first part we considered sensors measuring physiological data, namely skin conductance -also known as electrodermal activity (EA)-, heart rate variability (HRV), respiratory rate (RR), oxygen saturation levels (SpO2) and blood pressure (BP). The hearing measures part includes the severity of HL and HP, such as speech understanding or listening effort.

1. State-of-the-Art Analysis

Published research has so far focused on relating HL and two physiological parameters: EA and HRV. Summarising the literature published over the last 5 years (2012-2017), we have grouped the reviewed publications that measure associations with the physiological parameter they have researched, as shown in Table 1.

Table 1. Published research and the physiological parameter correlating with either HL or HP.

Physiological Measurement	Related Studies
Electrodermal Activity	[2], [3]
Heart Rate Variability	[3], [4]
Blood pressure	[4], [5]
Blood Oxygenation	None
Respiratory Rate	[3]
Environmental/Behavioural Relations	**Related Studies**
Smoking	[6],[7],[8],[9]
Physical Activity	[9],[10],[11],[12]
Body Mass Index (BMI)	[8],[9],[11],[12]
Alcohol consumption	[7],[13]

Below we present the results outlined by reviewing the aforementioned studies:

1.1. Electrodermal Activity

EA can be used as a measure of the stress that a person experiences. A change in the impedance of the skin, due to altering transpiration, is measured and used to determine the electrodermal activity. Speech recognition tests have been conducted: listeners were asked to rate the difficulty of understanding speech samples masked in noise in varying signal-to-noise ratios. During these subjective listening effort tests, skin conductance was measured. EA was then associated with increased listening effort (HP). [2,3] The results showed an increased EA for higher effort, displaying a higher stress level in harder listening situations.

1.2. Heart Rate Variability

Like EA, HRV is a measure of the stress that a person experiences. [3 and 7] found HRV to be associated with HP. In subjective listening effort tests (described in *1.1.*), this stress parameter has been measured simultaneously. With increasing difficulty, the HRV was decreasing, signalling higher stress levels. [3] Furthermore, people who experienced a sudden HL showed a lower HRV during night time measurements. [4]

1.3. Blood Pressure

BP is associated with HL. However, the conducted studies [4,5] were carried out through a longitudinal design. They found that higher BP is associated with a higher risk of experiencing a HL later in life [4]. Furthermore, people exposed to noise in the workplace have reportedly higher BP. [5]

1.4. Respiratory Rate and Blood Oxygenation

The literature currently published does not show any associations between other biosignals (RR and SpO2) and HL nor HP. No studies investigate the relationship between SpO2 and HL nor HP. In [3] RR was not associated with HL nor HP.

1.5. Environmental and Behavioural Associations

Environmental parameters, such as BP, have been investigated longitudinally for their association with HL and HP.

The amount of smoking was in [6-8] associated with severity of HL. Physical activity seems to prevent or delay HL [9-11]. Findings also suggest that a higher BMI increase the chance of HL for women [11], whereas men seem less affected. [9] Conversely [10,12], found that HL can lead to decreased physical activity and less healthy lifestyle in older citizens. In [13] the type of consumed alcoholic beverages was associated with a risk of HL. Women, who reportedly consumed beer had a statistically higher chance of suffering a HL. Whereas, those drinking a moderate amount of wine, had a significantly lower chance.

2. Discussion

The link between HL/HP and environmental and behavioural factors have been studied far more than with physiological measures. The development of wearable technology supports the research conducted in the HL/HP field, as more parameters can be measured with every new smart device. The selected parameters reflect the parasympathetic and sympathetic nervous system and can therefore be directly correlated to HL; as shown in the reviewed studies, the human body reacts to the increased difficulty of understanding things due to HL. Existing, commercially available devices form a solid base on which researchers can build on, along with an increase in the variety of physiological parameters that can be measured over the past years. Research-focused wearables are also being introduced to the market at a steady rate, making data collections from these wearables and their related software more accessible to researchers.

So far, only two parameters have been correlated with HL/HR: HRV and EA. Both have been linked to stress and listening effort. Research has yet to discover the correlations and physiological responses and HP. The first five listed parameters (EA, HRV, RR, SpO2 and BP) can be measured with a good time resolution and associated with HP, as measurements can be carried out simultaneously to listening tests.

The increased stress levels can be transferred into the real world, in stating that people experiencing hearing difficulties as a result of a HL suffer more stress symptoms.

Environmental relations are important to see trends, but they require longitudinal studies to uncover associations with HL.

3. Conclusion

As our results indicate, the field of research investigating associations between hearing and physiological parameters is currently immature. Based on the state-of-the-art research, mainly stress indicators, like RR, EA and BP, should be favoured as parameters to be tested and correlated with hearing measures, e.g. listening effort. A special interest should be given to BP, as this parameter has already been proven to be correlated with HL in longitudinal studies.

A better understanding of associations between hearing and physiological parameters will help policy-makers find right solutions that protect and support those in need. Enabling better continuous access to heterogeneous data sets, thus allowing better and more information bestowed upon researchers, policymakers, and other actors involved in policymaking, is paramount.

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Pharmacovigilance Mobile Tool Design in the Field of Arhroplasty

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Abstract. Pharmacovigilance is an important part of the patient safety and it has a great appeal to physicians. It is concerned with the safety of medical devices and treatments in the light of understanding the risks and dangers based on the already reported safety issues. Internet resources such as the Manufacturer And User Facility Device Experience (MAUDE) web-site are often retrieved due to the lack of internal, local safety databases. The research looked at how Human Computer Interaction could improve user experience. We have designed data entry for safety reporting and pharmacovigilance based on the web-bases system called WebBISS (Web-based implant search system). The expectation is not only to improve usability, but also to stimulate physicians to enter their safety data and become also contributors, and not only users of information. The expert evaluation has been generally positive and encouraged stronger help and error reporting functions. The high fidelity design has given a good impression of the future mobile solution.

Keywords. HCI design, high fidelity porotype, safety reporting, pharmacovigilance, arthroplasty

Introduction

The reporting of adverse events is an important step to secure patient safety and to prevent potential medical issues in the future. It is important to understand the reasons behind adverse events so that medical staff can recognize situations of high risk for patients and identify medical devices which might endanger patients' health. In Norway severe adverse events should be reported to Helsedirektoratet to alert about the risks of either medical devices or procedures. Helsedirektoratet publishes annual reports, but offers currently no online support. Therefore many clinicians and researchers turn to the systems like MAUDE (Manufacturer And User Facility Device Experience), which is a web-based system [1], that collects and provides information about adverse events. It is available for surgeons, doctors and general public. The Federal Drug Administration (FDA) uses MAUDE to monitor medical devices and collect information about performance or warning signs regarding the patient safety.

The World health organization defines pharmacovigilance as the science and activities relating to the detection, assessment, understanding and prevention of adverse events. They have also widened the definition to include herbals, traditional and complementary medicines, blood products, biological, medical devices, and vaccines. Pharmacovigilance's goal is to improve patient care and safety in relation to the use of

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medicines and all medical and paramedical interventions with aim to improve health and safety. It also contributes to assessment of benefit, harm, effectiveness and risk of medicines, encourages safe and rationale use of medicines and devices, promotes understanding, education and training in pharmacovigilance and effectively communicates with the public.

It is essential that adverse events are reported, analyzed and communicated [2] to improve patient safety and lower health care costs in the process [3]. Pharmacovigilance is important in ensuring that doctors and patients have enough information to make a decision regarding a treatment [4].

We have explored possibilities of improving pharmacovigilance in the field of arthroplasty. There is a great number of surgical procedures performed and systematically documented even within the Norwegian national arthroplasty registry [5], but there is no automatic system to retrieve pharmacovigilance information. To improve that we have first developed a web-based system called WebBISS (Web-based implant search system) [6] and now designed a mobile solution by combining Interaction design and User experience techniques.

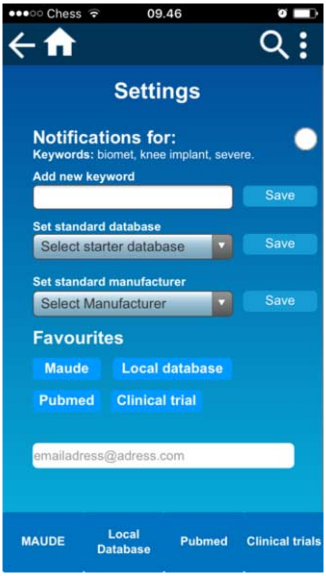
1. Method and Material

We have used Interaction design to create a high fidelity porotype trough three design iterations. The first iteration dealt with concepts of safety reporting, the second and third were directed towards designing a pharmacovigilance mobile tool. The design has combined knowledge of technological possibilities, systems, aesthetic judgment and empirical facts about users [7]. There are four possible user groups identified: biomedical engineers, clinicians, students and researchers. Evaluation considered three different prototypes ranging from the low to high fidelity prototypes; the low fidelity prototype was evaluated by two Human Computer (HCI) experts, the final high fidelity prototype was evaluated by one HCI expert.

We have followed five design principles: visibility, feedback, constraints, consistency, and affordance [8]. Those were evaluated according to the Nielsen's heuristics [9] and the System Usability Scale (SUS) [10] using a set of predefined tasks ('go to you user page', 'search for given key words', 'chose a database', and 'inspect the results'). A total of 7 evaluators performed the tasks.

2. Results

Mobile design solutions are presents as a set of screenshots. The user starts by entering key words (Figure 1) which triggers search through the MAUDE [1], Clinical trials database [11], PubMed and the internal local database proved by the biomedical engineers at the Haukeland University Hospital in Bergen. Results of the retrieval are available through the interaction of the graft (Figure 2). The interaction is also possible via navigation bar. Results of the MAUDE database (Figure 3) and the BIOMED database (Figure 4) provide detailed records in their original data format. The BIOMED database is managed by the Biomedical Engineering Laboratory as a part of the routine clinical work done on the explanted medical devices. The screenshots belong to the last design iteration (a high fidelity) [12]. The heuristic evaluation found that most of the participants were satisfied with the visibility of the system, the match between real world and system, consistency of the system, easiness of navigation and icons used, according to the evaluators. The heuristics with the lowest score was related to error prevention, help and documentation.



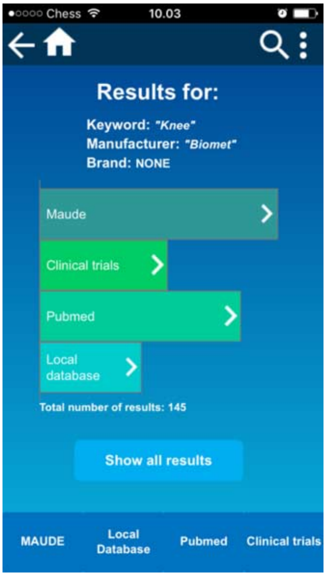
Settings

Notifications for:
Keywords: biomet, knee implant, severe.
Add new keyword
Set standard database: Select starter database
Set standard manufacturer: Select Manufacturer

Favourites
Maude | Local database
Pubmed | Clinical trial

emailadress@adress.com

Figure 1. Initial user page (Screenshot).



Results for:

Keyword: *"Knee"*
Manufacturer: *"Biomet"*
Brand: NONE

Total number of results: 145

Figure 2. Navigation through the databases for given key words (Biomet).

Date Recived: 12/20/2014
Brand Name: PALACOS R BONE CEMENT
Event type: Malfunction
Manufacturer: Biomet

Date Recived: 12/22/2014
Brand Name: PALACOS R BONE CEMENT
Event type: Malfunction
Manufacturer: Biomet

Figure 3. Results retrieved in the MAUDE database (Screenshot).

Record number: 1497
Record date: 12/20/2013
Status: Complete
Created by: EirikB
Product name: Palacos R + G
Manufacturer: Biomet

Record number: 1342
Record date: 12/20/2013
Status: incomplete
Created by: EirikB
Product name: Palacos R + G
Manufacturer: Biomet

Figure 4. Results retrieved from local database (Screenshot).

Lower scores were expected since these functions were not implemented yet in the prototype. There also seems to be a problem of understanding the medical terminology by non-medically trained participants; some words were hard to understand and it was equally demanding to grasp the content of different databases. This could be easily fixed in the future by generating an 'About' or 'Help' page. There were also some cases where most participants gave a high score, and one participant gave a very low score. This might be due to a misunderstanding, but the participant opted not to ask for help during or additional during the evaluation. All participants were told that they could spend as much time they wanted/needed and that they could ask questions at any point. The SUS scores vary from 57 to 75 and thus showing a need for improvement. Some evaluators commented that it was very intuitive to use the tool and the only help they would have liked would be an introduction to the specific databases and their content. Some of the evaluators had again issues with the medical language, which they found hard due to their background in HCI, so that they gave a low score regarding the usability.

3. Conclusions

To enable retrieval of information regarding patient safety we have proposed and designed a pharmacovigilance mobile solution. It combines different databases via one single search window. All the functionalities are designed to take the user straightforward to the public databases and retrieve safety information in an easy manner. The results suggest that the design was a good step supporting pharmacovigilance. The main reasons for hindering a prompt safety reporting seem to be a workload, work culture, a fear of reprimand [13]. Therefore a better and easier pharmacovigilance could be considered as one reliable way of enabling patient safety. The mobile tool was evaluated using the low and high fidelity prototypes which gave good critique and suggestions that will be used in the next design iteration(s).

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Intelligent Phonocardiography for Screening Ventricular Septal Defect Using Time Growing Neural Network

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Abstract. This paper presents results of a study on the applicability of the intelligent phonocardiography in discriminating between Ventricular Spetal Defect (VSD) and regurgitation of the atrioventricular valves. An original machine learning method, based on the Time Growing Neural Network (TGNN), is employed for classifying the phonocardiographic recordings collected from the pediatric referrals to a children hospital. 90 individuals, 30 VSD, 30 with the valvular regurgitation, and 30 healthy subjects, participated in the study after obtaining the informed consents. The accuracy and sensitivity of the approach is estimated to be 86.7% and 83.3%, respectively, showing a good performance to be used as a decision support system.

Keywords. Time growing neural network, intelligent phonocardiography, machine learning, paediatric heart disease.

Introduction

Trend of the healthcare technology in the developed countries shows a tendency toward development of decision support systems by which timely screening of health-related problems can be substantially improved, and meanwhile unnecessary refers to the expert physicians might be noticeably diminished [1]. A consequence of such precious attempts is an increasing life expectancy in those countries in conjunction with a cost benefits for their healthcare systems. This could be of special importance when it comes to the heart disease detection, considering the fact that heart disease is, yet evidenced as the main factor of human mortality. Serious studies have been directed to develop advantageous decision support systems for detecting cardiac disease which are implementable both on the web technology and as the stand-alone systems used by the nurses or practitioners in primary healthcare centres [2,3]. In this perspective, phonocardiogram which had been previously discoloured in the clinical settings, received interests from the multidisciplinary researchers. It could be used to detect vital signals, and to investigate cardiac lesions, thanks to the rapid progresses in machine learning methods [4-6]. Many

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studies reported applicability of the signal processing and machine learning methods in detecting septal and valvular cardiac disease from the phonocardiogram [7-11]. Our longstanding endeavour led to intelligent methods, which innovatively introduced the "intelligent phonocardiography", as a tool for improving the accuracy of detecting the heart diseases in primary healthcare centres [12,13]. However, development of a robust method for discriminating between Ventricular Septal Defect (VSD) and regurgitation through the atrioventricular valves has been an open study. The previous studies were mainly based on the analysis of the systolic murmurs, for the classification purposes. In this study whole the systolic phase is explored using our original neural network, named Time Growing Neural Network (TGNN), for the discriminating VSD from the valvular leakage. The resulting method can be installed on a portable computer to serve as a decision support system for screening the children with VSD, who need critical cares versus those with valvular leakage which is often considered as a mild pathology that may need no special treatment until a certain age when appropriate disease management is administrated. It is important to note that such a screening task can be of complexities in neonates that can be much facilitated by the proposed approach.

1. Material and Methods

1.1. Data Preparation

The phonocardiogram recordings of 10 sec lengths were collected from the paediatric referrals to the echocardiography lab at the Children Medical Centre hospital of Tehran University, Iran. A WelchAllyn Meditron Analyzer electronic stethoscope together with a laptop were employed for signal recording. The study had been approved by the local ethic committee. The informed consent was obtained from the legal guardians according to the Good Clinical Practice that complied with the Declaration of Helsinki. The patient group was introduced as the referrals with VSD, versus the reference group comprised of the healthy referrals and also those ones with Mitral Regurgitation (MR) and Tricuspid Regurgitation (TR). Table 1 lists the data population.

Table 1. Patient population

Heart Condition	Number of Patients	Average Age ± STD (years)
Healthy with no murmur (NM)	30	6.7±3.7
Mitral Regurgitation (MR)	15	11.8±4.1
Tricuspid Regurgitation (TR)	15	12.6±4.4
Ventricular Septal Defect (BAV)	30	3.6±1.2

All the referrals were examined by paediatric cardiologists who used echocardiography as the gold standard. ECG and chest x-ray were also used by the physicians as the procedural routines of the hospital.

1.2. The processing method

The processing method is based on applying the TGNN on systolic segments, where the average output of the TGNN is employed for the classification. The TGNN, uses temporal frames with the same initial point, but growing length, where the longest frame covers the whole segment. The initial point is the beginning of the systole of a cardiac cycle. Each frame is characterized by its spectral contents, which is found by using conventional periodogram. The spectral energies are calculated over a number of the frequency bands with the possibility to provide optimal segregation. The Fisher criteria is employed for finding the optimal bands [14]. Details of finding the spectral energies can be found in [15]. In contrast with our previous studies, the initial frame for a cycle defined as the length of the first heart sound within the cycle. The spectral contents of the growing frames are employed by a multi layer perceptron neural network to perform the classification. The activation function of the hidden and output layer is defined as the tangential and logarithmic sigmoid, respectively. The neural network is trained using back propagation delay method. Details of the neural network can be found in [16].

1.3. The statistical validation

Performance of the method is validated by Leave-One-Out method using the accuracy (P_{AC}), sensitivity (P_{SN}), and specificity (P_{SP}) as the performance measures.

$$Pac = 100(N_{TP}+N_{TN})/(N_{TP}+N_{TN}+N_{FP}+N_{FN}) \tag{1}$$
$$Psn = 100N_{TP}/(N_{TP}+N_{FN}) \tag{2}$$
$$Psp = 100(N_{TN})/(N_{TN}+N_{FP}) \tag{3}$$

where N_{TP} and N_{TN} are the number of the correctly classified recordings from the patient and reference group, respectively. N_{FP} is the number of the recordings from the reference group, classified as the VSD subjects and N_{FN} is the number of the VSD patient classified as reference group. In this method, one sample of the patient population is used for testing and the rest for training the method. This procedure is repeated N times ($N= N_{TP}+N_{TN}+N_{FP}+N_{FN}$) with one single sample is used only one for the testing. The testing includes calculation the three performance measures. This validation method is employed due to the fact that the group size is relatively small for learning the spectral contents.

2. Results and Discussion

The proposed TGNN, with the number of the growing frames of 8, is applied to the systolic intervals where the spectral energies are calculated over one optimal band for per frame, and therefore the features vectors have 8 dimension. The number of the growing frames is deemed to be less than one tenth of the training data size, as a practical consideration to avoid over-fitting. The accuracy/sensitivity of the method is calculated to be 86.7%/83.3%, when the Leave-One-Out method is employed for validation. Our previous analyses show that the performance might be decreased by approximately 5% when repeated random sub-sampling is employed for the validation. However, the accuracy can be improved by involving a larger training data with a broad range of the possible classes with sufficient group sizes. Nonetheless, results show an acceptable accuracy for the method in terms of decision support. The results are satisfactory even when compared to the conventional auscultation, as studies show that the auscultation accuracy is typically 50% for the practitioners and 78% for the paediatric cardiologists [17]. It is worth noting that the conventional auscultation is still considered as the first screening technique by which proper subjects are selected to undergo echocardiography. The transition from the conventional to the proposed intelligent tool can substantially improve the screening accuracy.

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Distance to Veterans Administration Medical Centers as a Barrier to Specialty Care for Homeless Women Veterans

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Abstract. Homeless women Veterans have a high prevalence of chronic mental and physical conditions that necessitate frequent healthcare visits, but travel burdens to specialty services may be overwhelming to navigate for this population, especially for those in rural settings. Access to specialty care is a key priority in the Veterans Health Administration (VHA) and understanding the geographic distribution and rural designation of this population in relation to medical centers (VAMC) can assist in care coordination. We identified 41,747 women Veterans age 18-44y with administrative evidence of homelessness in the VHA anytime during 2002-2015. We found 7% live in rural settings and 29% live >40miles from a VAMC. The mean travel distance for homeless women Veterans with a rural designation to a VAMC specialty center was 107 miles. Developing interventions to overcome this travel burden and engage vulnerable Veterans in necessary care can improve overall health outcomes for this high-risk population.

Keywords. Health services accessibility, homeless, women Veterans

Introduction

Women Veterans are the fastest growing population of U.S. Veterans Health Administration (VHA) eligible users, nearly doubling in the past decade and numbering more than 2 million in 2015 [1]. Women Veterans who access VHA services are a vulnerable population with high prevalence of medical and mental health comorbidities [1,2] and experience a 4-fold increased risk of homelessness compared to the civilian population [3]. In order to meet the needs of this growing population, the VHA prioritized expansion of comprehensive primary care by a single, designated women's health provider (DWHP) [4]. While a DWHP may be located at Community Based Outpatient Centers (CBOCs), any specialty care services, including gynecology or other medical specialties, require a referral to a Veterans Affairs Medical Center (VAMC) or to a community civilian provider, if available. Rural women Veterans have significantly worse physical health than urban Veterans, are more likely to use VHA services, and report that transportation difficulties affect health care decision-making [5]. Longer drive time is also associated with VHA attrition in women Veterans, identifying a continued need for service provision improvements [6].

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Healthcare for homeless Veterans is characterized as resource intensive due to their complex mental, physical, and socioeconomic needs [2]. Homeless women Veterans have additional reproductive health needs to avoid adverse pregnancy outcomes and, unlike Veterans with more resources, may not be able to overcome travel barriers to access specialty care. Additionally, they are less likely to access care through non-VHA providers due to lack of insurance and homeless civilian clinics have variable services and are typically located in urban settings. Thus, we undertook this study to understand the impact of travel distance to VAMCs and rural designation on access to specialty care services in homeless women Veterans.

1. Methods

1.1. Participants

We identified all women Veterans with administrative evidence of homelessness at any time who accessed the VHA between fiscal years (FY) 2002-2015 using a national VHA research database of administrative and clinical data managed by the Veteran's Informatics and Computing Infrastructure (VINCI) [7]. Homelessness was identified through previously validated *International Classification of Diseases, Ninth Revision (ICD-9)* codes, Homeless Care stop codes, or treatment specialty codes [8]. We included only women Veterans age 18-44y in birth cohorts for each FY. The University of Utah Investigational Review Board and the Research and Development Committee at the Veterans Administration Salt Lake City Health Care System approved this study.

1.2. Measures

We extracted demographic and military characteristics on all homeless women Veterans, then defined their geographic "residence" as the last known zip code reported at the VHA site of homelessness designation. The population density of homeless women Veterans per zip code was plotted on a map with locations of VAMCs. The map background included the geographic distribution of all 18-44y women Veterans using the National Center for Veterans Analysis and Statistics county-level counts.

Travel distance was measured first as the number of drive miles between the Veteran's "residence" zip code and the nearest VAMC within their Veterans Integrated Service Network (VISN). Finally, the census tract-based Rural-Urban Commuting Area Codes (RUCA) were used to assess the effect of rurality on travel distance. These codes were developed from the 2010 work commuting data from the U.S. Census Bureau and classify census tracts using measures of population density. We spatially joined these area classifications to ZIP Code data point files. There are two levels of classification and only the first level was used in this analysis: metropolitan (urban-focused, 81% of U.S. population), micropolitan (large rural city/town, 9.6% of U.S. population), small rural town (5.2% of U.S. population), and isolated small rural communities (4.2% of U.S. population) [9].

2. Results

We identified 41,747 women Veterans age 18-44y with administrative evidence of homelessness at any time between FY2002-2015. Of the participants, 19% were married, 43% identified as black, 87% non-Hispanic, 54% served in the US Army, and 40% reported a history of military sexual trauma.

We then excluded any participant with a zip code outside the continental US and those with missing or incomplete zip codes, leaving 33,873 Veterans geocoded to ZIP Codes. The U.S. Census rural designation identified 6.9% (2,321) of homeless women Veterans as living in isolated, small, or large rural settings. We found 9,665 (28.5%) of homeless women Veterans lived >=40miles from the nearest VAMC (the distance defined as "undue travel burden" by the VHA) and this group had a mean drive distance of 94.7 miles (range 40-427.9). Even those living <40 miles from a VAMC or a CBOC (32,962 (97.3%)) had a mean travel distance of 15.9 miles (range 0-39.9). The Rural-Urban Commuting Area designation for urban vs. rural found the mean drive distance to a VAMC ranged from 42.9 miles for those in a metropolitan core area to 107.4 miles for those in an isolated rural area. When drive distances also included a CBOC option, drive distances dropped to 14.5 miles and 46.8 miles, respectively (Table 1). Figure 1 illustrates a regional view of the national map for calculating travel distances.

Table 1. Homeless women Veterans' Rural-Urban Commuting Area Codes (RUCA) and travel distance to Veterans Affairs Medical Centers (VAMC) and VAMC or Community Based Outpatient Clinic (CBOC)

RUCA Core Code	Count of geocoded homeless women Veterans (%)	Mean Drive Miles for VAMC	Mean Drive Miles for VAMC or CBOC
Metropolitan	30,330 (89.6)	42.9	14.5
Micropolitan	2,080 (6.2)	82.6	28.4
Small Town	970 (2.8)	92.3	37.8
Isolated Rural	493 (1.5)	107.4	46.8
Total	33,873 (100)	63.6	23.9

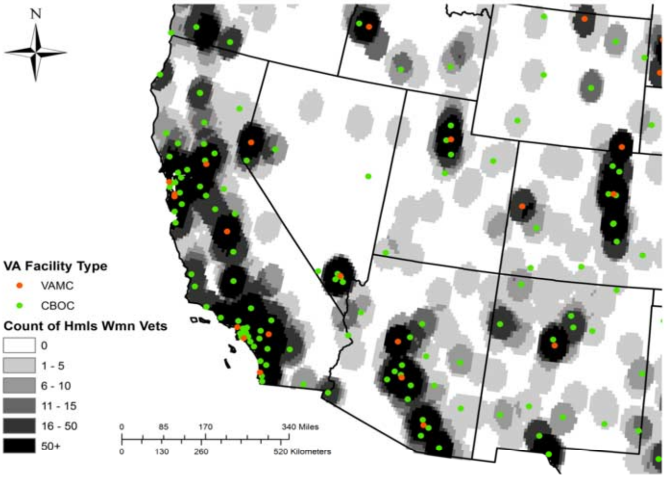

Figure 1. Veterans Affairs Medical Centers (VAMC: orange) and Community Based Outpatient Clinics (CBOC: green) in the Southwest United States are shown plotted against Zip Code-based populations of homeless women Veterans. For many of these areas, drive distances to VAMCs for specialty care are much greater than would be required if CBOCs were also an option.

3. Discussion

Homeless women Veterans need access to specialty care for high-risk medical, mental health, or behavioral issues, but rural homeless women Veterans may experience insurmountable barriers to this care due to travel distance. This study highlights the geographic distribution of reproductive age homeless women Veterans outside the expected urban areas where VAMCs with homeless and gender-specific services are primarily located. As these are reproductive age women, travel barriers can not only impact health outcomes, but also adversely affect a pregnancy, if it occurs in the settings of poorly managed chronic conditions. Geocoding and subsequent generation and consideration of travel distances to care facilities can assist policy-makers in developing targeted interventions to improve access to comprehensive preventive health and specialty care services in the VHA for high-risk, cost-intensive populations, in order to minimize adverse outcomes and improve quality of life for Veterans nationwide. Not surprisingly, extending specialty care access to CBOCs would allow more homeless women veterans to obtain the health services they need.

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Substitution of Assisted Living Services by Assistive Technology - Experts Opinions and Technical Feasibility

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Abstract. Ambient assisted living (AAL) may support ageing in place but is primarily driven by technology. The aim of this work is, to identifying reasons to move into assisted living institutions, their range of service and possible substitutability. We did semi-structured interviews with five experts from assisted living institutions and used results to design and implement assistive technologies in an AAL environment using BASIS, a cross domain bus system for smart buildings. Reasons for moving to assisted living institutions are expected benefits for chronic health problems, safety, social isolation and carefree living. We implemented six application systems for inactivity monitoring, stove shutdown, air quality monitoring, medication and appointment reminders, detection of unwanted situations before leaving and optical ringing of the doorbell. Substitution of selected assisted living services is feasible and has potential to delay necessity to move into assisted living institution if complement social services are installed.

Keywords. ageing in place, ambient assisted living, smart buildings

Introduction

Facing demographic developments and increase of healthcare costs, ambient assisted living (AAL) environments are one strategy for maintaining autonomy and self-determination of the elderly [1]. This is an important foundation for ageing in place as strategically defined by governments [2-4] and stakeholders [5-7]. The own house or apartment is the preferred place to age and straying there for as long as possible, significantly increases quality of life and satisfaction, even if the place of living is not fully suitable or adapted to the needs of independently living elderly with potential age-related functional deficits [4-6]. Assisted living institutions are an intermediate solution to maintain the feeling of living in the own home but a move is required and costs are higher, than a regular rent. Using ICT to cope for cognitive, social, physical or mental limitations specific to ageing may facilitate a longer period of independent living at home which in turn reduces costs for the entire healthcare and care-insurance system [8-10].

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There is a range of projects and initiatives regarding the use of ICT to create assisted environments for the elderly, ranging from monitoring and notification systems [11,12] over service accessibility [13] to socio-technical interventions [8,14,15]. However, the possibility to actually shift entry age to assisted living institutions requires in-depth knowledge of actual benefits and services of these institutions as well as a seamless integration into the home environment.

Therefore, the objectives of this paper are, (1) to directly identify expected benefits, services and potential future developments from experts in assisted living institutions and (2) to design and implement suitable assistive technology in an AAL environment.

1. Methods

To identify the range of service of assisted living institutions, a semi-structured, qualitative interview with experts from local assisted living institutions has been conducted. We developed an interview guide containing two parts:

1. basic questions regarding the role of the expert in the institution, reasons for elderly to apply for assisted living, types of assistive services, existing technical application-systems in the institution and how such application systems can be used at home already from the experts' point of view,
2. questions about the proposed system concept and the expected benefits, chances of application, possible problems and future projections.

The basis for expert identification was the set of all assisted living institutions in the region of Braunschweig in northern Germany. A total of nine institutions have been identified and were contacted by telephone. Five institutions agreed to be interviewed. Interviews have been done face-to-face with audio recordings, a signed privacy policy provided. Results have been transcribed, pseudonymized and summarized by matching services, existing application-systems and experts' estimations.

Identified use cases have been implemented using the BASIS system, an integrated, energy efficient, secure, cross domain bus system for smart buildings [16].

2. Results

2.1. Identified range of service

A total number of five interviews have been carried out taking from 40 to 90 minutes in total. Three interview partners are director of their institution, one is head of a department and one a social worker.

Reasons to move into assisted living institutions are social isolation (n=5), health problems (fear of falling, fear of accident, prevention; n=4), having a 24/7 contact person (n=3), carefree living (no need for cooking, home safety; n=1) and the decision made by relatives (n=1). All but one expert rated their residents to have low affinity for ICT. Four institutions provided emergency call systems with manual triggers at the finger or around the neck. Two institutions provided internet access. No other assistive technology was installed. However, all experts agreed, that assistive technologies would help. Requested are stove monitoring (n=4), detection of falls (n=4), optical bell for hearing impaired (n=2), electronic locking system (n=2) and general remote controlling of blinds and windows (n=1). Answers to possible future technology were limited and mainly related to existing monitoring and emergency detection systems. Concerns addressed technical failures (n=5), surveillance anxiety (n=5), inappropriateness for certain residents (n=3) and increasing social isolation (n=3). All experts expected manual assistance in assisted living institution to vanish over time while focus shifts to social work and integration.

2.2. Implemented assistive technology

Based on the interviews six distinct assistive application systems were implemented in a BASIS enabled multi-apartment house containing six apartments (see Figure 1).

An activity monitoring and notification plugin used existing PIR sensors, light switches and door contacts to detect unusually long periods of inactivity and possibly give a warning to the resident or neighbor via an in-home text display. Stove monitoring and shutdown is done using activity information like in the respective monitoring plugin. It detects inactivity (general or in the kitchen) for a certain period and possibly give a warning or disables the stove using a bus controllable power relay (for high electrical load). Air quality monitoring and notification uses a volatile organic compounds (VOC) sensor connected to the bus to determine air quality and give a notification. Medication and appointment reminders use a simple calendar backend to display reoccurring medication with type and dose as well as appointments using the text display. Detection of critical situations before leaving occurs by combining multiple types of sensor information. Power sockets and controllable relays are read to determine running devices. Open windows are detected by integrated reed contacts and the approximate length of absence is asked to regulate the thermostats if necessary. A volume adjustable and optical bell is made possible by obtaining per-room activity and flashing lights in the respective rooms.

Figure 1. Apartment equipped with BASIS bus system (f.l.t.r): corridor with nightlights, kitchen with sensor array at ceiling, sensor array (PIR, VOC, temperature, brightness), controlled power sockets with smart meter, night light, heater control, text display at entrance door.

3. Discussion

We were able to show, that AAL environments (BASIS in this case) are technically suitable to substitute or support basic services of assisted living institutions. None of the experts has been surprised or upset, that shape of care is changing. Assistive technology can replace or support selected care services and enables residents to stay home longer.

This reflects the results of many other reported systems [14,17]. In Addition to these, our methodology focused on the experts' point of view and showed that an important role of assisted living institutions is social integration and prevention of isolation, which is rarely addressed by assistive technology [17].

Our work had some limitations regarding the small number of experts who were willing to contribute. We cannot foreclose a selection bias, since the institutions were already known partners or have been found on the internet. Despite the diverse types of institutions, the interviews have been carried out by a single researcher, which may lead to a bias due to his way of carrying out the interview.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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Effect of Social Media in a mHealth Application

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Abstract. In this project the potential of social media has been reviewed in terms how it can promote a healthy lifestyle utilized in an app. A mHealth app for smartphones has been developed using Design Science methodology, where various features from social media have been implemented with the goal of increasing physical activity. The application has been evaluated extensively in order to meet usability requirements. In addition, a focus group has contributed towards the application's potential to increase physical. The data collected is suggesting that social features have a positive impact on promoting physical activity.

Keywords. Sedentary Lifestyle, mHealth, App, Social Media

Introduction

The World Health Organization (WHO) has shown that obesity nearly doubled between 1980 and 2008, indicating its rapid growth. Obesity has been shown to be strongly correlated to a sedentary lifestyle, which is also leading to other various health-problems such as depression, cardiovascular diseases, diabetes, and some types of cancer. WHO has also stated that sedentary lifestyle is the fourth most leading risk factor for global mortality [1]. Sedentary lifestyle seems to have become a global problem. People tend to be less active in the everyday life. Long hours at work sitting still in front of the computer in conjunction with unhealthy eating habits, is likely one of the reasons obesity rates have increased significantly [2].

mHealth (mobile health) is a somewhat new field which is addressing issues such as sedentary lifestyle by clever use of mobile technologies [3]. This project has focused on developing a social fitness application that is aimed at countering sedentary lifestyle. This is achieved by allowing the users to; create activities, social networking, and activity monitoring. The app is utilizing various social features in order to motivate the users to be more active and social at the same time. Research has shown that some social media have had a negative effect on people's physical activity level as people often end up socializing from home instead of actually going out. Research has also shown that social media can have a great effect in terms of motivation. It can for instance be more fun to compete with other real people, share images or results from various activities, or by actually meeting people in real life where activities can be done together.

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The Application

The main research questions that the application would help answering was: ‘Is it possible for a mHealth application (MoveFit) to reduce sedentary lifestyle by use of social media features?’ The design of the app includes a set of different features to answer this question. This allows various degrees of engagement and activities tailor-suited to the individual users.

Top active friends
#1 Kine Lohne de Nijs
#2 Petter Rossebø
#3 Evy Tråstadkjølen

Evy Tråstadkjølen
Offline
Age 31
19 km away

Olcia Goryszewska
Offline
Age 29
15 km away

Erlend Hopland
19 km

Name	Age	Gender	Score
Kine Lohne de Nijs	32	Female	965
Trond Kjetil Tufte	27	Male	907
Petter Rossebø	26	Male	733
Andreas Se kkingstad	26	Male	0
Olcia Gorys zewska	29	Female	0
Kjetil Tufte	56	Male	0
Evy Trästa dkjølen	31	Female	0
Mikkel Lea	25	Male	0
håvard gerner	27	Male	0

Figure 1. Left: Scoreboard Screenshot, Right: Friend-list Screenshot.

The application allows users to create their own activities or routes, e.g. jogging, walking, hiking, bicycling or skiing. Depending on the activity type and length of the route, the user will be rewarded points. The points are being used as a motivational factor. People can compete with each-other by earning points and track their progress. There is also a scoreboard where all the people who are in the same area as the user, is listed. This list will display the user's information as well as score. See Figure 1 (left). The scoreboard is meant to encourage competition among the users, as the best will be on top.

The novelty of the application lays in the combination of social media features and physical activity stimulating features. This will ensure that users are social in real life versus being social only through the conventional social media, which has been shown to actually decrease real life social engagement [4].

1. Methods

This project founded on Design Science and System Development resulting in a multi-methodology usage. Moreover, Hevner's 7 guidelines were applied through the design process [5].

1.1. Quantitative Research

For the quantitative research part, two different structured surveys have been used. The first survey is for “normal” users i.e. end users without any required technical background. This survey is based on System Usability Scale (SUS) [6] and it aims to find how non experts handle the app developed in this project. The 10 selected users were given 10 predefined tasks to perform before answering the survey. Some tasks were for instance to create a profile, send friend requests and create an activity. Nowadays usability is a quite important aspect of applications, as the users have gotten used to a relative high standard [7] and therefore evaluation is important. The second survey aimed at “expert” users i.e. people who actually have a background in IT. There were 10 participants. They were given the same set of tasks to perform as the normal users and then answered the well-known survey Nielsen's heuristics [8]. The application has also been collecting user data. From its publication in September 2016 to December 2016 it has had up to 60 users. Data registered is related to the user e.g. basic user information is collected such as name, age etc. as well as initial activity level. Data related to the user's activity is also collected, e.g. routes created, distance moved etc. But the most interesting data collected is related to the social aspects. These data include friendships established, requests sent, profile images uploaded, and number of messages sent. The data has been stored in the cloud hosted by Microsoft, who is also ensuring security. No data is stored on the device.

1.2. Qualitative Research

The qualitative research in this project is revolved around a focus group where that goal has been to explore the impact of social media in a social fitness application. In this case, the focus group is bit different than the conventional one i.e. the group has operated via social media, e.g. Facebook, Skype etc. and can therefore be considered a form of social media focus group [9]. During the evaluation observation has been used [10].

2. Results

There are three instances yielding results. First is the two surveys used; namely SUS and Nielsen's Heuristics. The SUS evaluation gave a score of 74.7/100. One of the participants failed to complete the survey, and has therefore been exempted from the final result. The expert evaluation with Nielsen's 10 Heuristics gave a total score of 6.1 / 10 suggesting that there is room for improvements in regards to the user interface and usability. Secondly, the application has acquired data in the database on activity and social engagement; there are 71 connections among the users, where 34 instances are friendships. Thirdly we have some data-results from the focus group. In the survey it was apparent that the route/activity creation and the social features were the most appealing features of the application. The participants of the focus group were asked if they would like to use the app further on as it matures. The results were positive, ranging from quite likely to very likely.

3. Discussion and Conclusions

The application has been thoroughly evaluated both by experts and non-experts. Usability and impact of social features have been weighted the most. The data acquisition should ideally be with more than the 60 users that participated in this project, and over a longer period of time so that one could observe the long term effects. The focus group could have been expanded to a larger group as well in order to get more subjective opinions on the various social features and how they play out in real life. One ought to consider that there are various user groups who can utilize this type of application. There are differences in age, interests, activity level, social engagement etc. This application has tried to meet a broad group in terms of user requirements, and it is therefore allowing for tailored solutions for the users, as they can freely choose activities and duration. The user activity was not physiologically measured, but it could be understood from MoveFit's data that the users were more active, as activities were created, routes used and friendships established [11]. It seemed that the users appreciated the various social media features, it also seemed to be the case that these features were the ones that promoted physical activity the most. The application appeared to able to motivate people to be physical active as well as being social in real life. The application could be adjusted to be used with established chronic-disease diagnoses who often are involved in patient groups as means of coping with their conditions. It is likely that tools like this app could utilize mobile technology to benefit patients and a proper trial should be considered to better explore potentials of this app and other similar apps. It would also be interesting to see the long term effect that the app could have in regards to staying active for longer periods of time, how much more active one would potentially become, and the level of socializing.

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Evaluation of Standards for Access Control Enabling PHR-S Federation

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Abstract. The adoption of the Internet of Things (IoT) and mobile applications in the healthcare may transform the healthcare industry by offering better disease tracking and management as well as patient empowerment. Unfortunately, almost all of these new systems set up their own ecosystem and to be really valuable for the care process they need to be integrated or federated with user managed access control services based on international standards and profiles to enable interoperability. Thus, this work presents the results of an evaluation of available specifications for federated authorization, based on a set of basic requirements.

Keywords. Security, Personal Health Records, Access Control, Authorization

Introduction

In the last years many projects have been started for inter-organizational healthcare data exchange to improve quality of care for patients. However, in order to solve upcoming challenges in the field of health and elderly care such an organization-centered health approach does not go far enough for some experts, who expect a further step in the direction of "personal care" [1]. Thus, health related data provided by the citizen him-/herself and stored in “personal health records” (PHRs) is expected to play a major role in future healthcare. Especially with the increasing number of mHealth applications for smart devices (e.g. smartphones), which often include data from personal health devices, the advantage in context of monitoring and self-management of chronic diseases is obvious and benefit has been shown in several studies (e.g. [2]).

Nevertheless, most of these apps and services have their own small “ecosystem”, which results in an infrastructure with several distributed archives (“data silos”), although these systems have to be integrated to be valuable. Currently it is even difficult for the users themselves to maintain accounts and data of the distributed systems. In such environments users need to have personal access to an integrated view as well as to manage access rights for other persons (e.g. health professionals) based on security policies.

Enabling these functionalities requires setting up a federated domain of Personal Health Record Systems (PHR-S) based on international standards for communication protocols and semantic definitions (see [3]) as well as for security and privacy to ensure interoperability. This paper focusses on requirements for authorization processes, evaluates international standards to propose the best solution to be implemented by applications participating in such domains.

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1. Methods

In a top down approach based on a use-case analysis including different generic scenarios such as mobile health services, patient centered health data archives, telemonitoring environments as well as patient centered ad hoc collaboration services like tumor-boards, the following steps have been performed:

1. Analysis of a general security policy domains and process models for access control
2. State of the art of international standards, profiles and specifications for implementation of federated authorization
3. Evaluation of these according to the following requirements:

- Scalability (SC): support for adding more applications and expanding the architecture of the system without sacrificing functionality, having redundant data or increasing the complexity of the access control model.
- Enables utilization of identities federations (FedIDM) (a detailed analysis of different models can be found in [4])
- Support for policy based patient managed access control (UMAC) (see 2.1)
- Support for different types of access control models (ACP). e.g. role based (RBAC) or attribute based access control (ABAC)
- Completeness of specification (COMPL). Degree of freedom in specific implementations of standard or profile (hindering interoperability)
- Low complexity for implementation (CPLEX), and support for “lightweight” RESTful web-services (REST)

General security requirements for healthcare data exchange (e.g. transport layer encryption) are not covered in this analysis (overview can be found for instance in [5]).

Services for healthcare data exchange need to have a trust relationship, which can be built on different trust management concepts ranging from basic concepts based on electronic certificates (e.g. [6]) over complex trust frameworks (e.g. Kantara) up to dynamic frameworks for pervasive systems as described e.g. in the THEWS project [7].

Results

Security policy domains and processes

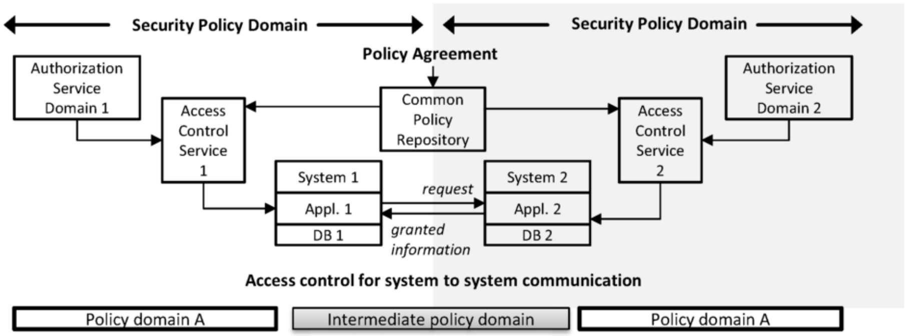

Figure 1. Access control process and policy domains according to ISO 22600-1 [8]

Health data exchange (providing data) as well as granting direct access to data (e.g. for integration purposes) by services of different providers (realizing different security policy domains) requires access control based on a common security policy accepted by all communication partners. This common policy has to be

a) negotiated between organizations either manually (e.g. see [8]) or automatically (e.g. HL7 proposal for "Trust Framework for Federated Authorization")
b) ruled by the data owner, such as in a patient managed access control scenario

and results in a separate intermediary/bridging policy domain. Process and policy domain model overview are shown in Fig. 1. Service oriented implementations are discussed in [9].

International standards, profiles and specifications

Standards, profiles and specification identified in the research are shown in table 1.

Table 1. Standards and frameworks for authorization

Name	core aspects
SAML+WS-Trust	SAML (details in [10]) defines **XML** based implementation of security tokens with security claims. HTTP&SOAP binding. Used with Security Token Services defined in WS-Trust (details in [11])
XACML	Defines a **XML** based specification of a policy description language and architecture for policy administration and enforcement. For details see [12]
OAuth2	Industry-standard protocol for authorization providing secure delegated access to server resources for clients on behalf of a resource owner. Specifically made for use with HTTP. For details see [13].
IHE IUA	Provides an authorization profile for HTTP **RESTful** transactions, e.g. browser based. Utilizes JSON Web Tokens. Combination with SAML possible. For details see [14]
Kantara UMA	Enables user managed access control by defining two APIs based on **OAuth2**. For details see [15]
OpenID HEART	Profiles based on **OAuth2 and UMA [16]**. Also offers profile for healthcare data exchange based on HL7 FHIR

Evaluation

Table 2 represents the evaluation results of the different standards / profiles according to the requirements mentioned in section 1.

Table 2. Evaluation results. + bad/no support, ++ average/fair support, +++ good/full support

Name	SC	FedIAM	UMAC	ACP	COMPL	CPLEX	REST
SAML	+++	+++	+	+++	++	+	+
XACL	+++	+	+++	+++	++	+	+
OAuth2	+++	+++	++	++	+	++	+++
IUA	+++	+++	++	+++	++	++	+++
UMA	+++	+++	+++	+++	++	++	+++
HEART	+++	+++	+++	+++	++	++	+++

Discussion

Although implementations based on SAML and XACML have been widely adopted and are well accepted in SOAP based web-service environments, they are facing the problem of being "heavy weighted", costly and difficult to implement especially on smart devices. Services based on mobile technologies and smart devices are mostly based on the “light weight” RESTful web-service approach and therefore OAuth2 is mostly recommended to be used in such environments. Unfortunately, OAuth2 only provides the basic specification leaving a lot of important issues outside the scope and therefore in the responsibility of the system designers or implementers, which in detail causes a lot of interoperability problems between different services. Thus, UMA and further the profiles defined by HEART, offer the best approach for fostering interoperable service implementations. Nevertheless in both specifications there are still some further constraining and therefore additional specifications are necessary.

In the end the biggest challenge will be that all PHR-S will have to correctly implement the appropriate security interfaces. This will probably require a framework of free software components, which enables easy integration of federated identity and access management functionalities by system developers into their services.

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Using Structured and Unstructured Data to Refine Estimates of Military Sexual Trauma Status Among US Military Veterans

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Abstract. Sexual trauma survivors are reluctant to disclose such a history due to stigma. This is likely the case when estimating the prevalence of sexual trauma experienced in the military. The Veterans Health Administration has a program by which all former US military service members (Veterans) are screened for military sexual trauma (MST) using a questionnaire. Administrative data on MST screens and a change of status from an initial negative answer to positive and natural language processing (NLP) on electronic medical notes to extract concepts related to MST were used to refine initial estimates of MST among a random sample of 20,000 Veterans. The initial MST positive screen of 15.4% among women was revised upward to 21.8% using administrative data and further to 24.5% by adding NLP results. The overall estimate of MST status in women and men in this sample was revised from 8.1% to 13.1% using both data elements.

Keywords. Military Sexual Trauma, Veterans, Disclosure of trauma

Introduction

US military Veterans are at risk for experiencing sexual trauma while serving in the armed forces. This is referred to as military sexual trauma (MST) and is considered an important public health issue, similar to sexual trauma among adults in the general community and in college campuses. The challenge in estimating the true prevalence of MST is that there is under-reporting of this trauma due to social stigma.

In the Veterans Health Administration (VHA), where former US military service members who are now Veterans are provided care, there is a coordinated effort to screen for MST and provide free medical care to those who report it. The screen is administered to all Veterans seeking care in VHA and the results are recorded in the electronic medical record. Here too, there is a challenge in that not all Veterans disclose their true MST status due to various factors [1-3]. Official estimates of the prevalence of MST are based on a positive screen for MST administered to all Veterans who seek care in VHA medical

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facilities; approximately 25% of all women Veterans and 1% of all male Veterans report a positive screen for MST [4,5].

Preliminary work has revealed that the MST status of several Veterans who have screened negative at their initial screen is later changed to positive status in administrative or structured data. Furthermore, we have also noted that some Veterans disclose a history of MST to their mental health or medical provider in the course of regular visits to VHA and if the Veteran has no objection, these disclosures are recorded by the provider in the free text of medical notes (unstructured data) [6].

This aim of this study was to determine whether and by how much structured and unstructured data could add to estimating the prevalence of MST positive status as reported by Veterans to providers in VHA.

1. Methods

1.1. Administrative data related to military sexual trauma in VHA

The US Department of Veterans Affairs (VA) serves nearly 6 million unique Veterans through a network of 152 hospitals around the US. Many of these hospitals are have emergency departments and urgent care clinics. Administrative data on MST screens and their results (positive or negative) were extracted from the VA corporate data warehouse using Veterans Informatics and Computing Infrastructure (VINCI), a secure research portal [7,8] on a randomly selected sample of 10,000 women and 10,000 men Veterans from recent wars in Afghanistan and Iraq.

1.2. Natural language processing on electronic medical notes to extract MST concepts

All outpatient electronic medical notes in the 12 months following the date of the visit when the MST screen was first completed were extracted using VINCI. Using an NLP pipeline expressly developed for this project, positively asserted concepts related to MST were extracted from these notes. A total of 13,501 Veterans (6,623 women and 6878 men) were found to have electronic medical notes for processing by NLP during the study period. NLP outputs were reviewed by trained human annotators to determine if the concepts were true or false positive and whether they represented concepts related to MST.

1.3. Data analysis

Using administrative data, the number and percentage of women and men Veterans who had an initial positive or negative MST screen was first determined. Then, during a long follow-up period of up to 14 years, the number and percentage of Veterans who had a change of MST status from negative to positive was determined. Using NLP outputs, the number and percentage of Veterans with evidence of positively asserted NLP concepts related to MST were determined.

2. Results

2.1. MST initial screen results and switch from negative to positive.

From the random sample of 10,000 women and 10,000 men Veterans, 16,847 Veterans had initial MST screen results available for analysis. Of the 8,442 women, 1,297 (15.4%) reported a positive screen; of the 8,405 men, 62 (0.7%) reported a positive screen. During the follow up period ranging from 4 to 14 years, a total of 541 women (6.4%) had a change of MST status from negative to positive. A small number of men (29, 0.3%) had a change of status recorded in structured data. This resulted in an upward estimate of MST positive screen from 15.4% to 21.8% in this group of women Veterans and from 0.7% to 1.0% for men Veterans. When taken together, the MST status by initial positive status in this group of 16,847 women and men Veterans was 8.1% (1,359 positive screens). When adding the status change just from structured data, the MST status for both women and men is revised upward to 11.5% (total 1,929 positive screens).

2.2. NLP on electronic medical notes to extract positively asserted concepts for MST

Electronic medical notes from a total of 13,501 Veterans in the study sample were evaluated using NLP. In this set of 6,623 women Veterans and 6,878 men Veterans, a total of 1,264 Veterans reported a positive screen for MST at their initial screen. This represents a total MST positive screen of 9.4% in this group of Veterans. Using NLP followed by human review of the NLP outputs, a total of 284 (230 women and 54 men) Veterans who were MST screen negative were found to have positively asserted concepts (true positives) related to MST. The overall revised estimate of MST positive status in this group using just the NLP outputs is 11.5% (1,264 + 284 by NLP of 13,501).

2.3. Revised estimates from structured and unstructured data mining

Using structured data from MST status changes and evidence from NLP, we were able to revise the estimate of positive MST status in the women in this study sample from 15.4% (1,297 of 8,442) to 24.5% (1,297 + 541 from structured data MST status change + 230 from NLP of 8,442). Similarly, for men in this sample, the revised estimate is 1.7% (62 + 29 from structured data MST status change + 54 from NLP outputs of 8,405). Overall estimate for the study sample is revised from 8.1% to 13.1% using both data elements.

3. Discussion

There are inherent challenges in estimating the true prevalence of an extremely sensitive problem such as sexual trauma as victims often are not willing to disclose this history. As such, surveying a large number of Veterans on this topic may not provide any better estimates. Thus, we undertook a study to examine whether mining and analyses of structured and unstructured data would help us refine the estimate of prevalence of MST.

Starting with baseline data on MST positive screen status, mining structured data for MST screen status from negative to positive alone resulted in an upward estimate of MST positive screens by 6.4% in women Veterans, NLP added another 2.7% such that the revised estimate in women Veterans in this study sample was 24.5% (from 15.4%). The change in status recorded for men Veterans in administrative in this study sample was small. Similarly, a small number of men were noted to have NLP evidence of MST. The revised estimate for men Veterans in this sample is 1.7% based on both structured and unstructured data mining. Using both data elements, the overall estimate for the prevalence of MST positive status among women and men in this study sample was revised upward from 8.1% to 13.1%. This study demonstrates that it is feasible to revise estimates of MST positive status using structured and unstructured data.

The differences in baseline MST positive screen status in women Veterans in our sample (15.4%) versus the 25% reported by VHA sources is likely due to differences in the populations studied. Our study sample consisted of a random sample of 20,000 women and men Veterans from recent conflicts. It is interesting to note that our revised estimate of prevalence of MST status in the women in our sample was 24.5%.

We acknowledge several limitations of this study. It is possible that the structured data elements of the MST screen were not complete and thus we may be underestimating the true prevalence of changes from negative to positive screen. There are false positives and false negatives from the outputs of NLP and this affects the ability to identify relevant concepts. The concordance of MST screen results from administrative data and NLP evidence of MST merits further study. There is also a need for work on determining the feasibility of extracting concepts related to other sexual trauma such as childhood sexual abuse and adult sexual re-victimization using NLP.

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Medical Informatics Idle YouTube Potential

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Abstract. YouTube as an online video-sharing service in the context of Web 2.0 goes beyond the bounds of pure fun, for which the platform was primarily established. Nowadays, commonly to other social media, it serves also educational, informational and last but not least, marketing purposes. The importance of video sharing is supported by several predictions about video reaching over 90% of global internet traffic by 2020. Using qualitative content analysis over selected YouTube videos, paper examines the current situation of the platform's marketing potential usage by medical informatics organizations, researches and other healthcare professionals. Results of the analysis demonstrate several ways in which YouTube is already used to inform, educate or promote above-mentioned medical institutions. However, their engagement in self-promo or spreading awareness of their research projects via YouTube is considered to be low.

Keywords. YouTube, medical informatics, qualitative content analysis, education.

Introduction

The importance of video sharing is supported by several predictions about video reaching over 90% of global internet traffic by 2020 [1]. YouTube, founded in June 2005, is an online service for video-sharing with over a billion users [2] and over 4 billion videos viewed per day [3]. There are several academic studies examining the potential of YouTube platform for health information dissemination, especially when it comes to health conditions information for patients [4,5], continuing medical education for scholars [6], well-being promotion [2], as well as the questions of privacy violation arising when physicians and other medical professionals use the Internet [7].

Apart from Medical Informatics field, there are also studies describing growing importance of online branding and self marketing – e.g. non-profit, for-profit and government agencies developing their identity and credibility when using YouTube videos to inform viewers about their mission, services or current projects [8-10]. Not only can this strategy help organizations to increase credibility and social recognition, on broader scale it helps them reach their donors, sponsors or other stakeholders.

Drawing from all above-mentioned, the aim of this paper is to provide an insight into current YouTube usage by medical informatics organizations and professionals. By outlining its current status and purpose of shared videos, the paper aims at providing suggestions on how to engage with viewers in a more effective way.

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1. Methods

In order to understand if and how medical informatics organizations use YouTube videos, qualitative content analysis method was adopted [11]. Research conducted in March 2017 depicted the data in three steps[2]: (1) Relevant YouTube videos were identified using "*medical informatics*" as a key searching phrase. Initial search resulted in 95,500 videos. (2) Videos uploaded more than 12 months ago were excluded. This provided the research with up-to-date data plus reduced the number of records to 7,200. (3) Videos were sorted by the relevance using one of the filtering criteria available on YouTube. First 350 videos were reviewed by two researchers. Based on the eligibility and relevance for the research, 207 samples were excluded[3]. Rest of the videos (N=143) were summarized and are included in qualitative content analysis.

Two main research questions were set aiming at providing an insight into what specific organizations or users stand behind YouTube channels posting videos including a "medical informatics" key phrase as well as defining the type of content being shared:

RQ1: What types of individuals or organizations stand by YouTube channels with medical informatics videos?

RQ2: What primary purpose do medical informatics videos serve?

Regarding the purposes of videos examined in the second research question, we categorize YouTube videos using Kardas' (1993) classification schema [12] into four groups: videos educating and informing public about the organization's mission, program or services; videos entertaining the audience; videos increasing the viewer's level of personal involvement with the organization; videos inspiring the audience to change the world[4].

2. Results

Selected videos represented a great mix of content from the medical informatics field.

The overview of different channel representatives as the analysis result for the first research question (RQ1) is explained in Table 1. The most represented were, naturally, medical informatics organization, research centres and respective communities (N=41) or universities with departments offering courses within the discussed field (N=47). There is also a specific category of channels representatives formed by individual medical informatics students (N=27), mostly from the USA, recording their project and class presentations and posting it on YouTube as part of their soft skills training.

In terms of channels location, majority of videos are from the USA (N=55) followed by the United Kingdom (N=7) and India (N=6)[5].

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[2] As a technical analysis limitation it should be noted, that the verification of final research sample may not be possible due to YouTube videos removal (e.g. copywriting reasons, privacy violation, other reasons).

[3] All the videos excluded due to non-eligibility were click baits - videos promoting free download of medical informatics publications, however linked to online advertising websites to generate revenue.

[4] All the videos were additionally also analyzed for the basic characteristics of each video such as rating, views, style (professional/amateur). Due to the limitations, not all of the information is included in the paper.

[5] An enormous difference between the number of videos from the USA and the second location is caused by the fact, that not all the videos have the country of their origin set on YouTube.

Table 1. Types of individuals and organizations standing behind YouTube channels with medical informatics videos.

Type of representative	Number of videos	Representative description
Universities	47	Universities with departments offering Medical Informatics courses. The majority of them are located in the USA (30/47) with the UK, India or Canada among the other countries. Specific courses are often promoted by department's representatives and are professionally edited. The other important part of universities' YouTube content consists of recorded lectures or important student life events.
Health informatics institutions	41	Organizations, research communities, healthcare centres doing business in the field of medical informatics (both for-profit and non-profit), e.g. AMIA, Centers for Disease Control and Prevention (CDC) and many others.
Individual students	27	Individual scholars who usually share their school project or class work. Videos are amateur, shot either via mobile or laptop camera.
Single users	10	Non-professionals. Videos are amateur, mostly sharing technology news or Medical Informatics conferences' videos.
Medical informatics professionals	7	Doctors, nurses or medical technology professionals posting either amateur videos from conferences or their insights into the field.
N/A	11	Identification not available. A channel posting video series on healthy lifestyle and health prevention with no further link to an individual or an organization.

As per the second research question (RQ2) the videos were divided according to their purpose into four groups and described in more details. During the process of qualitative content analysis, it turned out that a video served more than one purposes. In such cases the main video purpose was chosen.

The majority of videos served the first purpose (N=96). Among educating and informing videos there are webinars, recorded school lectures or medical informatics professionals' insights included.

Only N=1 video had a purely entertaining purpose, it was an amateur Christmas animation posted by a health professional for his colleagues with together 111 views.

In terms of our research sample, the purpose to increase the viewer's level of personal involvement with the organization was relevant for N=46 videos including carrier promoting videos posted by companies doing business within the medical informatics field, or universities' videos promoting courses for students. A common feature of videos included in this category is professional production, using corporate branding (either with logo or colours) as well as institution's representatives inviting new members.

Inspiring audiences to a change the world purpose was obvious in self-promoting videos posted mainly by medical informatics organizations or also by universities (N=13). The difference between this class and the upper one lies in the object of promotion. While for the fourth category it was typical to promote own service or mission as well as the positive outcome of one's work on people's health and the quality of life, the third category focused specifically on position, its requirements. Also less postproduction effects were used when promoting a job position in comparison to the world change.

3. Discussion and Conclusion

The information retrieved from YouTube using the search words “medical informatics” proves a shy presence of the field. The purpose of the presentations is limited to inform or educate audiences, promote university courses and document personal achievements. The sense of a brand or marketing that could be achieved using this kind of communication while mixed with other communication options has not been developed. The versatility of on-line, interactive communication in brand building is purely utilized. It is not necessary to sell the idea of Medical Informatics, but stronger awareness, organization’s increased credibility and a brand image obtained with effective social network usage might be beneficial in terms of fundraising or sponsorship.

Apart from recorded webinars and conferences’s content, Medical Informatics could also use social media to offer a real insight into the field and suggest effective ways to learn the subjects. Currently, there is no specifically designed field respective the educational content shared on YouTube.

In addition to YouTube’s marketing and business potential, a number of possibilities to promote causes, services, and products can be listed [13]. However, drawing from the analysis results, medical informatics research projects, success stories or other types of emotionally positive content do not have any great coverage. An increasing number of such videos may not only lead to higher viewers’ engagement, but consequently may also provide additional resources or establish a new cooperation. Consequently the social media strategy can be more specified and targeted depending on what type of an organization or an individual stands behind the channel as well as what their aims are.

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Comparison of Grouping Methods for Template Extraction from VA Medical Record Text

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Abstract. We investigate options for grouping templates for the purpose of template identification and extraction from electronic medical records. We sampled a corpus of 1000 documents originating from Veterans Health Administration (VA) electronic medical record. We grouped documents through hashing and binning tokens (Hashed) as well as by the top 5% of tokens identified as important through the term frequency inverse document frequency metric (TF-IDF). We then compared the approaches on the number of groups with 3 or more and the resulting longest common subsequences (LCSs) common to all documents in the group. We found that the Hashed method had a higher success rate for finding LCSs, and longer LCSs than the TF-IDF method, however the TF-IDF approach found more groups than the Hashed and subsequently more long sequences, however the average length of LCSs were lower. In conclusion, each algorithm appears to have areas where it appears to be superior.

Keywords. Natural Language Processing, Boilerplates, templates.

Introduction

Often information needed for biomedical research is only available in the text of medical records [1]. Templates and boilerplate sections in clinical text present idiosyncrasies that can challenge information extraction systems due to their lack of correct grammatical structure [2]. Such templates can take the form of check boxes or fill in the blanks but also could be copied text. These can exist as entire documents or only portions and come from sources such as surveys and discharge notes. This article is a follow-up to an article we recently published on a heuristic algorithm to detect novel boiler-plate and similar templates from a corpus of text with minimal training and tuning [3].

Our algorithm first finds groups of documents that are likely to contain a template. The second, and more computationally intensive, step uses these groups and applies a longest common subsequence (LCS) algorithm to the group as a whole to find the common elements [3]. The longer an LCS is, the more likely it is that it came from a boilerplate template and is not common by chance. Template signatures can be used to find additional instances, mitigate the effect of boiler plates in information extraction, and to separate portions of text that originate in templates from the patient data inserted by providers.

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In this paper, we focus on the grouping stage of the algorithm that has been previously described [3] and investigate the characteristics of the grouping methodology to give more guidance on the selection of grouping algorithms and approaches.

1. Methods

The document corpus comes from the United States Veterans Healthcare Administration (VA) where we sampled records from 10,000 male and 10,000 female Veterans first seen at the VA between FY2010-FY2014. The cohort was limited to those Veterans who served in the recent conflicts in Iraq and Afghanistan. From these Veterans, we sampled 1,000 documents at random and applied the grouping and extraction algorithms.

We compare two grouping methods. The first replicates the method for grouping as originally proposed, the hashing algorithm, see [3]. The second approach uses term frequency inverse document frequency metric (TF-IDF) to determine the most relevant keywords and group on the presence of those in documents, which has been used successfully in the past to group documents [4,5]. We computed the TF-IDF for all tokens in the corpus and then restricted to the most relevant tokens, determined by the top 5% of the mean TF-IDF across all documents. Both methods use a hierarchical clustering with complete linkage on a Euclidean distance. Where they differ is that the hashing algorithm computes distance on hashed bin counts and the TF-IDF on relevant term counts.

We investigate the properties of the two approaches in obtaining small groups that contain a common template. We compare the two approaches for consistency in group creation and length of resulting LCSs.

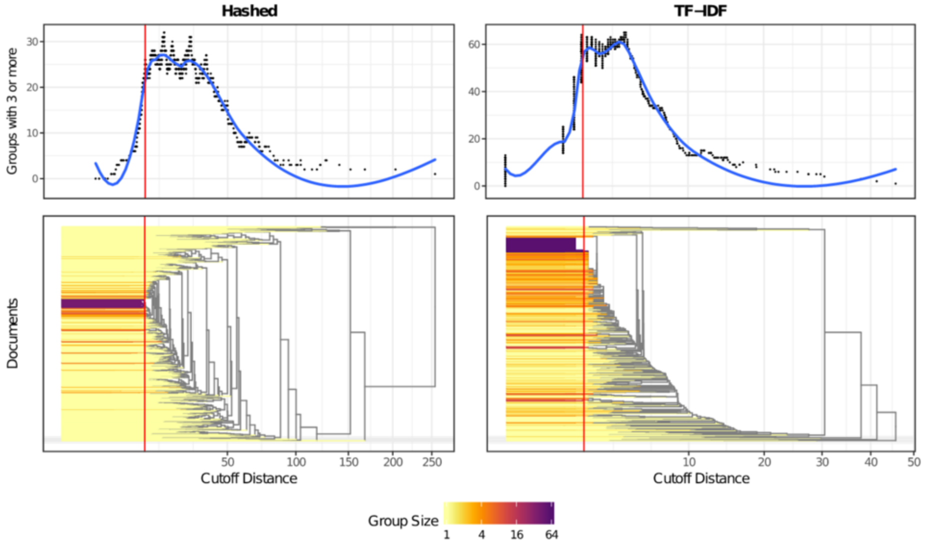

Figure 1. The plots on top are for determining cutoff for hierarchical clustering. The bottom shows the dendrograms of the clustering algorithms. The horizontal axes match top to bottom and are shown on a square root scale to show detail and account for the long tail of the cutoff heights. The red vertical line shows the cutoff used. Groups are colored according to the cutoffs to show size.

2. Results

2.1. TF-IDF computation

When computing the top 5% relevant terms by TF-IDF there were 116 documents that did not contain any of the key terms and so were excluded from grouping. Restricting the subsequent grouping of these documents to the 884 remaining.

2.2. Determining cutoffs

Figure 1 shows plots designed to assist in determining an appropriate cutoff value for the hierarchical clustering. The vertical axis shows the number of groups that contain at least 3 documents, the minimum we require for template extraction through LCS. The plots show similar characteristics with three distinct phases; a first phase where individual documents are grouped together, a middle phase where the number of qualifying new groups formed is approximately equal to the number of groups being combined, and eventually a decline where more groups are combined. In selecting a cutoff, one seeks to maximize the number of potential groups for template extraction while also minimizing the number of extraneous documents. We have selected the cutoffs right at the beginning of the second phase. With this cutoff the TF-IDF appears to create more qualifying documents than the hashed clustering. The TF-IDF graph plateaus around 60 qualifying groups and the Hashed graph plateaus mostly below 30.

2.3. Clustering Results

We see from the dendrograms in figure 1 that the TF-IDF results in a single cluster that is mostly built by adding on a few documents at a time, whereas the hashed clustering is a more uniform building up of clusters. However, both show the behavior of having a single large group that forms early on.

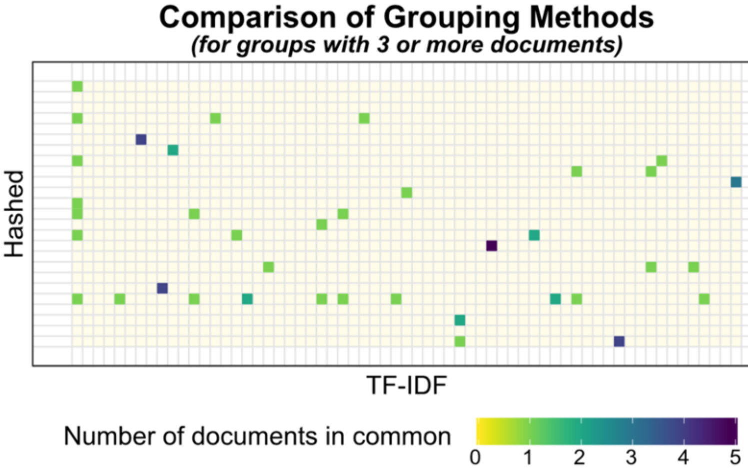

Figure 2. This image demonstrates the crossover of how many documents in a group from one method are present in a group from the other. No color indicates that there were no common documents.

Figure 2 gives a comparison and information about the consistency of the methods. While each group had a single large cluster of tightly grouped documents, the documents in that cluster are not the same documents.

Table 1. A comparison of the two methods in regards to the number of extracted sequences.

Metric	Hashed	TF-IDF
Number of qualifying groups	26	64
Groups resulting in a non-zero LCS	16	35
Mean length of non-zero LCS	43.7	16.8
Groups resulting in sequences longer than 5	10	13
Percent of qualifying groups resulting in an LCS larger than 5	38%	20%
Longest sequence	189	189

Table 1 shows the two methods side by side with metrics related to the number of sequences that were successfully extracted from the groups. Hashed had a higher success rate at 38% as well as generally longer sequences. Both algorithms found a single large template that results from the same documents being clustered by each algorithm. The template found was a template resulting from a mental health progress note.

3. Discussion

Each method presented appeared to have areas in which it was superior. The original hashed algorithm excelled in the successful extraction of sequences as well as longer sequences on average. This may be important since the task of LCS extraction is computationally expensive. The TF-IDF was superior in finding more groups and subsequently more templates. A surprising result we did not foresee was lack of overlap in the groups formed. The task does not appear to be agnostic to the grouping approach used; thus we present these results to educate and leave the final choice to researchers as resources and goals vary widely.

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Implications and Modelling of Data Quality on Confidence of Clinical Decision Support: A Conceptual Framework

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Abstract. Integrated care paradigms depend on multiple sources of data. The quality of data used in decision-making will ultimately affect the delivered care to the patient. Quality includes several dimensions, which may affect the result. This paper presents how data quality dimensions may affect the delivered service, and propose a conceptual framework for the classification of confidence in data used in clinical decision-making for integrated care.

Keywords. Clinical decision support, decision-making confidence, data quality, integrated care

Introduction

In recent years, there has been the impetus for patients to self-manage their healthcare, for both physical and mental health issues. Advances in the way humans interact with computers, such as gesture and voice recognition, has allowed easier modes of interaction with IT applications, requiring very little technical skill. Furthermore, the evolution of mobile devices has provided a platform for integrating sensors, as well as applications personalised to the user [1-3]. The ability of the patient to interact with the healthcare service, has resulted in the increasing design and adoption of new paradigms of healthcare. These paradigms include active consideration of data communicated by the patient, such as self-taken measurements, patient reports, as well as entries by healthcare professionals who have examined the patient. Data can be produced by continuous or intermittent monitoring, and constitute part of the patient's personal healthcare record (PHR). This enriched PHR enabled to make decisions about the care plan of the patient.

The quality of data used in decision-making will ultimately affect the delivered care to the patient, and includes several dimensions. For example, consider a healthcare expert using out of date values to make an assessment. This may result in a decision based on data that are no longer valid, hence potentially adversely affecting the patient. The heterogeneous sources in the new integrated healthcare paradigms, may affect the quality dimensions of data. Different manufacturers of devices used for self-quantification, skill

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of the patient to use devices and report values, as well different IT applications, may compromise data quality. This affects the confidence with which decisions are made.

This paper takes an example of clinical decision making, amenable to new healthcare paradigms, and illustrates how data can be evaluated using the quality dimensions. The work then proposes a classification, which can be used by healthcare professionals, to understand the impact quality may have on the confidence with which they make decisions.

1. Data considerations in clinical decision making

Figure 1 presents an example excerpt of a clinical guideline, – guidance CG127 from the UK National Institute for Health and Care Excellence (NICE) for diagnosis and management of hypertension disorder, which already relies on multiple data sources, including home monitoring [4].

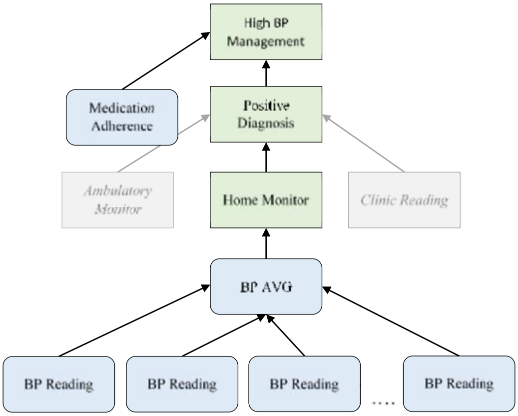


Figure 1. Data representation of guideline UK NICE – CG127

The disorder (excerpt in this example) can be diagnosed in three different ways: a measurement at a clinic, through an ambulatory monitor (i.e. a 24/7 wearable monitor), as well as patient home-based monitor. A positive diagnosis using home monitors, requires multiple readings in specific intervals (see Fig.2), creating an overall average measurement. This average measurement value can then be used to diagnose the disorder. This intent of these requirements is to remove potential deviating readings due to the equipment, its use, or readings when the state of the patient is not known (e.g., after exercise), which may skew the end-result. Nevertheless, even with these requirements, readings can be divergent due to common failures, such as skill of measurement, as well as a consistently uncalibrated equipment.

Use the average value of at least 14 measurements taken during the person's usual waking hours to confirm a diagnosis of hypertension. When using home blood pressure monitoring (HBPM) to confirm a diagnosis of hypertension, ensure that: for each blood pressure recording, two consecutive measurements are taken, at least 1 minute apart and with the person seated and blood pressure is recorded twice daily, ideally in the morning and evening and blood pressure recording continues for at least 4 days, ideally for 7 days. [UK NICE - CG127]

Figure 2. BP data requirements for UK NICE – CG127

The decision making regarding the disorder is further affected by patient originating data, during the disorder management stage. Moreover, the healthcare professional will need to evaluate the effectiveness of the patient's medication under the current care plan. This implies an understanding of medication adherence, which is something not considered explicitly by the guidelines.

For people who are already having treatment with bendroflumethiazide or hydrochlorothiazide and whose blood pressure is stable and well controlled, continue treatment with the bendroflumethiazide or hydrochlorothiazide. [UK NICE - CG127]

Figure 3. Patient data dependency for hypertension management UK NICE – CG127

In a healthcare service that expects the patient to report adherence (e.g., via a mobile application), adherence data will have a crucial role on subsequent decision-making. The implications of this become more pronounced in complex services, such as patient-centric, multi-morbidity management, which may have to integrate multiple guidelines.

2. Impact of data quality attributes on healthcare service

Data possess a number of attributes, representing different issues, which may affect the purpose for which they are used; in this case the function of clinical decision support [5]. Table 1 illustrates how a representative set of these attributes can affect how data are used by a service.

Table 1. Data quality dimensions applied to the hypertension disorder example

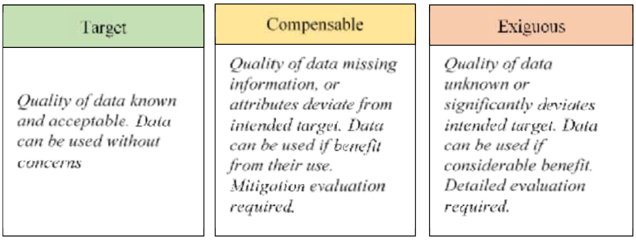
Data Attribute	Example Issue with Attribute
Accuracy	BP reading divergent from actual BP value of the patient
Validity	BP reading captured in an unexpected way such as different units, or extreme values (e.g. swapping systolic with diastolic reading)
Reliability	Equipment used not fit for purpose, or patient not trained to capture BP reading accurately
Timeliness	BP reading older than required, taken at wrong interval
Relevance	Use of BP instead of BPAVG
Completeness	Stored value missing units or clinical identifier

Ultimately, data may contribute to only a few risks, in this case: 1) wrong diagnosis (false positive, false negative) and 2) mismanagement of treatment. Understanding the data attribute that may be the reason for concern, allows us to draw more meaningful conclusions, about how we can use them (i.e. data). For example, consider the timeliness of BP not being according to the guidelines (i.e. >1 min between consecutive values), but taken less than a minute apart. If acceptability of that value is seen as binary it will be rejected; however, a qualitative evaluation of the value may still result in meaningful conclusions.

3. Qualitative confidence assessment

Simply masking data with decisions (e.g., rejection of BPAVG due to a value not meeting the quality criteria) may not offer sufficient resolution to healthcare professionals, often in a position where they need to make decisions based on imperfect knowledge [6]

Context of how the information is used is also important. For example, lack of confidence (due to insufficient quality) may be acceptable if the decision is to ask a patient, based on their PHR values, to visit a doctor, than if the decision is about which medication is more suitable for a patient. A framework for classifying and directing professionals to evaluating quality and subsequent confidence in a decision can be a useful tool. Figure 4 proposes a traffic light classification for data, based on the suitability of the data for intended use (e.g., timeliness requirements from a guideline), and the information (or lack) of about the quality attributes of the data. The classification accepts use of data with other than intended quality, given some usefulness for the patient. Additionally it considers whether there is sufficient information about data quality.



Target	Compensable	Exiguous
Quality of data known and acceptable. Data can be used without concerns	*Quality of data missing information, or attributes deviate from intended target. Data can be used if benefit from their use. Mitigation evaluation required.*	*Quality of data unknown or significantly deviates intended target. Data can be used if considerable benefit. Detailed evaluation required.*

Figure 4. Traffic light confidence framework

Confidence gaps, as well as corrective action taken, are attributes that can be recorded in a PHR (future aims of this work). This allows traceability on what professionals perceived acceptable trade-offs of data quality, as well as provide a clear audit trail for subsequent patient examinations.

Conclusions

New care models employ decision making dependant on multiple integrated sources, of not well known pedigree and quality standards. Data quality consists of a number of dimensions that may affect the service to the patient, also resulting in risks. Use of data for decision making should enable healthcare professionals to understand the trade-offs of data quality and incorporate this knowledge to their decision making. the authors are working towards a EHR/EPR compliant IT implementation of the framework.

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Health Informatics Scientists' Perception About Big Data Technology

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Abstract. The aim of this paper is to present the perceptions of the Health Informatics Scientists about the Big Data Technology in Healthcare. An empirical study was conducted among 46 scientists to assess their knowledge about the Big Data Technology and their perceptions about using this technology in healthcare. Based on the study findings, 86.7% of the scientists had knowledge of Big data Technology. Furthermore, 59.1% of the scientists believed that Big Data Technology refers to structured data. Additionally, 100% of the population believed that Big Data Technology can be implemented in Healthcare. Finally, the majority does not know any cases of use of Big Data Technology in Greece while 57,8% of the them mentioned that they knew use cases of the Big Data Technology abroad.

Keywords. Empirical study, Big Data, Big Data Application, Healthcare

Introduction

Big data is a term that includes large volumes of complex, high velocity, and variable data that wants advanced techniques and technologies to enable the capture, memory, distribution, management and analysis of the information [1]. The factors influencing big data are "Volume", "Velocity", "Variety" and "Veracity. On the other hand, the healthcare industry historically has generated large amounts of data, driven by record keeping, compliance and regulatory requirements, and patient care [2]. While most data is stored in hard copy form, the current trend is toward rapid digitization of these large amounts of data [2]. Driven by mandatory requirements and the potential to improve the quality of healthcare delivery, meanwhile reducing the costs, these massive quantities of data (known as 'big data') hold the promise of supporting a wide range of medical and healthcare functions, including among others clinical decision support, disease surveillance, and population health management [3,4]. The aim of this paper is to present the perceptions of the Health Informatics Scientists about the Big Data Technology in Healthcare.

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1. Methods

In order to investigate the Health Informatics scientists' perceptions about Big Data technology a qualitative survey was conducted based on former surveys in the field of Big Data [5-8]. The survey's questionnaire was divided in two parts. The first part included the demographical data and the second part included questions about the knowledge and usage of the Big Data Technology in Healthcare. All questions were in Greek language. The questionnaire was anonymous and was distributed through Google forms, to 46 Greek scientists on the field of Health Informatics, on a period of one month in 2017. The statistical analysis for the demographical data and the Big Data knowledge and usage was conducted using the SPSS.

2. Results

The survey's population was formed by 46 scientists in Greece. The 60.9% of the sample were female and the 39.1% were male. The age of the population was between 23 and 36 years old. Also 95.7% of the sample acknowledged the term Big Data while 86.7% population had knowledge about the Big Data Technology. Also, 48.9% of the sample reported that they obtained knowledge of the Big Data technology through University Lectures or Seminars, while 37.8% reported the World Wide Web as their source of information. Furthermore, 8.95% of the scientists reported that they heard about Big Data in their workplace. Additionally, the vast majority of the population believed that Big Data Technology could be used in Healthcare (86.4%), followed by Research and Education (70.5%), Public Sector (65.9%) and Finance (63.6%). Also, the scientists reported the following files as an appropriate source for data collection: Healthcare data (93.3%), Internet (62.2%), Sensors' data (60%), Social media (44.4%), Online transactions (42.2%) and Email (24.4%). Furthermore, 59.1% of the scientists believed that Big Data Technology refers to structured data, 45.5% to semi-structured data and 31.8% to unstructured data. The majority of the population (48.9%) did not know about software that is used for Big Data analysis and management. On the other hand, 20% of the sample mentioned Hadoop and Cisco Common Big Data Platform, 15.5% of the population mentioned Cassandra, 17.4% of the population mentioned MongoDB and 4.4% of the population mentioned other systems.

It is remarkable that 100% of the population believed that Big Data could be implemented in Healthcare. Additionally, 57.8% of the scientists reported that they knew use cases of the Big Data Technology abroad, while 88.9% of the sample did not know use cases of the Big Data Technology in Greece. Finally, scientists reported that the following could be used as a data source for the collection of Big Data in Healthcare: Electronic Health Records (91.1%), E-Prescription (84.4%), Clinical Decision Support Systems (51.1%), Vital points (44.4%), Internet (44.4%), PACS (37.8%), Scientific magazines (28.9%) and Social Media (26.7%).

3. Discussion

Based on the study findings, it can be assumed that the majority of the responders have knowledge about the Big Data Technology. It can also be assumed that the responders do not know that Big Data is a combination of structured, semi-structured and unstructured data. It is also important that only the half of them had been informed about Big Data through university lectures or Seminars. Furthermore, they believe that Big Data can be implemented in Healthcare, although a vast majority does not know use cases of the Big Data Technology in Greece. It can be assumed that Healthcare Sector in Greece is not familiar with Big Data Technology yet. Finally, another important thing is that the responders do not know exactly which the appropriate data format for the Big Data is.

4. Conclusions

A survey was conducted to present the perceptions of the Health Informatics Scientists about the Big Data Technology in Healthcare. The majority of the responders are informed about the Big Data Technology although they don't know exactly the structure of data. A limitation of the current study is that the people who formulate the sample came from a Postgraduate Programme in Health Informatics. This questionnaire is applied for the first time and it is required sample at different populations. Future work may include further investigation of the knowledge and usability of Big Data in healthcare professionals. Afterwards a Big Data application in Healthcare will be developed [9]. The aim of this application is to emphasize the potential of the Big Data technology in healthcare. The application will be tested by healthcare professionals. Finally, the healthcare professionals will assess the usability and the utility of this application.

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Real-Time Process Analytics in Emergency Healthcare

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Abstract. Emergency medical systems (EMS) are considered to be amongst the most crucial systems as they involve a variety of activities which are performed from the time of a call to an ambulance service till the time of patient's discharge from the emergency department of a hospital. These activities are closely interrelated so that collaboration and coordination becomes a vital issue for patients and for emergency healthcare service performance. The utilization of standard workflow technology in the context of Service Oriented Architecture can provide an appropriate technological infrastructure for defining and automating EMS processes that span organizational boundaries so that to create and empower collaboration and coordination among the participating organizations. In such systems, the utilization of leading-edge analytics tools can prove important as it can facilitate real-time extraction and visualization of useful insights from the mountains of generated data pertaining to emergency case management. This paper presents a framework which provides healthcare professionals with just-in-time insight within and across emergency healthcare processes by performing real-time analysis on process-related data in order to better support decision making and identify potential critical risks that may affect the provision of emergency care to patients.

Keywords. Big Data, Business Process Analytics, Real-time Analytics, Emergency Care

Introduction

Recent years have seen a dramatic transformation in the fundamental structure of the healthcare industry worldwide [1]. Effective and positive change is a perennial struggle for providers who are being constantly bombarded by new and difficult demands on their time, energy and budget. As healthcare providers strive to keep up with this unprecedented change, they focus anew to business processes that guide healthcare delivery and on the technologies that support them. Aging legacy software, new reporting requirements, changing payment structures and the shift towards more patient-centered care are all familiar challenges by now as is the integration of analytics tools in existing systems to enable better decision making and compliance. Currently, the various healthcare processes (e.g. clinical, administrative etc) involved in every-day clinical practice generate large volumes of data (process and event data), lumped under the term 'big data', which can be both structured and unstructured and are obtained from several sources [2]. However, little insight can be gained from these data

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regarding the efficiency and effectiveness of organizational processes due to the volume and the complexity of the data or to data access restrictions (e.g. real-time access is not feasible, certain part of the data is accessible etc). In this era of information complexity and regulatory compliance healthcare providers will succeed in their goals to provide high quality healthcare by achieving to manage, integrate, analyze and leverage these information from across their enterprise and external to their enterprise, thus providing all stakeholders with actionable data at the right time and place. Especially in systems, like Emergency Medical Systems (EMS), where insights are useful when drawn in real time, advanced analytics tools can prove important as they can help identify critical process issues pro-actively before they affect emergency care delivery. The last few years, a number of approaches have been proposed for the analysis of business processes, some of which utilize traditional approaches to Business Process Analysis (BPA), while others utilize big data driven analytics methods [5]. However, these approaches have certain shortcomings such as significant delay in processing data related to business process performance. This paper assumes an EMS system which has been modeled as an inter-organizational process involving ambulance services and hospital emergency departments and presents a framework which facilitates real-time monitoring of this healthcare process. In particular, it monitors the healthcare process during operation and analyzes the relevant process-related data in order to deliver actionable insights to the key stakeholders. Real-time analysis of process-related data is being performed by means of an analytics service, which integrates process-related data (transactional data and user input) from all possible resources into a structured view and analyses it in order to identify potential critical issues arising during emergency healthcare process executions.

1. Methods

The basic motivation for this research stems from our involvement in a recent project concerned with developing a prototype EMS system which is enhanced with data analytics tools to improve quality of pre-hospital emergency care while containing cost. Figure 1 illustrates a high-level architectural view of the proposed framework which comprises three main components: (a) Sources generating events during healthcare process execution (b) Real Time Analytics Service (RTAS), and (c) client portal. In the proposed system, event sources are considered to be all the components comprising the EMS system implementation. That is (i) the health information systems (HIS) hosted by healthcare providers, which store information regarding each incident. These are heterogeneous and reside at different settings, (ii) the web services providing access to existing HISs, (iii) the Business Process Management System (BPMS) part of which is a BPM engine that is capable of interpreting and executing Business Process Modeling Notation (BPMN) processes by orchestrating the aforementioned web services, and (iv) the authorization server that manages who, in terms of role, can perform the various BPMN activities. The RTAS is a service that performs real-time analysis on the data generated during healthcare process execution. These data are related to healthcare process performance as well as to issues relevant to emergency case management. The RTAS main components are:

(a) **Data Management Service (DMS):** It is responsible for handling process-related data (event data and user input). Event data are being collected in real time from various sources. The relevant events occur within process steps, and constitute a continuous and changing sequence of data that continuously arrive at the central event-handling backbone of the RTAS. As soon as the data are collected, they are integrated in order to be further analyzed. Each event contains pieces of information, such as a unique identifier, the identifiers of the process definition and the process instance it originated from, the date and time the event occurred and the state of the process at the time the event occurred. Since many of the healthcare processes may by cross-organizational, apart from the aforementioned set of data, a number of additional data items are also included in each event recorded. These are, among others, the *participant* who initiated the process activity instance and the *node* where the event was generated. The latter is particularly important in a highly distributed environment, such as the healthcare environment, where healthcare providers participating in healthcare process execution may be geographically distributed. Moreover, *incident-related data* are obtained, which are provided by users during each process instance execution (e.g. a patient's condition).

(b) Real Time Data Analysis Service (RTDAS): It is responsible for analyzing process-related data in real time and pushing the results to the Visualization Service. It supports both archived and stream data. After data have been collected by DMS, they are being fed up to RTAS for analysis and generation of alerts where needed. The healthcare process aspects that need to be monitored in emergency case management are related to both the *transactions* occurring during process instance execution and the *user input* provided. The analytic figures which are used to monitor transactions (process metrics) are absolute measurements extracted from the relevant time stamps included in process-related events that belong to the same process or activity instance. Calculations performed on these time stamps can provide useful insights into issues of each process instance execution (e.g. delay in task execution accompanied with possible cause of this delay). Metrics related to emergency care delivery such as availability of resources (e.g. ambulances, staff in hospital to deal with each particular incident etc) are extracted by user input provided during process instance execution.

(c) **Visualization Service (VS):** It is responsible for receiving the output of RTDAS and generate alerts and relevant reports which provide useful insights regarding process performance and other aspects affecting emergency case management. These data can also be used for the generation of dashboards and ad-hoc queries.

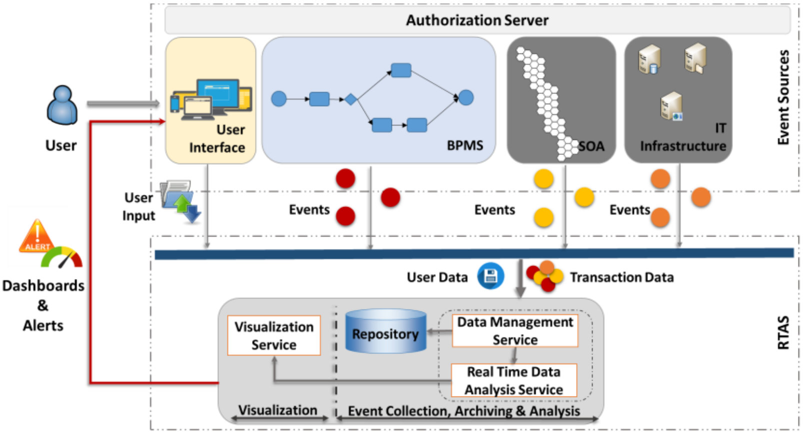

Figure 1. System Architecture

Finally, the client portal is a web portal, whereby medical professionals and decision makers can access reports and alerts generated by VS.

2. Results

To illustrate the functionality of the proposed framework, a prototype system was implemented in laboratory environment using the following components of Oracle 12c Business Process Management Suite [6]: (i) JDeveloper for developing web services user interfaces; (ii) a services registry for discovering and managing the lifecycle of services; (iii) a BPM engine for tying the services into business processes which are also exposed as web services; (iv) an enterprise portal for healthcare professionals, patients and collaborating healthcare organizations to access content and relevant performance metrics, collaborate and take actions via interaction with healthcare processes; and (v) Oracle 12c BAM Web Services for the implementation of RTAS [6].

3. Discussion

In healthcare sector, the quality of medical care provided to patients is closely tied to the performance of the healthcare processes supporting it. Currently, data are captured, stored and analyzed in order to extract insights regarding the effectiveness and efficiency of processes after the fact. However, in EMSs, many benefits would be realized if data could be continuously analyzed in real-time thus enabling the uptake of immediate action. This paper presents a framework that sets the ground to realize these goals in emergency case management by performing real-time healthcare process analytics. In particular, the proposed framework performs continuous, real-time analysis of streaming and, when appropriate, of stored data, with the ability to take immediate action on the discovered insights. System evaluation in a real EMS environment is a task to be undertaken in the near future aiming at determining the system usability. Thus, its potential weaknesses may be revealed suggesting directions for future work. It is expected though that sociocultural obstacles may be encountered, such as resistance to establishing routine audit, as there is a tendency for staff to see audit as a potentially punitive tool rather than a tool for improvement.

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Investigating the Perceived Innovation of the Big Data Technology in Healthcare

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Abstract. The research aim of this study is to investigate the perceived innovation of the Big Data Technology in Healthcare. A survey was conducted using a theoretical model based on Rogers' Innovation Diffusion Theory, on Davis' Technology Acceptance Model, and relative research work. The results reveal that the Big Data Technology may be an innovation on the field of Health Informatics as it offers a lot of advantages compared to the traditional ways of data handling and processing, and it is compatible with the current technological status on the healthcare domain. Additionally, the current study presents the positive attitude of the Informatics Experts about the usage of the Big Data innovative technology on Health sector.

Keywords. IDT, Big Data, TAM, Healthcare, Innovation

Introduction

Big data can be assumed as evolutionary and innovative technology in many domains of the everyday life [1,2]. Nowadays, Big Data systems are applied in Healthcare sector too [3], offering significant advantages on health data management [4,5]. According to these, the research aim of the current study is to investigate the perceived innovation of the Big Data Technology in Healthcare among the experts of the informatics domain.

1. Methods

A survey was conducted to measure the Perceived Innovation of the Big Data Technology in Healthcare. A theoretical research model was constructed based on Rogers' Innovation Diffusion Theory (IDT) [6], on Davis' Technology Acceptance Model (TAM) [7], and on previous research work [8-11] (Figure1). The "Relative Advantage" (RA) and "Compatibility" (COMP) dimensions were chosen from IDT, and "Attitude towards Use" (ATT) and "Behavioral Intention to Use" (BIU) were chosen from TAM.

The following hypotheses were tested on the current model:
H1+: How "Relative Advantage" can positively affect the "Attitude towards Use".
H2+: How "Compatibility" can positively affect the "Attitude towards Use".
H3+: How "Attitude towards Use" can positively affect the "Behavioral Intention to Use".

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A questionnaire was developed, based on related scientific work [8-11], in order to measure the aforementioned dimensions. Two questions (items) were used in each dimension. All items used a 7-Likert scale from "strongly disagree" to "strongly agree". Also, the gender and the age of the participants were recorded. All questions were in Greek. The questionnaire was anonymous and was distributed through Google forms. The data analysis was performed using the Partial Least Squares path modeling, with SmartPLS 2.0 M3 [12]. 89 Informatics Experts took part on this survey, in 2017, in Greece.

2. Results

The 51.7% of the population were male and 48.3% female. The age range varied from 18 years old to 63 years old, with mean at 32.9 years old.

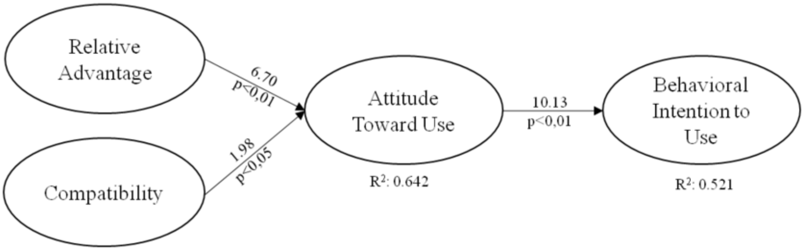

Figure 1. Results of the structural model

According to the partial least squares analysis, the measurement and the structural models were investigated [13]. On the measurement model, the coefficient of determination (R^2) was 0.642 for the "Attitude towards Use" and 0.52 for the "Behavioral Intention to Use". This means that the two latent variables (RA and COMP) explained 64% of the variance of the values of the "Attitude towards Use". Additionally, "Attitude towards Use" explains 52% of the variance of "Behavioral Intention to Use". The hypothesized path relationships between all the dimensions were statistically significant. Thus it can be assumed that: RA and CO are predictors of AT, as well as AT predicts the BI. To ensure the validity and the reliability of the model, individual item loadings and internal consistency (model reliability), as well as, convergent validity and discriminant validity (for model's validity), were examined and produced reliable results [13]. The structural model was investigated by applying a bootstrapping technique (with 5000 resamples) and two statistically significant levels: $p<0.05$, and $p<0.01$, based on a two-tail t-test. Results are presented on Figure 1. All the hypotheses were confirmed (inner model), with significance level of 99%, except of COMP to ATT (H2+) with significance level of 95%. Also, all the items of the Reflective Measurement Scale (outer model) were confirmed with significance level of 99%.

3. Discussion

Based on the results of the structural model, a very strong significant effect is presented of the Relative Advantage (H1+ at $p<0.01$) to the Attitude towards Using Big Data Technology on Healthcare domain, along with the significant effect of Compatibility

(H2+ at $p<0.05$) to the dimension of Attitude towards Use. Also, a very strong significant effect of the Attitude towards Use (H3+ at $p<0.01$) to the Behavioral Intention to Use was produced. These results present the positive perception of the Informatics Experts that Big Data Technology may be an innovation in Health Informatics domain as they believe that the Big Data Technology offers a lot of advantages compared to the traditional ways of data handling and processing, as well as, this technology is compatible with the current technological status on the healthcare domain. In addition, the sample's positive attitude for this technology reveals their intention to use Big Data in Health, so it can be assumed that they may accept this technology.

4. Conclusions

The current study reveals the positive attitude of the Informatics Experts toward the usage of Big Data innovative technology on Healthcare domain. A limitation of the current study is that the participants did not have an actual experience in using Big Data systems as the implementation of this technology is still on preliminary stage in Greece. Future work on the current field may include an evaluation of the Big Data Technology after an implementation and a pilot usage of actual systems.

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Chapter II

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Reducing Length of Stay by Enhancing Patients' Discharge: A Practical Approach to Improve Hospital Efficiency

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Abstract. For years, hospitals have responded to inefficiencies by adding more resources, whereas research suggests that it is a flow problem. King Faisal Specialist Hospital and Research Center decided to improve efficiency and enhance patient flow through improving patient discharge and reducing length of stay. Eight interventions were implemented; dedicating slots in diagnostic services for discharges, improving communication, eliminating pending exams, identifying discharges the day before, prioritizing laboratory tests, coordinating discharge medication processing and utilizing case management. 14.1% of discharges after improvement, compared to 21.7% before, experienced delays. Discharge cycle duration was reduced from 17.9 to 9.2 hours. 4.1% of discharges after improvement, compared to 14.8% before, experienced procedures delays. Procedure turnaround time was reduced from 46.9 to 15.3 hours. Average length of stay (ALOS) was reduced from 12 days to less than 10. Improving hospital efficiency is an integrated process and the responsibility of all hospital staff.

Keywords. Length of Stay, Discharge, Patient Flow, Performance Improvement, Efficiency, Hospitals.

Introduction

The burden of health care expenditure on national budgets has increased worldwide over the past two decades. Recent studies provided explanations; among these is the weakness of efficiency improvement measures [1]. Efficiency is defined as the ability of a system or a process to avoid wasting materials, energy, efforts, money, time or other resources in achieving the intended outcomes or producing the desired results. It is concerned with the relationship between resource inputs and either the intermediate outputs, such as the numbers of patients treated or the eventual healthcare outcomes, such as number of lives saved, life years gained, or quality adjusted life years. Inefficiency can be identified if resources could be reallocated in a better way to increase quantitative or qualitative value of healthcare outcomes [2]. One of the effective tools to improve efficiency is to enhance patient flow and to optimize discharge processes [3]. Because waits, delays, and cancellations are very common, they are assumed inevitable in the health care process. For years, hospitals responded to inefficacies and delays by adding more resources; beds and buildings or more staff, few

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organizations today can afford this. Recent research on assessing the reasons for delays suggests that adding resources is not the answer. In many cases, delays are a flow not a resource problem [4]. The average length of stay (ALOS) in hospitals is often regarded as the most important indicator of efficiency. All other things being equal, a shorter stay will reduce the cost per discharge and shift care from inpatient to less expensive post-acute settings. However, shorter stays tend to be more service intensive and more costly per day. Too short a length of stay could also cause adverse effects on health outcomes or patient recovery. The international benchmark for ALOS has fallen from 10 days in 2000 to only 8 days in 2013 [5]. At King Faisal Specialist Hospital and Research Center, Saudi Arabia, a performance improvement project was launch to enhance patient flow by improving patient discharge processes in order to reduce the ALOS of patients and improve the hospital efficiency.

1. Methods

The aim of the study was to identify and manage reasons of delay in discharging inpatients. A root cause analysis was conducted, showing that delays in discharges were relevant to all patients and are related mainly to three components; 1) Discharge process, starting with writing discharge orders by consultant physicians, then placing orders on hospital information system and finally physically preparing patients to be discharged, 2) Pre-discharge required procedures which are necessary for discharge; lab tests and imaging and 3) Preparing beds for next patients. A delay was considered when the turnaround time of any process exceeded two hours, as per hospital policy. A specially designed database tool was developed and nurses were trained to use it to collect data about discharges and delays at three different medical units; General Medicine, Nephrology and Gastroenterology. Nurses registered four check points; 1) Date and time of decision to discharge, 2) Date and time of placing the order on the system, 3) Date and time when the patient physically left the room and 4)Date and time when the bed is ready for the next patient. Three phases are now identified in between these four check points and the tool allowed nurses to register reasons of delays in each phase. The tool allowed nurses as well to register delays of required pre-discharge procedures and the reason of delays, including operative, imaging procedures and lab investigations. The improvement project was conducted in three phases; 1) Data collection and analysis for delay frequencies, magnitudes and reasons over the first two quarters of 2016, 2) Launching a group of improvement interventions, based on the analysis, in June 2016. 3) Recollection and analysis of data for the post-improvement, from July to September 2016. Improvement included eight interventions; 1) Dedicating slots in radiology department for discharging patients, 2) Establishing clear line of communication between radiology and head nurses to coordinate procedures, 3) Reviewing all the radiology exams pending from previous days and addressing the reason for delays by supervisors, 4) Identifying all actual and potential discharges the day before by rounding consultants, 5) Labeling laboratory samples for morning discharge patients with a different color and handling these in priority in collection, transportation and in lab, 6) Requesting pharmacy team to coordinate with head nurses to improve response and expedite the discharge medications, 7) Establishing clear line of communication between head nurses and housekeeping to improve on the turnaround time of cleaning patient rooms after discharge, and 8) Assigning case managers to coordinate with different departments and family to facilitate discharge.

2. Results

Considering that workload and staff to patients' ratio were the same, comparing the first two quarters of 2016 with the third, we find that before improvement, 21.7% of discharges (257 out of 1,187) compared to only 14.1% (72 out of 511) after improvement experienced delays. As shown in Table 1; there has been a significant improvement over the total discharge cycle duration, with an improvement in the mean from 17.9 to 9.2 hours (48%), on the median from 6.5 to 5.4 hours (17%) and on the 90thpercentile from 30.1 to 15.2 hours (49%). There also have been variable improvements over all of the three phases of the process. Delay reasons, of the three phases were analyzed and sorted descending by their frequency of occurrence to develop improvement procedures. In the pre-discharge procedures delay analysis, shown in Table 2, there has been a significant improvement of turnaround time, the mean improved from 46.9 to 15.3 hours (67%), the median from 25.3 to 5.4 hours (79%) and the 90th percentile from 94.3 to 43.1 hours (54%). Before improvement, 14.8% of the discharges (176 out of 1,187) experienced delays in procedures, while only 4.1% of the discharges (21 out of 511) after the improvement experienced delays. As a result of this improvement in both discharge processes and the pre-discharge procedures; the ALOS for the three medical units could be reduced, for the first time in 2 years from almost 12 days to less than 10 days.

Table 1. Mean and 90th percentile of the 3 phases and total discharge process cycle measured in hours comparing before and after the improvement.

Phase	Phase 1 Mean & 90th Per		Phase 2 Mean & 90th Per		Phase 3 Mean & 90th Per		Total Mean & 90th Per	
Before	4.8	4.0	8.7	11.2	4.5	4.3	17.9	30.1
After	1.5	3.2	5.3	8.7	2.4	4.0	9.2	15.2

Table 2. Mean, median and 90th Percentile of pre-discharge procedure process measured in hours comparing before and after the improvement. Count is the incidents of reported delays in discharged patients.

Procedure Cycle	Count	Mean	Median	90th Percentile
Before	176	46.9	25.3	94.3
After	21	15.3	5.4	43.1

3. Discussion and Conclusion

Since all the delays in discharges were relevant to all patients and to improve the discharge process, it is very essential to dedicate slots in the radiology schedule and utilize after hours for patients that are under discharge process. Research discusses the positive influence of prioritizing discharge patients on streamlining patient flow and improving discharge efficiency [6]. Improving direct communication between radiology department staff and head nurses, to coordinate discharge patients' procedures, can improve patient flow and minimize delays [7]. Better communication, as well, between nurses and housekeeping can spare a lot of wasted time though avoiding occasional slow response of making beds ready for next patients [8]. To avoid simple and routinely encountered delays, discharges have to be planned in advance. Patients on discharge list need to be identified early the day before, whether these are actual or potential discharges. This can be achieved through prioritizing physicians' rounds, improving discharge planning efficiency [9]. Laboratory samples for morning discharge patients should be labeled with a different color and handed in higher priority for collection, transportation and processing. It is the pre analytical phase improvement that can significantly enhance patient flow and discharge by reducing turnaround time of lab results needed for discharge [10]. Since discharge medication preparation and reconciliation is an essential component of the patient flow improvement, it is very important to requesting perfect coordination between the pharmacy team and the head nurses, responsible for discharge, to improve response and expedite the discharge process [11]. Add to all these interventions, utilizing case management to coordinate work throughout different services proved to improve patient flow significantly and improve post hospital transitions of patients to other settings [12]. The improvement of discharge process and reduction of inpatients' length of stay remain among the most effective interventions to improve enhance patient flow inside hospitals and improve their efficiency [13]. It might also be beneficial to monitor and then improve an extra new phase; the interval from the time inpatient bed is made ready for the next patient until the bed is physically occupied by the newly admitted patient. This new phase is not related to the discharge of the patient but related mainly to the efficiency of admission and boarding processes and is an influential factor on the hospital efficiency and the patient flow [14]. As a matter of fact, improving hospital efficiency and optimizing patient flow is an integrated and highly connected process, it is not a department specific or a specialty task; rather it is the responsibility of all hospital staff members.

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Use of the DPP4BIT System for the Management of Hospital Medical Equipment

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Abstract. The Information and Communication Technologies (ICT) combined with the development of innovative skills within the broader health sector, can significantly improve and upgrade health care quality services. The proposed DDP4BIT system supports an alternative channel for digital information recording and equipment handling of Biomedical Technology Departments (BITs) of Health Care Units. This technology is ideal for all types of procedures based on handwritten forms that are commonly used in Health Care Units. The collection of useful statistics for analyzing and exporting data indicators is used in order to reduce ratios, such as operating time ratio, ideal operating time indicator, number of repetitive quality failures, total maintenance cost, etc. and supports decision-making

Keywords. DPP4BIT, ICT, Digital form, Digital pen & paper, Medical Equipment.

Introduction

The type of medical equipment is the most important aspect in determining health care cost and operating expenses of Health Care Units. It must be taken into consideration in order to define the quality levels of health care provided [1]. The international scientific community faces the modern challenges of the rational and equitable allocation of health care funds, combined with the upgraded health care quality services [2]. According to WHO, the first step that should be taken towards the successful handling of health-related technology is specific data identification and technology recording, currently applied in the health sector. In other words, it's of a main concern to edit or develop some sort of Medical equipment Registry or a "health-related cadastre" [3]. The DPP4BIT application can successfully proceed with the digital recording and handling of the Medical equipment owned and run by the Biomedical Technology Departments (BITs) of Health Care Units, using a digital pen and paper which enables the user to fill in forms, without having to type them. The manuscript is digitized at first, that is converted into digital information (text, image) and finally saved as a digital file [4].

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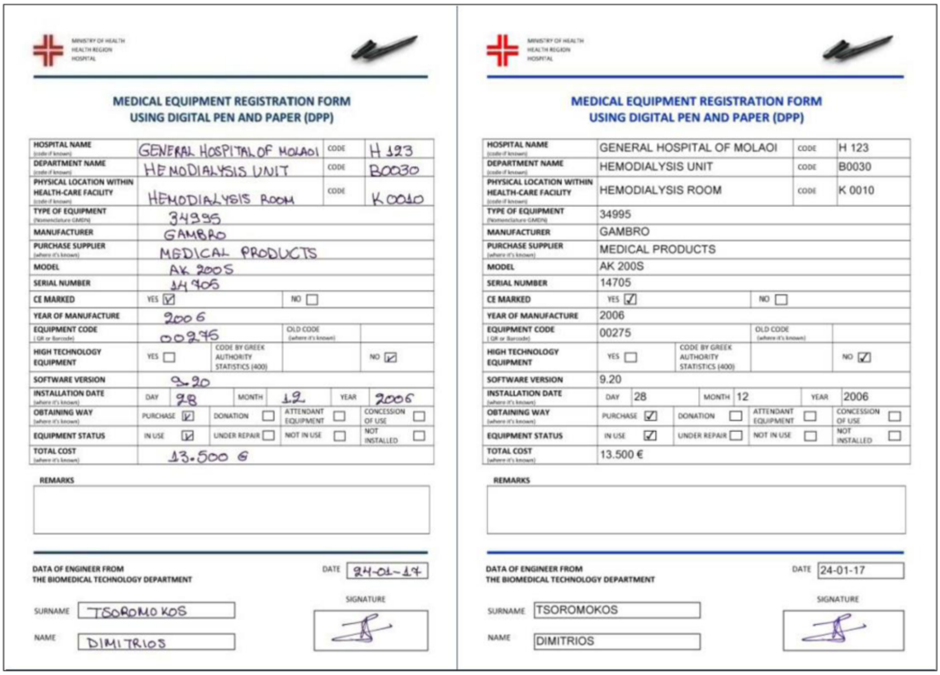
1. Materials and Method

The DPP4BIT application operates on a simple web-based platform which allows editing, management, import, and export of any document in digital form. At first, the application user roles (Administrator, Printer, Designer, Viewer, Clerk) are described and the devices to be used (digital pen, tablet, or a combination of both) are determined. The digital pen launched by Anoto has a light bulb that emits infrared radiation, a small-sized image sensor, a Bluetooth communication unit, a memory storage media, a processor and a battery. Data is saved in the memory storage media and is wirelessly transferred by using a Smartphone's Bluetooth device or usb stick operating on "PenPusher" software. Memory unit can store up to 200 A4 pages/forms, or 40 A4 full manuscripts without digital pen connection for sending data and before battery charge [5]. Each digital image contains enough information to identify the exact location of the pen, the kind of data edited, the editing time (timestamp), the user ID, as well as the kind of paper used [6].

Then, by using the so-called "Design Tool" application which is uploaded on the "Formidable" web-based platform, designing and digital field zoning on the standardized form is performed. The existing form can be designed from scratch, depending on the requirements of the service. The next step is registration language setting in all fields. The 2.13 version supports over 30 languages and has access to 9 alphabets. The handwritten imprint takes place in single-line, multi-line, or boxed fields and include date, time, a checkbox, a drawing area and the signature area. The drawing area and the signature area are not edited and they are saved as an image digital file. The other fields are converted into digital characters, supported by Optical Mark Recognition (OMR) & Optical Character Recognition (OCR) software and they are saved as well. The digital file is downloaded in the "Design Tool" application and it can be exported as .xml, .csv, .pdf, or .textual pdf file. The file receiver can either be the person that uses the digital pen himself or the person who owns Viewer or Clerk rights. It can also be sent as an email message and it can be uploaded on the "Formidable Viewer" application, which enables the final inspection of the form. Finally, data acquisition takes place by the central data acquisition center of the Hospital Unit (ERP, CRM, etc.) [7].

The digitized document is printed by using the "Print Processor Manager" software which has a unique code and a dots pattern. The pattern can be printed on any type of paper by using various printing techniques, including offset, laser and inkjet printing. The dot pattern, designed for this specific pen, consists of small black dots printed in intervals of 0.3 mm. The layout of the pattern can be used as a unique identification location code on the paper. Both the pattern and the image sensor located on the tip of the pen, enable Anoto system to record and transmit accurately everything is written in 60 million square kilometers in Anoto pattern [5].

Finally, the designed standard form is an A4-sized paper (210 x 297 mm) which has been developed by studying the existing documents of BIT departments, the standard documents used by Ministry of Health [8] and the needs of clinical technicians. The medical equipment registration form is based on the Digital Pen application and Paper (DPP) consists of 22 single-line fields, 1 multi-line field, 1 date field, 12 checkboxes, as well as 1 signature area. In Figure 1, a handwritten document (pdf) is illustrated (left side), and the conversion of a document into a digital form is performed (right side). The document is filled in by the clinical technicians of Health Care Units.



MINISTRY OF HEALTH
HEALTH REGION
HOSPITAL

MEDICAL EQUIPMENT REGISTRATION FORM
USING DIGITAL PEN AND PAPER (DPP)

HOSPITAL NAME (code if known)	GENERAL HOSPITAL OF MOLAOI	CODE	H 123	
DEPARTMENT NAME (code if known)	HEMODIALYSIS UNIT	CODE	B0030	
PHYSICAL LOCATION WITHIN HEALTH-CARE FACILITY (code if known)	HEMODIALYSIS ROOM	CODE	K 0010	
TYPE OF EQUIPMENT (Nomenclature GMDN)	34995			
MANUFACTURER	GAMBRO			
PURCHASE SUPPLIER (where it's known)	MEDICAL PRODUCTS			
MODEL	AK 200S			
SERIAL NUMBER	14705			
CE MARKED	YES ☑		NO ☐	
YEAR OF MANUFACTURE	2006			
EQUIPMENT CODE (QR or Barcode)	00275		OLD CODE (where it's known)	
HIGH TECHNOLOGY EQUIPMENT	YES ☐	CODE BY GREEK AUTHORITY STATISTICS (400)		NO ☑
SOFTWARE VERSION	9.20			
INSTALLATION DATE (where it's known)	DAY 28	MONTH 12	YEAR 2006	
OBTAINING WAY (where it's known)	PURCHASE ☑	DONATION ☐	ATTENDANT EQUIPMENT ☐	CONCESSION OF USE ☐
EQUIPMENT STATUS	IN USE ☑	UNDER REPAIR ☐	NOT IN USE ☐	NOT INSTALLED ☐
TOTAL COST (where it's known)	13.500 €			

REMARKS

DATA OF ENGINEER FROM
THE BIOMEDICAL TECHNOLOGY DEPARTMENT

DATE 24-01-17

SIGNATURE

SURNAME TSOROMOKOS

NAME DIMITRIOS

MINISTRY OF HEALTH
HEALTH REGION
HOSPITAL

MEDICAL EQUIPMENT REGISTRATION FORM
USING DIGITAL PEN AND PAPER (DPP)

HOSPITAL NAME (code if known)	GENERAL HOSPITAL OF MOLAOI	CODE	H 123	
DEPARTMENT NAME (code if known)	HEMODIALYSIS UNIT	CODE	B0030	
PHYSICAL LOCATION WITHIN HEALTH-CARE FACILITY (code if known)	HEMODIALYSIS ROOM	CODE	K 0010	
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MODEL	AK 200S			
SERIAL NUMBER	14705			
CE MARKED	YES ☑		NO ☐	
YEAR OF MANUFACTURE	2006			
EQUIPMENT CODE (QR or Barcode)	00275		OLD CODE (where it's known)	
HIGH TECHNOLOGY EQUIPMENT	YES ☐	CODE BY GREEK AUTHORITY STATISTICS (400)		NO ☑
SOFTWARE VERSION	9.20			
INSTALLATION DATE (where it's known)	DAY 28	MONTH 12	YEAR 2006	
OBTAINING WAY (where it's known)	PURCHASE ☑	DONATION ☐	ATTENDANT EQUIPMENT ☐	CONCESSION OF USE ☐
EQUIPMENT STATUS	IN USE ☑	UNDER REPAIR ☐	NOT IN USE ☐	NOT INSTALLED ☐
TOTAL COST (where it's known)	13.500 €			

REMARKS

DATA OF ENGINEER FROM
THE BIOMEDICAL TECHNOLOGY DEPARTMENT

DATE 24-01-17

SIGNATURE

SURNAME TSOROMOKOS

NAME DIMITRIOS

Figure 1. The image on the left presents the Handwritten text (.pdf) and the image on the right presents the Text conversion in digital form (.pdf)

2. Results

A successful pilot test was carried out at Hospital Unit of Molaoi in Greece using the Digital pen and paper. The technicians and nursing staff had been urged to use this digital application to register Medical Devices, to report or repair damage and prevent quality failures. Some data was acquired by interviewing the staff. The pilot research lasted for three months. An overall assessment report which summarizes the results of this test has produced the following:

- Data was acquired faster using the digital pen and the technicians earned 50% of their daily time to complete their reports
- 90% of nursing staff reported that this type of pen and paper was absolutely user-friendly
- 85% of users said they felt more confident using the digital pen
- Work efficiency was highly improved because the completed forms were quickly directed inside and outside the agency

This pilot research has confirmed that data entry by using this digital pen is a very useful application that reduces the daily workflow [9]. A number of procedures must be followed for the correct equipment handling and special knowledge is needed with regards to the successful system implementation and task coordination [1].

3. Discussion

The presented application improves the quality of digitized information, handwritten before and acquired during the daily workflow of the Biomedical Technology (BIT) Department of Health Care Units (HCU). Various BIT documents are directly available in the central information system of the Health Care Unit, such as the medical equipment registration form, the accountability reporting form, the maintenance & troubleshooting form, etc. Data is directly and securely processed by the authorized users in order to achieve the optimum result.

The Digital Pen and Paper utilizes Anoto technology and offers a novel and user-friendly writing experience in editable forms, giving the opportunity to enhance business performance and data accuracy. It can also achieve significant cost cuts. The presented application helps upgrading the quality of the services provided, restructures the internal procedures and serves employee needs in a more effective way.

This technology is ideal for all types of procedures based on handwritten forms that are commonly used in Health Care Units (HCU). The collection of useful statistics for analyzing and exporting data indicators is used in order to reduce ratios, such as operating time ratio, ideal operating time indicator, number of repetitive quality failures, total maintenance cost, etc. and supports decision-making. These ratios and results help political - decision makers to choose between a variety of effective means of health care policy. Thus, policy makers can evaluate their effectiveness and use this kind of technology as a baseline for supporting future action [10].

The Digital Pen application can serve multiple diagnostic and therapeutic needs, reducing cost, time and hospital stay. It’s a user - friendly application that helps everyone to acquire data in a few seconds and make useful decision about patient’s health status.

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Perceived Benefits of Implementing and Using Hospital Information Systems and Electronic Medical Records

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Abstract. Hospital information systems (HIS) and electronic medical records (EMR) are currently considered a major part of the healthcare system, on which all the processes of care delivery depend. They have the potential to provide substantial benefits to healthcare professionals, patients and healthcare organizations. The study used quantitative survey methods through a questionnaire to collect data and information directly from different categories of healthcare professionals of four Saudi hospitals. Valid responses were 153 and ten perceived benefits were validated and ranked, these are; 1) Improved information access, 2) Increased healthcare professionals productivity, 3) Improved efficiency and accuracy of coding and billing, 4) Improved quality of healthcare, 5) Improved clinical management (diagnosis and treatment), 6) Reduced expenses associated with paper medical records, 7) Reduced medical errors, 8) Improved patient safety, 9) Improved patient outcomes and 10) Improved patient satisfaction. There is still limited data regarding the direct economic benefits of HIS & EMR.

Keywords. Hospital Information Systems, Electronic Medical Records, Perceived Benefits, Hospitals.

Introduction

Hospital information systems (HIS) and electronic medical records (EMR) are considered a major part of the healthcare system, on which all the processes of care delivery depend [1]. The importance of these systems emerges from their fundamental role in managing all patient data and information including investigations, diagnoses, treatments, follow up reports and important medical decisions [2]. HIS and EMR have the potential to provide substantial benefits to healthcare professionals, patients and organizations. They can facilitate workflow and improve the quality of patient care and patient safety [3]. Application of information technology has been identified by the Institute of Medicine as one of the principal ways to improve quality of healthcare [4]. Poor coordination of care due to information inaccessibility, as a nature of the paper based medical records, has negative consequences and contributes to higher medical costs. HIS and EMR have the potential to improve coordination of healthcare by making information electronically available and accessible at the point of care, especially if implemented widely within the organization [5]. Studies examined the

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relationship between using systems and improved accessibility of information for better coordination of healthcare activities [6]. Some EMR applications such as dictation systems and automated voice recognition, hand held bedside information technology solutions and other software innovations could enhance productivity of healthcare professionals [7]. Studies discuss the direct link between wide implementation, acceptance and use of HIS and EMR and the improved clinical management and patient outcomes, in terms of diagnosis and treatment [8]. Studies suggest improvement in quality of healthcare with the implementation and use of EMRs, although most were unable to demonstrate direct improvements in patient clinical outcomes. These studies examined the effectiveness of systems in various areas, including mainly improvement in the delivery of patient care and reduction in medication errors [9]. Computerized physician order entry has been shown also to improve patient safety by reducing adverse drug events and drug interactions [10]. EMR are widely viewed as useful tools for supporting the provision of high quality healthcare. However, the evidence of their effectiveness is mixed. Some studies tried to consider the availability and use of specific EMR features, and also tried to assess the relationship between the use of an EMR and some of its specific features with the improved quality of care [11]. Some others proved that patient satisfaction is affected by the use of computers in general and more specifically in the examination room, where patients who have experienced computers in the exam room expressed higher satisfaction [12]. A study performed a cost-benefit analysis of EMRs in ambulatory primary care settings; benefits came primarily from savings in drug expenditures, improved utilization of radiology tests, better capture of charges, and decreased billing errors when using EMRs rather than paper based records [3]. Health information technology and electronic medical records could also improve accuracy of coding and billing through better documentation and coding decision support to providers translating this into enhanced revenues [13].

1. Methods

This study used quantitative survey methods, through the development and application of a questionnaire to collect data and information directly from different categories of well-informed healthcare professionals, who already have experience with HIS and EMRs, including doctors, nurses, technicians and administrative staff of Saudi hospitals, mainly four selected hospitals, two private and two government, and then analyzed the results using SPSS software to rank and sort benefits of implementing and using HIS and EMR. The questionnaire included two sections of questions. The first section was about the participant, with some demographic information, and the second was about ten validated benefits of implementing and using HIS and EMR. The reliability and internal consistency were tested showing a high Cronbach's Alpha. The four selected hospitals were fully implementing HIS and EMR. Data were collected using systemic random methods to include 5% of the hospital staff. In this method sample members from the larger population are selected according to a random starting point and a fixed periodic interval. This sampling interval is calculated by dividing the population size by the desired sample size. Data was collected with 153 valid responses out of 300 selected participants; 51% response rate, over 6 months duration on 2016. Nurses and administrative staff showed over 60% response rate, while physicians and technicians showed less than 40%. Private hospitals showed insignificantly higher rate.

2. Results

Taking experienced opinions into consideration, the overall mean, for all participants on all of the benefits perceived when implementing and using HIS and EMRs was 4.18, which means that participants overall agree that implementing and using HIS and EMRs at their hospitals had a lot of benefits. The benefits were ranked using descending sorting as shown in Table 1.

Table 1. Evaluating and ranking benefits of implementing and using HIS and EMRs.

Item	Mean	Participants' Opinion
Improved information access	4.49	Strongly Agree
Increased healthcare professionals productivity	4.31	Strongly Agree
Improved efficiency and accuracy of coding and billing	4.30	Strongly Agree
Improved quality of healthcare	4.27	Strongly Agree
Improved clinical management (diagnosis and treatment)	4.22	Strongly Agree
Reduced expenses associated with paper medical records	4.13	Agree
Reduced medical errors	4.05	Agree
Improved patient safety	4.05	Agree
Improved patient outcomes	4.01	Agree
Improved patient satisfaction	3.95	Agree

3. Discussion and Conclusion

The most important perceived benefit of implementing HIS and EMRs was the improved information access. Consistently, in their study, O'Malley and her colleagues identified six ways in which such systems could facilitate information accessibility and coordination of care; improving access to data during patient encounters, improving processes workflow, managing information overflow to clinicians, enhancing medical decision-making process care plans, supporting operational processes and improving financial data accessibility [6]. HIS and EMR can also decrease costs of some services such as medical transcription and reporting, making the work of healthcare professionals more productive [7]. They also have the potential to support better randomized trials by identifying larger numbers of eligible patients [14]. It is well documented that the use of computerized physician order entry with decision support as integrated parts of the implemented electronic medical record systems could have a role in reducing the number of medication errors [15]. Patient safety has many other dimensions than medication errors; that include reporting, analysis, and prevention of other types of medical errors. The adoption and use of health information technology could enhance the process of identifying, reporting and analyzing medical errors, so they could be easily avoided in the future not to occur with the same patient or with others [16]. Some studies examined the extent of EMR usage and how the quality of care delivered in the different healthcare practices varied according to duration of EMR implemented and used [17]. Physicians received higher overall patient satisfaction rates when a computer was used to retrieve patient information and also received similar satisfaction rates when a computer was used to enter patient information [18]. There is still limited data regarding the direct economic benefits of EMR to an institution. This type of evidence is especially difficult to obtain because the majority of healthcare organizations cite lack of funding as the most common constraint in implementing clinical information technology solutions like an EMR [19]. We still need to do more studies on the direct and indirect benefits of developing, implementing and using HIS and EMR, since this study didn't include evaluating the influence of implementing HIS and EMRs through a pre-and-post implementation objective impact analysis.

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Medications Related Emergency Admissions: Causes and Recommendations

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Abstract. Adverse drug events could require a patient to visit the emergency department, many of these visits lead to hospital admissions. A retrospective study, October 2015 to March 2016, examined the severity and factors contributing to medications related emergency visits leading to admissions at King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia. Out of 698 reviewed patients, 92 were medications related admissions. Adverse drug reactions were the primary cause (46.7%), drug prescribing (30.4%), compliance (14.1%), and drug dosing (8.7%). The majority of cases were of moderate severity (82.6%). Most medications involved in emergency admissions were antihypertensive (18.4%), chemotherapy (17.4%), anticoagulant (15.2%), and anti-diabetics (12%). Emergency admissions secondary to medication could be minimized whenever the causes of problems are identified. Motivating physicians to apply shared decision making strategy during prescribing and involving pharmacists in emergency and ambulatory care setting is highly important and to educate patients and support healthcare providers in making best medications related decisions.

Keywords. Adverse Drug Events, Emergency Visits, Admissions, Hospitals.

Introduction

Medications are the most common, convenient and appropriate treatment option for many acute and chronic medical conditions, however the inappropriate use of medicine could harm or injure patients. The undesired effect caused by a drug is known as adverse drug events (ADE) [1]. Those events can be further classified into adverse drug reactions (ADR); any unintended harm or injury resulting from the use of a drug given at proper doses during regular use, and medication errors (ME); any preventable event that occurs during prescribing, transcribing, dispensing, administrating, adherence or monitoring of a drug [2]. ADE could occur in variable severity; some might lead patients to visit the emergency department (ED), many of these could result in hospital admissions [3]. In 2011, the center of disease control and preventions reported that there were a 136.2 million emergency visits caused by medications in the United States, whereas 11.9% of them needed hospitalization [4]. Many studies investigated the reasons for medications related emergency admissions (MREA). Researchers found prescribing error contribute to 35% of all medications related admitted patients, the adherence to the medications accounts for 30% with antiepileptic, hypoglycemic,

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diuretics, inhaled corticosteroids, cardiac glycosides, and beta blockers as commonly associated with the admission [5]. Other investigators found that 6.5% of admissions are drug related and 69% of them were preventable. The avoidable medications related admission was caused mainly by an error in prescribing (35%), monitoring (26%) or adherence (30%), Geriatric population with polypharmacy was at higher risk for MREA [6]. The purpose of this study was to investigate the incidence of ADEs leading to hospitalization and to evaluate the severity and factors contributing to MREAs at King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia.

1. Methods

A retrospective study was conducted, over October 2015 to March 2016; all inpatients admitted through ED and reviewed by a pharmacist for mediation reconciliation were included, those have been identified through medication safety record that has all the reconciled admitted patients, we focused only on those patients reconciled from ED to be included. We excluded all self-poisoning patients, drug abusers and ADR's with Naranjo score less than five. The primary outcome is to evaluate the frequency of MREAs, in relation to all inpatient admissions done through the ED, and the secondary outcome is analyzing the severity and factors contributing to the MREA. We classified the causes of MREA to 1) Adverse drug reactions (ADR), 2) Patient compliance issues, 3) Drug prescribing causes and 4) Dosing causes. We defined ADR as any unintended harm or injury resulted from the use of a drug given at proper doses during regular use. The Naranjo Adverse Drug Reactions Probability Scale was used for the assessment of adverse drug reactions; it is designed to determine whether an ADR is actually due to the drug or a result of other factors [7]. We categorize patient's compliance to non-compliant; who doesn't take or stopped taking prescribed medication, and wrongly compliant or non-conforming; who takes his prescribed medications but not as instructed [8]. Drug prescribing causes include drug-drug interactions (DDI), contraindications (CI), patient self-medications (PSM) and uncontrolled condition (UC). We defined drug dosing causes as any sub-therapeutic or supra-therapeutic dose in which a patient takes too little or too much of the correct medication [8]. The severity ranges from minor, moderate, to severe. Minor includes laboratory abnormality or symptoms not requiring immediate medical intervention, moderate symptoms required treatment either by emergency physician or by admitted service whereas, severe when patient had permanent disability or has been coded or came with life-threatening symptoms that required an emergent intervention [9].

2. Results

Out of 2199 emergency admissions over the study period; 698 patients have been enrolled in the study. 92 (13.2%) were admitted due to drug related problems. Males were 53.3% and females were 46.7%. The mean age was 55 in medications related emergency admissions patients and 54.3 in non-medications related admissions. Causes of MREAs have been classified to ADR which were 43 (46.7%) of all MREAs, 16 (37.2%) out of the 43 were chemotherapy related ADRs. Drug prescribing was 28 (30.4%), 25 (89.3 %) were uncontrolled conditions, 1 (3.6%) was a DDI, PSM, and CI. Compliance 13 (14.1%), in which 10 (76.9%) were non-compliant and 3 (23.1%) were wrongly compliant. Drug dosing were 8 (8.7%), where sub-therapeutic dose were 5 (62.5%) and supra therapeutic dose were 3 (37.5%). The severity of cases ranged from minor 4 (4.35%), moderate 76 (82.6%) to severe 12 (13.04%).The service of admission was 17 (18.5%) oncology patients and 75 (81.52%) from other services. Most medications involved in emergency admission are antihypertensive 17 (18.48%), Chemotherapy 19 (17.39%), anticoagulant 14 (15.22%) and anti-diabetics 11 (11.96%). Other medications that were not involved frequently in MREAs are antiepileptic's 9 (9.78%), antimicrobials 7 (7.61%), Analgesics/Sedatives 6 (6.52%), both steroids and bronchodilators 3 (3.26%), bisphosphonates 2 (2.17%). While immunosuppressant, diuretics and muscle relaxants MREAs were only 1 (1.09%).

3. Discussion and Conclusion

Ensuring medication safety and preventing errors is becoming a goal for all high standard healthcare institutes [10]. This needs an assessment of the causes and correlations with the healthcare system in each country, the hospital system and patients' psychology and literacy. Unnecessary visits contribute to ED overcrowding, which could risk patient safety and jeopardize the reliability and the quality of the emergency services [11]. In our study, medications related emergency admissions accounted for 13.2% of all emergency admissions. Similarly in a study conducted in Vancouver general hospital, Canada, 12% of emergency visits were drug-related [12]. Preventing ADRs could be obtained by improving the hospital system; implementing an ADR reporting to track the incidence and re-occurrence of ADRs among medications, improving the nursing system in administering and monitoring medications, emphasizing on the importance of allergy documentation and providing a system that alerts physician for possible ADRs while prescribing. Involving pharmacists to revise physicians' orders and provide education on medications to health care providers and patients could also help in ADR awareness and minimization [13]. Other ways include considering patient's age, especially elderly patients with multiple medications, patient's weight, renal/hepatic functions and underlying conditions [14]. Closer monitoring of patients with a known uncontrolled medical condition is needed to minimize emerging situations. In Saudi Arabia, the rules and regulations that control the healthcare system are not firmly applied. Prescribed medications, which should strictly be dispensed based only on a doctor's prescription, are sometimes dispensed by community pharmacies to patients based on their personal request without a written prescription; this could increase the risk of undesirable ADE. Patient adherence to medication plays a significant role in treatment success. Factors that influences non-adherence include complex medication regimen, patient satisfaction, patient literacy level and length of treatment. Healthcare providers play an important role in improving medication adherence. Ensuring the understanding of patient to his/her treatment is critical. Patients have the right to know what their medications are for, how they work, and how long the course of the treatment is. Physicians and discharge counseling pharmacist could answer these questions; however, the time barriers could affect the physician ability to talk to their patients. In fact, discussing treatment options and the selection of the best regimen upon prescribing is a good way in promoting patient's adherence. Recently, studies have investigated the impact of the shared decision making strategy in improving patients' outcome [15]. Other adherent methods include the use of tools like schedules, mobile applications, and pillboxes.

Some patients need to schedule their mediations with one of their routine habits to avoid forgetting them. Behavioral intervention and family support help in better adherence with a complicated regimen [8]. Methods to minimize dosing problems include: implementation of hospital dosing protocols, patient awareness for symptoms associated with high or low drug levels, laboratory monitoring of certain medications to ensure optimum drug level and educating physicians and patients for possible drug interactions that might require an adjustment of doses, taking into consideration the high worldwide noncompliance rate of clinicians and low response to system drug alerts. In conclusion, emergency admission secondary to medication problems could be minimized whenever the causes of medications related problems have been identified. The impact of the health care system, hospital system and patient's psychology should be considered. It is recommended to assess patient's needs, increase drug awareness and promote drug adherence. Furthermore, it is recommended to motivate physicians to apply the shared decision making strategy during prescribing and involve pharmacists in emergency and ambulatory care setting to counsel and educate patients and support healthcare providers in making best medications related decision.

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A Suggested Model for Building Robust Biomedical Implants Registries

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Abstract. Registries are an essential source of information for clinical and non-clinical decision-makers; because they provide evidence for post-market clinical follow-up and early detection of safety signals for biomedical implants. Yet, many of todays biomedical implants registries are facing a variety of challenges relating to a poorly designed dataset, the reliability of inputted data and low clinician and patient participation. The purpose of this paper is to present a best practice model for the implementation and use of biomedical implants registries to monitor the safety and effectiveness of implantable medical devices. Based on a literature review and an analysis of multiple national relevant registries, we identified six factors that address contemporary challenges and are believed to be the keys for building a successful biomedical implants registry, which include: sustainable development, international comparability, data reliability, purposeful design, ease of patient participation, and collaborative development at the national level.

Keywords. Surveillance, Post-market, Biomedical, Saudi Arabia.

Introduction

The technological advancements of medical devices along with the growing medical infrastructure and healthcare expenditure have led to a progressive expansion of medical interventions. Nevertheless, the evidence-based practices that facilitate the safety and effectiveness assessments of these interventions have not been adequately addressed from both clinical and regulatory perspectives, which emphasize the need to evaluate the clinical outcomes and scan for potential safety signals, especially for high risk devices, including biomedical implants. Registries are powerful tools for many stakeholders, including clinicians, regulators, and manufacturers and can aid in providing data that address the safety and performance concerns of medical devices. However, many medical registries, and especially biomedical implants registries, have been established with two primary objectives, which are: 1) the collection of epidemiologically sound data that permit adequate judgment of the clinical outcomes, and 2) the traceability of implantable biomedical devices that facilitate the communication with patients in case of identifying safety concerns. Today, biomedical implants registries are overwhelmed by many challenges, but mainly those related to the data quality and integrity; as a result of a poorly designed dataset, data incompleteness, or the low clinician and patient

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participation in the registry. In this paper, we provide a model for the development of biomedical implants registries to address the challenges raised above.

1. Method

A literature search was conducted on 2017. Key search terms such as "biomedical implants," "cosmetic", and "registries" were searched via the Google Search engine and PubMed. We included both grays (eg., Government and non-governmental agencies) and academic literature sources that were related to: biomedical implants registries, written in English, and cosmetic. We excluded papers that were in languages other than English and registries that were clinical and/or not related to biomedical implants registries. Specifically, we focused on literature that showed the strengths and weaknesses of implantable biomedical device registries. Our primary focus was on cosmetic implant registries due to three main factors: 1) the long and rich history of building and maintaining registries in the domain; 2) the numerous national registries available for study; and 3) the maturity of the domain in surveillance, recalls, and crisis management.

2. Results

The outcomes of the search were the identification of 13 national registries, for the period of 1993-2016. Although, these registries have identical objectives, which relate to the data collection and the implants traceability, they significantly diverge in many elements, but mainly, the design of the minimum dataset and the patient consent model. The domain maturity in operating registries has aided in obvious transformations of some registries, especially the Australian Breast Device Registry (ABDR) that succeed to develop an optimal model through designing a recognized and effective dataset form; achieving a capture rate that proceed 97%; a surgeon's participation of 86%; and site coverage of 81%. [1] Following the successful experience of ABDR, many other countries have recently developed similar registry design, including the United States of America, France, Ireland, Netherland, and New Zealand. [2] An analysis of the registries included in this study identified three main themes relating to registry development.

2.1. A demand for a national level registry that is internationally comparable.

The Australian breast device registry model was successful because it was supported and funded by the Australian government. An earlier version of the registry was paid for by patient contributions at a cost of 25 AUD per implant, where only 3.4% of patients registered, as compared with 99% patient registration when the government began managing the registry. Government involvement led to the participation of other key stakeholders such as specialized institutes, associations and surgeons. [3] In addition, and with regard to the quality of the dataset, a case report form was created through the co-operation with the international collaboration of breast registry activity (ICOBRA), which helped improve the quality of the dataset, with an attempt to report only the fields required for outcomes assessment, at the time of the surgery, or thereafter during the follow-up periods, as recognized by ICOBRA experts, beside the experience of the frequent adverse events reporting of the participated registries. [2]

2.2. A demand for enhancing the data reliability.

The data reliability can be attained by satisfying high levels of registry participation, data completeness and quality. [4] National registries have tried different approaches to improve surgeon and patient participation. One approach is to consider an *opt-out patient consent model,* where institutions, surgeons, and patients are automatically registered in the registry, unless they desire to opt-out. This model conflict with the conventional *opt-in patient consent model,* which refers to the optional participation of patients and imposes a request to opt-in. [5] According to Jack et al, the conventional method of opt-in recruitment limits population uptake to approximately 30%. [6] The opt-out model has proven effective results in a number of registries, including the Australian Joint Replacement Registry and the ABDR, where the capture rate reached approximately 97% in both registries. [2] Furthermore, and with regard to satisfying the data completeness and quality, ICOBRA recommends averting the complexity of the data collection form, which can act as a disincentive factor for participation, and also act in undermining the form completeness and data quality. [4] As expressed by Crosbie et al, the more we ask for data, the less likely we are to get a report at all. [7] As a result, ABDR and ICOBRA, have recently designed a minimum dataset form of a single tick-and-stick page that can be completed in a few minutes during the operation, to avoid the consequences that might result from the complex form. The use of electronic patient identifiers, nomenclatures, and unique device identifiers (UDI) were found to be helpful in easing the task of data entry, while providing plentiful content and data integrity that can be easily incorporated within the hospital information system. [7] Furthermore, data completeness and quality can also be improved through the development of quality measures to safeguard the robustness of the clinical data, involving the validation of case ascertainment through the comparison of the reported cases with related hospital discharge codes to ensure data completeness, beside the monitoring and auditing of medical records to insure individual data quality. [4] As the longitudinal data contained in the registry dataset for the frequent complications, the patient-reported outcome measures (PROMs) were found to enhance the understanding of the clinical outcomes that have not yet been incorporated into the registry datasets.

2.3. A demand for ensuring the registry sustainability

Registry sustainability is greatly influenced by two main factors: sustainable funding and government oversight. Government funding is critical to maintain the integrity of the registry, while the government personnel aid in ensuring oversight of the registry tasks. [8] Building registries requires a long-term commitment, where the longer the registry is sustainable, the more data accumulation is gained, which maximize the analytical power of the registry and lead to improve safety analysis and decision making reports. [7]

3. Discussion and Conclusion

Biomedical implants registries are useful sources of data for post-market surveillance and post-market clinical follow up. From a regulatory perspective, registries can be used to track the performance of implants, the early detection of safety signals, and can be used as an implant traceability tool, while clinically, they can be used to identify trends in patient adverse events and complications. Globally, only a few registries have been designed to meet all these objectives. Instead, most of today's registries are designed to satisfy clinical or patient stakeholder groups and regulatory bodies. [9] However, as a result of a careful analysis of the previously described concepts, a comprehensive perspective can be attained by satisfying high levels of patient participation and data quality in biomedical implants registries. Patients participation is greatly influenced by designing the registry at a national level, ensuring sustainability, and applying best practices techniques that make it simple for registry stakeholders to participate. Such initiatives have shown positive results towards linking the registry with grant groups, ensure data accumulations, and elevate the data capture rate. Whereas, the data quality can be improved by meeting the international best practices when designing the registry dataset, considering parameters that satisfy each objective, and developing quality measures to safeguard the robustness of the data. Figure 1 illustrates our model, which contains six elements that are not only believed to reflect a dynamic clinical and regulatory perspectives, but also to be the keys toward effective and successful biomedical implants registries. Even though these elements reveal the international best practices, express high level of feasibility, and thought to advance the robustness of registries, some limitations are still expected, similar to any other clinical data registries, especially those related to logistical, legal, and ethical issues.

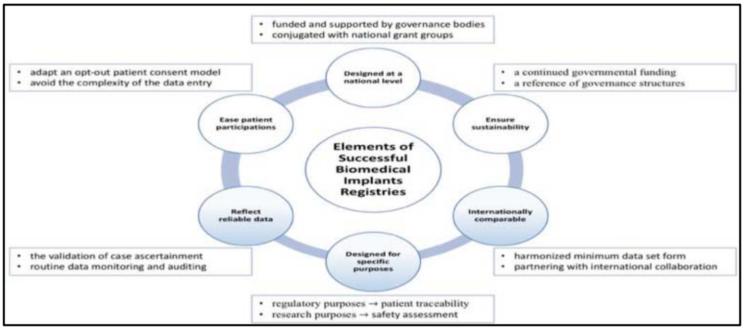

Figure 1. The six main elements of successful medical implant registries, where the shaded circles address elements to improve data quality, and the clear circles are elements to improve participation.

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Smart Telecare Technology in Health and Social Primary Care Management for Personalized Approach in Greece

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Abstract. The paper studies the smart telecare utility in health & social care fields for the satisfactory increase of external and internal user through personalized approach and the capability proof of continuing management improvement through quality indicators. Primary survey studies of aged people's satisfaction through smart telecare in Greece – maybe in good health or patients or socially isolated – interviewing four types involved – aged, caregivers, health or social care providers and smart technology providers or producers. The sample seems positive to smart telecare for prevention, protection, safety and security. To sum up, they believe there are organizational problems in Greece due to lack of information.

Keywords. Smart personalized telecare, Greece

Introduction

Smart technology is derived from the fourth information, communication and computing generation, creating a peak for user through virtual reality [1]. Interaction is the goal of ergonomic [2] and with fidelity user support through artificial intelligence, robotics and "computational sense" [3].

Smart technology gives opportunities of face, habits, place, time and reasons recognition and calculation [4], while it releases from spatiotemporal, geographical, income and social restrictions. Being used in health and social care services it leads to prevention of problems, sending real time information [5], advising, producing diagnosis, combined with electronic health record through interoperability and decision-making systems [6] – using knowledge base, actuators and sensors – in a qualitative way through specific standards and in a sufficient level of primary care operability.

There are several types of smart technology. These are smart devices or devices which are able to be transformed into smart ones by interconnection to the electronic health record and decision-making systems use, smart buildings with high safety and accuracy levels [7] through continuing amelioration [8] in combination with cost decrease [9], and smart cards with gradient personal data protection [10] for processing

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time decrease, simplification and automation. There is usefulness in telecare through personalized approach [11] for prevention of problems like falls and social isolation in remote areas [12] or chronic diseases. The result is smart cities formation. Personalized telecare approach increases autonomy, prevention and secondary health care decongestion through the state's cooperation for citizens' macro-satisfaction [13].

The purpose of the study is the discovery of the current Greek situation and the reasons for the acceptance or not by the involved.

1. Methods

In order to clarify telecare level through smart technology for personalized approach in Greece, literature review – it created a sample of case studies – and primary qualitative research [14] were used.

The research hypothesis was that smart technology increases user satisfaction [15] through personalized approach of telecare. Aged people – in combination with other involved in their smart telecare – were chosen, because they may be healthy or patients, with social care need or not, but in combination with comorbidity [16] and demographic aging, they cause the highest percentage of social protection expenditure [17]. The research tool – based on SF-36 [18] and Rialle et al 2007 [19] in order to form open questions for semi-structured interviews – contained health problems, body, psychological, social burden and independence level as holistic health dimensions, and alarm notice, smart home prevention, real time interconnection and advising decision-making systems as technological dimensions.

Communication was with 6 aged and 8 caregivers – accidental sampling – 6 health or social care providers – case studies of smart technology users – and 8 smart technology producers or installers – case studies location. Interviewing was analyzed to sample as a way to examine the reasons for their positive or negative opinion.

2. Results and Limitations

In Greece, the interviewing lead to two case studies discovering for smart personalized approach.

Vidavo is related to telehealth, through electronic health record, smart home, alarm and location platform by technology side, but it is addressed to health professionals. The goal is for telecare for external users. Cardioexpress refers to external users – patients presently – but producing only telemedicine – medical services using supplied technology – for missions, local societies and citizens even with home care if there is need. The ultimate goal is for telehealth through electronic health record. Interviewing creates limitations but it was chosen because of actions heterogeneity, which could not lead to generalized results, and the need for discussion of the reasons of points of views.

Aged sample interviewed supported that health, geographical, socio-economic and retirement factors affect the independence and monitoring needs in a suitable combination level, verifying the demand for personalized approach. Caregivers – all of them were relatives of their aged in need – pointed that utility of smart technology use is to manage a higher control level of aged well-being in circumstances of extra personnel used when they cannot be home. Small, simple and automatic devices are preferred for usefulness and flexibility.

Health and social care providers assumed the capability of the specific fields' combination with informatics for primary care development, secondary care decongestion by primary care diagnosis of emergency, travel and time reduction, increasing prevention through monitoring, especially if processes are controlled by family doctors with interdisciplinary cooperation. Smart technology goal has to be for health professional and caregiver support, not a decrease in human contact. Smart technology providers and producers referred to parameterization, system self-testing, remote control and interaction opportunities according to personal needs and supporting demographic aging with parallel respect to sustainable development, because of finite resources, using renewable and recycled energy.

The sample had a positive reaction to technological dimensions. The most important generalization factor on behalf of the specific sample seems to be the smart telecare actions establishment by the Greek organizational framework in order to be supported and familiar to citizens.

3. Discussion and Conclusion

Personalized approach depends on holistic health care through interdisciplinary cooperation – health is considered as complementary good of every human activity.

It increases accessibility, efficiency, effectiveness, safety and security, quality through telecare. As a result it manages a high social return and prevention – through education – through healthy and quality life years' amelioration [20,21]. In addition, using smart technology provides transparency and accountability [22], job growth [23], professional's health protection – for example from sharp objects [24], burnout [25] and danger because of psychological patients in home care [26] – and engagement increase through fear decrease [27]. In order to be accepted, there are needs for suitable education [28], organizational culture, leadership [29] and system friendly interface [30], having as ultimate goals social welfare and sustainable development [31].

In Greece, there are smart technology applications for telecare personalized approach. Nevertheless, bureaucracy, induced demand and urbanization, problems often met in Greek territory, decrease speed, quality of processes and health results. In combination with demographic aging, smart technology is considered to be an opportunity for cost and travel decrease [32].

Smart telecare personalized approach contains a variety of choices per needs, for organizational and spatiotemporal problems decrease. There are a number of health needs for one citizen, and the goal is the satisfaction of all citizens in macro-level analysis, because good health increases productivity and social welfare [33].

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Specific Characteristics in Digital Assessment of Conjunctival Redness

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Abstract. Photodocumentation of allergic hyperemia induced during the conjunctival provocation test (CPT) is analyzed by digital imaging and by assessment from an external observer. Selected specific characteristics, derived from the measured conjunctival redness values, represent the relevance of digital imaging and reproducibility of the CPT. The characteristics discussed here are: the area under the ROC curve and Pearson's product-moment correlation coefficient.

Keywords. Image analysis, conjunctival provocation, specific characteristics

Introduction

Ocular allergy is an essential part of the seasonal and perennial allergies caused by airborne allergens [1], and its prevalence continues to rise. Most allergic rhinitis patients also suffer from allergic conjunctivitis upon allergen exposure [2]. The conjunctival provocation test (CPT) is a reproducible diagnostic method performed to evaluate the severity of allergic symptoms that appear after instilling allergen solutions into the conjunctival sac of the eye. The CPT is a sensitive and robust method to screen for allergies to airborne allergens, as it addresses well-assessable allergic symptoms of the eye: itching, redness, tearing, foreign body sensation, and swelling. The allergen units of the solutions are given in SQ/mL. A maximum of three consecutive instillations of allergen concentrations of 100, 1000, and 10 000 SQ/mL are applied. The CPT is discontinued when the threshold defined for the severe allergic reaction has been reached or when the highest concentration has been applied. Among allergic symptoms, only redness can be easily documented and evaluated independently from the investigator's subjectivity. To evaluate allergic conjunctival redness, the photodocumentation procedure [3] and vessel reconstruction from high-resolution digital images [4] were developed and applied to data collected in five prospective, multicenter, double-blind, placebo-controlled, immunotherapeutic hyposensitization studies on inhalative allergies. The collected high-resolution images were assessed by an external observer and by imaging software as described in [3] and [4]. The specific characteristics discussed in this work permit the validation of the diagnostic capability and relevance of digital imaging performed during the CPT.

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1. Methods

The methodology of the studies carried out is discussed in [3] and [4]. Digital analysis consists of three steps, schematically shown in Figure 1. Manually segmented region of interest (ROI) images were corrected to create similar conditions using white color balance, peak luminosity, and focus weighting procedures. Then, using the adaptive contrast enhancement algorithm [5], blood vessels were reconstructed in binary images and cleaned of reconstruction noise. Digital redness values were given as the percentage ratio of the reconstructed vessels (i.e. redness pixels) to all ROI pixels. Distributions of the digitally reconstructed redness values are shown in Figure 2.

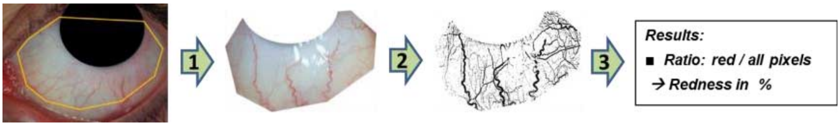

Figure 1. Imaging analysis steps: 1) selection of conjunctival ROI, 2) vessel detection via digital reconstruction, 3) calculation of redness.

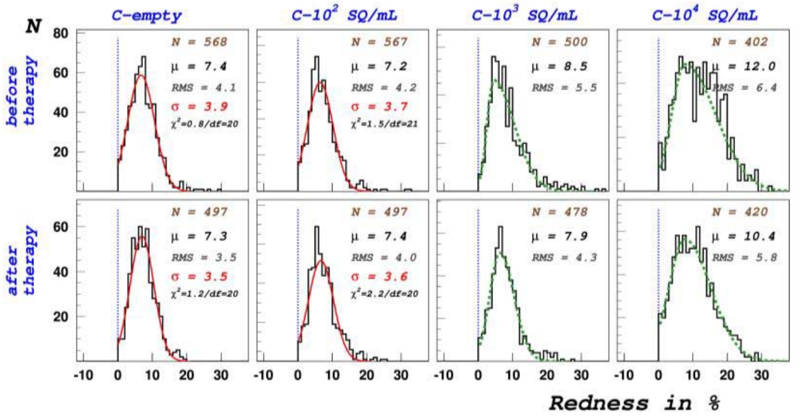

Figure 2. Digital redness in percent reconstructed by imaging software.

Most patients had no allergic reaction after the first instillation. Histograms *C-empty* (before instillation) and *C-10*^{2} SQ-U/mL (after first instillation) in Figure 2 were fitted using the normal Gaussian distribution (solid red fit-line) to compare the fitted parameters with *normalized* redness. Normalized redness (Figure 3) was derived as the difference (Δ) between the *C-10*^{2}, *C-10*^{3}, *C-10*^{4}, and *C-empty* values. Gaussian fit parameters in the first column of Figure 3, under the Δ(*C-10*^{2}*-C-empty*) heading, represent measurement uncertainties (or technical imperfections) of eye imaging and reconstruction of digital redness. Distributions of higher solution concentrations, which were more skewed from the normality, were fitted with the asymmetric Gaussian function (dashed green fit-line).

All patients were informed about the therapy and testing procedures and signed the informed consent form before being enrolled in the corresponding study. All studies were reviewed and approved by the competent ethics committees and by the regulatory agency of the German Federal Ministry of Health (Paul Ehrlich-Institut).

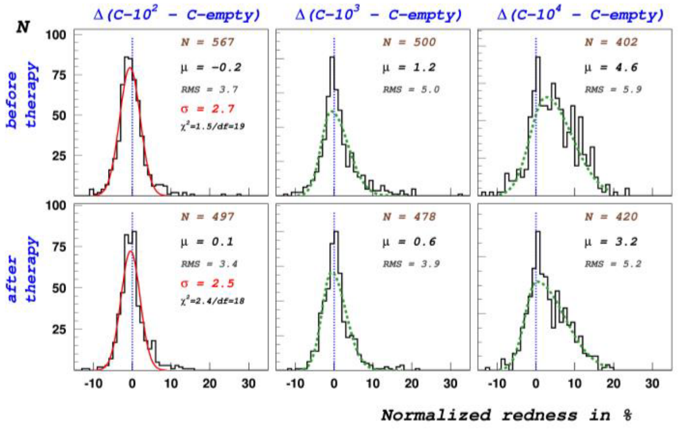

Figure 3. Normalized digital redness, calculated as difference of values before and after the instillation.

Current data, presented in Figures 2 and 3, were selected under the condition that there were no missing images before (*C-empty*) and after the first instillation (*C-10*^{2}). Digital values were independent of the observer's assessments given on a scale from 0 to 3: 0 = no visible reaction, 1 = mild, 2 = moderate, and 3 = severe redness.

2. Results

Operating with both digital and observer's assessments, and using an assessment by the external observer as the reference diagnostic performance, the AUC from ROC curves and the Pearson's correlation parameters were considered as the specific characteristics for evaluating the relevance and reliability of the digitally reconstructed conjunctival redness. ROC curves with corresponding AUCs are shown in Figure 4.

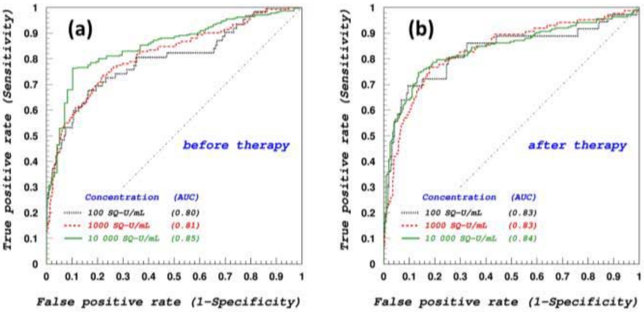

Figure 4. ROC curves: reconstructed digital redness versus the observer's dichotomous rating: **(a)** before and **(b)** after the therapy. The observer's rating is used as a reference.

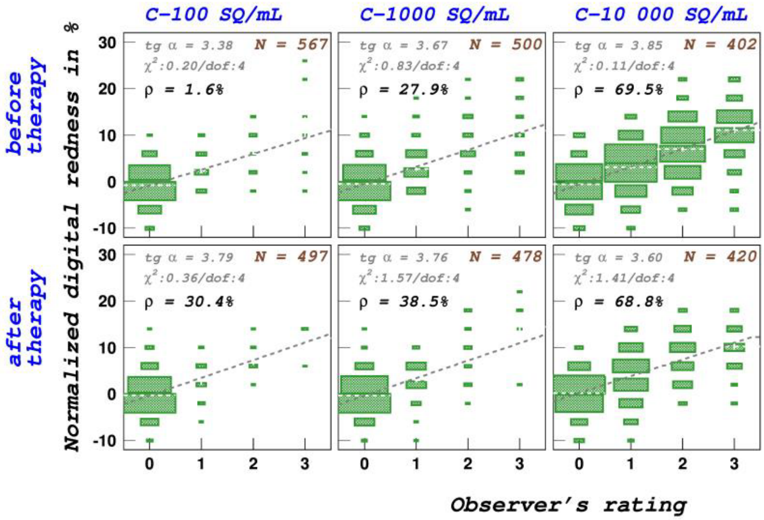

Figure 5. Correlations between digital redness and observer's assessments.

The Pearson's correlation coefficient ρ (Figure 5) is relevant only for the redness assessed after instilling the highest concentration solution of 10 000 SQ/mL.

3. Discussion and Conclusions

The relevance of the digital redness analysis via the CPT can be evaluated by the specific characteristics, comparing the digital imaging results with the reference measurement from an external observer. The robustness and measurement accuracy of the image-based analysis is demonstrated by the selected specific characteristics. We suggest using the characteristics discussed here for further analysis of missing data in collected data sets. With this work we hope to make a contribution to the topic of imaging in health informatics.

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Proposal for the Implementation of Quality Standards in a Medical Unit Through Integration to the Hospital Information System

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Abstract. Quality standards (QS) support and enhance health care services provided to patients and citizens, especially in sophisticated medical departments, such as Intensive Care Units (ICU). However, ICU staff lag behind in the adoption and compliance of QS protocols. In this paper, QS protocols implemented in the Intensive Care Unit of the Attiko University Hospital, a tertiary teaching hospital of the University of Athens, will be discussed. In this hospital, standardized procedures are implemented through the HIS, facilitating routine administration and services. We are aiming to facilitate educational processes and enhance staff compliance with the protocols by utilizing the Hospital Information System (HIS). In doing this, we propose the application of pop-up windows on the different user (medical or nursing) interfaces of the HIS, inter-connecting every electronic process with the corresponding QS protocol that has been developed in the ICU. This application may prove a valuable educational tool and may reinforce staff training and enhance compliance with the QS protocols.

Keywords. Hospital Information System, Intensive Care Unit, Quality standards, Compliance

Introduction

Modern societies aim to enhance healthcare services provided to patients and citizens, by upgrading the quality of services and reducing costs. In this context, standardization of procedures based on international standards [1] is a common practice [2] and Hospital Information Systems (HIS) support this effort [3]. Quality Standards (QS) have been widely adopted and define the function of many hospitals - public or private - in Greece [4]. The performance of sophisticated medical departments, such as Intensive Care Units (ICU), relies heavily on the implementation of QS protocols [5].

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However, education and training of ICU staff as well as their compliance with the protocols lags behind [6].

Attiko University Hospital is a tertiary teaching hospital of the Medical School of the University of Athens, established in 2003. QS protocols have been implemented in the 2nd Department of Critical Care, a multivalent (medical/surgical) 24-bed ICU, according to the International Organization of Standardization ISO 9000 - Quality management [1]. A recent survey in the ICU showed that, although the medical and nursing staff considers the QS protocols useful and essential for good clinical and nursing practice, the compliance rate was only 53% (anecdotal report). The Hospital Information System (HIS) of Attiko University Hospital integrates all standardized administrative procedures Authorized access to the HIS is provided to different user's categories, according to their role (administrative officer, nurse or medical doctor) [7]. Work in the ICU requires routine use of the HIS. The recent survey showed that insufficient staff education due to shortage of available time was the main underlying cause of low compliance rates. We hypothesize that direct access to the protocols through the HIS platform may raise staff awareness and accommodate education in a non time-consuming way and may enhance compliance. Hence, we propose an add-on application on HIS platform for the integration of the ICU QS protocols.

1. Methods

The aim of our proposal is to develop an educational tool that can be readily used by the staff during the routine work in the ICU. According to previous research, employment of specific tools may increase conformance quality in patient care [8]. The HIS provides access to patient electronic record, which includes separate sections for the various services and orders. We propose the use of an icon with the "ISO logo" placed on the user interface in different sections, which correspond to QS protocols implemented in the ICU. The icon may open a pop-up window containing a summary of the appropriate protocol, comprising of the recommended steps of every standardized procedure.

We propose the integration of this application in 4 sections of the HIS, as follows:

1. Administrative procedures: QS nursing protocols regarding patient management (admission of a new patient, discharge or transfer of patients to other departments of the hospital, demise and preparation of patient for transfer outside the ICU for imaging or other studies) are implemented in the ICU. All these procedures are registered on the electronic patient record in the HIS, in the corresponding section. We propose the addition of the application icon on every section, to open a window with the corresponding QS protocol.

2. Patient file forms: Patient files are currently processed and stored in hardcopy. File forms used are electronic standardized documents (according to QS protocols), which are printed and filled in by doctors in handwriting. The application icon could be added on the section "Medical Notes" on the patient electronic record of the HIS. A pop-up window would provide a list of all standardized documents of patient file: admission medical note, patient's medical history, patient's course, discharge medical note, medical instructions and medical reports. Every document could be selected, filled in electronically by the doctor and saved in the patient electronic record of the HIS.

3. Medical protocols: QS medical protocols regarding various medical procedures and treatments are implemented in the ICU, to ensure uniform management of patients,

according to international guidelines and evidence-based best practice. The patient electronic record in the HIS includes a medical section accessed only by medical staff. The application icon could provide a window added on this section, with a list of all medical protocols. The relevant protocol could then be selected from the list and reviewed by the doctor, every time he/she needs to apply the corresponding procedure. *4. Quality indicators (QIs):* The QIs are evidence based and are used as quality measures to monitor performance and identify variations in the quality of care [2,6,9]. QIs recorded in the ICU include: standardized mortality rate, length of stay, reintubation rate, ICU readmission rate, and others. The addition of a new QI section in the HIS is proposed. This section may contain a list of QIs recorded in the ICU. The staff would be able to select the appropriate indicator and fill in any adverse event applying to a QI (e.g. death, reintubation, readmission etc.). The HIS could perform extraction of cumulative data on every QI for a selected time period and a selected patient population, to produce QI reports.

2. Discussion

The main concept of our proposal is the integration of the QS protocols into the HIS, with the aim of enhancing staff education and adherence with the protocols. We believe that this application could facilitate our goal in many ways: (1) the ISO-logo icon could be utilized as an indicator, that the corresponding process in the electronic patient file in the HIS is standardized, according to ISO-9000 Quality management, thus serving as a reminder to the user, (2) the integration of this application in the HIS may provide the user with multiple opportunities to familiarize with the protocols, through every day use of the HIS during routine work in the ICU. Consequently, even new staff members, who are not familiar with the QS protocols, may undergo a fast and effective educational process during their work routine, without the need to attend regular educational staff meetings, which are time consuming and difficult to achieve full staff participation, (3) the timing of access (during management of patients) along with the concise form of the protocols may prove a useful tool for self-audit of the staff: the staff could use every QS protocol in the HIS as a check-list, to audit how s/he complies with it, thus enhance self-improvement. The HIS platform comprises a “Medical notes” section, which is not currently in use. We propose the electronic filing of the standardized file forms of the patient medical record, in accordance to the international use of electronic medical records [10]. Finally, the registration and reporting of QIs, which is essential for monitoring ICU performance and benchmarking [2,5,6,9], could be accommodated by the proposed application.

Our proposal is original and innovative, yet simple and easy to apply. To the best of our knowledge, there are no reports about integration of clinical protocols in the HIS, despite the fruitful research on the field of quality of care. There are only scant reports for the application of computerized protocols for usage in medical units [8-11]. Furthermore, the need for valid, complete and credible patient files is imperative. The development and application of electronic patient records is spreading [10], but its use has not been established in Greece. The introduction of HIS integrated electronic patient record may be the first step of a long and difficult implementation process. Many aspects of the HIS are amenable to modification and improvement by incorporating applications, designed to serve quality of care. Our present study aims to the upgrading of the HIS, in order to meet the needs of modern health care. However, we acknowledge certain limitations. This application has not been implemented yet. Thus, it is unknown whether it can deliver the expected results. We consider this application as an educational tool as well as a facilitator to staff compliance. Nevertheless, the successful implementation of every educational tool relies among others to the way it is perceived and used. There is no ensured success of any tool, and the only way to evaluate any results is through implementation. Finally, we developed this proposal based on the aspects of the ICU and the HIS of our institution. Thus, we can not presume on how this proposal can apply to other medical units and hospitals.

3. Conclusions

In this paper, we introduce a proposal for the integration of QS protocols into the HIS, aiming at enhancing quality of care in the ICU by facilitating staff education and their compliance with the QS protocols. Furthermore, we propose the development of an electronic patient record at the HIS, upgrading the patient files archiving processes of the hospital, as well as a recording and monitoring tool for QIs. Our future goals include: (a) the implementation of this application in the ICU and the evaluation in terms of perception and utilization by the ICU staff, compliance rates and quality improvement and (b) the automation and introduction of QS protocols and patient file forms in the HIS process.

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Juggling Doctor and Patient Needs in Mental Health Record Design

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Abstract. Providing patients access to mental health records is a controversial topic that gains growing attention in research and practice. While it has great potential in increasing the patient engagement, skepticism is prevailing among therapists who fear detrimental effects and face a lack of feasibility when treatment notes are handwritten. We aim at empowering both therapists to new documentation approaches and patients to higher engagement, and develop the collaborative documentation system Tele-Board MED (TBM) as an adjunct to talk-based mental health interventions. We present an evaluation of TBM by comparing four prototypes and testing scenarios, reaching from early simulations to attempts of real-life implementations in clinical routines. This paper delivers a systematic need comparison of therapists as primary users and patients as secondary users, both during and beyond treatment sessions. While patient feedback is thoroughly positive, the therapist needs are only partially addressed; the benefits remain hidden behind the perceived effort.

Keywords. Clinical psychology, patient access to record, user experience evaluation, secondary user

Introduction

It is well acknowledged in mental health care that increasing patient engagement in therapy helps to improve treatment outcomes. While in primary care and medical subspecialties, patient access to medical records is proliferating as a means to engagement, the mental health care domain is mostly excluded due to fear of undesirable patient reactions [1]. Kahn et al. [2] strongly support the idea of showing patients their mental health records and believe in a reduction of stigma and in increasing acknowledgement of health problems when notes are taken in a descriptive, nonjudgmental language. Germany passed a law in 2013, which calls for complete medical record transparency and grants patients the right to obtain electronic copies of their files any time [3]. While this is an opportunity for patients, it presents a challenge for therapists, also because handwritten treatment notes are still common practice in psychotherapy [4]. We aim at bridging the gap of legal requirements and clinical practice by designing a system that empowers both therapists to new documentation approaches, and patients to higher treatment engagement.

We develop the collaborative documentation system Tele-Board MED (TBM) as an adjunct to talk-based mental health interventions. The software system offers a whiteboard-inspired graphical user interface, which allows doctor and patient to take

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notes jointly during the treatment session (Figure 1). The documentation panels can be freely edited and filled with sticky notes, scribbles, and pictures. TBM is based on the web-based application Tele-Board [5] and is usable on different hardware devices. Whereas most computer system interfaces are designed for single users, TBM is designed for a collaborative setting involving two key users – therapist and patient. Therapists are our primary users, because they are frequent hands-on users of the system. Patients are considered secondary users [6], because they rely on the therapist to obtain information from the system and are influenced by their system experience.

This paper illustrates our approach to evaluating the concept and experience of TBM through prototyping and testing. We present four studies and analyze how the prototypes addressed – at times conflicting – needs of our primary and secondary users.

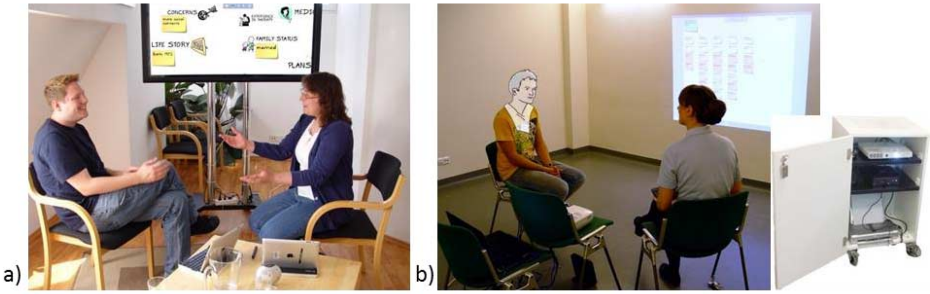

Figure 1. TBM settings with different hardware devices at an a) ambulant clinic and b) inpatient clinic.

1. Methods

We take a meta approach to evaluating the acceptance of TBM by comparing and contrasting different prototypes and testing scenarios, reaching from early simulations to attempts of real-life implementations in clinical routines [4,7,9].

1.1. Video Prototype for Gathering Therapist Feedback

In order to introduce the idea of TBM to therapists working at an ambulant clinic, a 15-min film regarding use cases, setup, features, and interaction was created. We sent out emails including a link to the video and a questionnaire. The survey evaluation has shown that therapists like the support that TBM provides in administrative documentation tasks and in fulfilling the legal requirements [7]. Skepticism was found regarding data privacy issues, a possibly impeded therapeutic relationship due to the use of technology, and the full file transparency requested by law.

1.2. Roleplay Prototype for Gathering Therapist Feedback

We invited therapists to an introductory event in an ambulant clinic, where TBM had been set up. We presented a roleplay of a psychotherapeutic treatment session with patient and therapist using TBM on a digital whiteboard. The participants had the chance to take on the therapist's role. In a survey on documentation habits, we learned that therapists need to find a good balance between giving the patient full attention and simultaneously noting down important contents [4].

1.3. Real-World Prototype at Ambulant Clinic as Attempt to Test Both Perspectives

TBM had been set up at the ambulant clinic. Data security measures were implemented [8] and a dedicated room was equipped with a digital whiteboard and supplementary hardware devices (Figure 1a). The software system was accessible outside of this room, too, on computers connected to the clinic network. After a 3-hour schooling event with therapists and the explicit invitation to use TBM, we waited for reactions, but without success. In retrospect, we identified several obstacles. Therapists were expected to experience a reduced workload with TBM due to the creation of digital notes that are immediately available for official case documents. However, they experienced an increased workload instead; they have to learn how to handle the novel technology. Eventually, therapists want to feel competent in front of their patients; unfamiliar technology both software and hardware seems to bear great risks in this regard.

1.4. Real-World Prototype at Inpatient Clinic for Gathering Patient Feedback

A second real-world prototype was used in a psychiatric inpatient ward [9]. Based on our experiences from the failed test in the ambulant clinic, we used a more basic and flexible setup, consisting of a laptop, a projector, a wireless keyboard with touchpad, and a printer stored in a trolley on wheels (Figure 1b). A member of the TBM team, who is a psychotherapist in training, worked at the psychiatric inpatient ward and experienced TBM with patients suffering from e.g. personality disorder. The joint note taking and the visual presentation led to an increased acceptance of diagnoses and to patient-therapist bonding. The patients were thankful for the print-outs to take home.

2. Results

During the process of repeated prototype creation and user testing we identified various therapist and patient needs. The need collection in Table 1 represents an overview of the common needs, which do not have to be comprehensively valid for each individual therapist or patient. We distinguish between needs that are pronounced during versus beyond a treatment session. Both are crucial to understand why or why not a system is accepted and how well or how poor its adoption works. The during-session needs strongly influence the social interaction of therapist and patient and the shared experience of systems like TBM. The beyond-session needs represent the individual context around a treatment session. Furthermore, the origin of needs differs: they might be personal wishes, or stem from legal or healthcare system regulations.

Table 1. User needs in talk-based mental health interventions both during and beyond treatment sessions.

	Therapist Needs	Patient Needs
During Session	Build up good therapeutic relationship	Trustful relationship
	Devote continuous attention to patient	Empathic nonjudgmental atmosphere
	Capture important observations	Being involved in decisions
	Feel competent in front of patient	Agree with treatment notes
Beyond Session	Adhere to legal requirements	Recall treatment session content
	Deliver administrative documents	Recall and do assigned homework
	Reduce documentation workload	Informed conversations with close persons

3. Discussion

While some needs of the primary user (therapist) and the secondary user (patient) are well compatible, such as the establishment of a good therapeutic relationship, there are certain needs that are conflicting and thus challenge the usage of TBM in treatment sessions. Patients have a positive attitude towards collaborative documentation with TBM as they feel involved in decisions and leave the session with a copy of their notes. However, the therapist need of feeling competent in front of patients (and possibly hiding the notes from patients) seems to be in peril when a system like TBM becomes part of the session. Even the prospects of easy fulfillment of legal requirements and quicker creation of official documents hardly make up for leaving the comfort zone and learning to operate TBM. Since our study took place in the context of behavior psychotherapy in Germany, the transferability of results to other cultures is limited.

We followed the design guidelines by Alsos and Svanæs [6] for information systems that involve a secondary user (SU) experience: TBM gives feedback to the SU, since the patient can see what is captured on the documentation panels and is invited to contribute. TBM's physical form, i.e. a digital whiteboard or a wall projection, supports non-verbal communication, because facial expressions and gestures are mutually visible. TBM provides an interface tailored for the SU and supports the use of patient language and representation. The graphical user interface in itself encourages visuals and capturing short texts on sticky notes, and the prepared documentation panels are designed in an intuitive way, so that no medical domain knowledge is required.

We conclude that TBM successfully addresses the needs of patients in talk-based mental health care. However, there is still work to be done to make TBM more attractive to therapists, because when the acceptance of a system is first and foremost dependent on the willingness of the primary users, their individual user experience is of top priority. It is yet very important in system development for collaborative settings, such as medical encounters, to design both user experiences together. However, we experienced that multiple, individual tests each focusing on a certain user group are an effective means to gain feedback and assess technology acceptance.

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Accounting Information Systems in Healthcare: A Review of the Literature

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Abstract. As information technology progresses in Saudi Arabia, the manual accounting systems have become graduallyinadequate for decision needs. Subsequently, private and public healthcare divisions in Saudi Arabia perceive Computerized accounting information system (CAIS) as a vehicle to safeguard efficient and effective flow of information during the analysis, processes, and recording of financial data. Efficient and effective flow of information improvesthe decision making of staff, thereby improving the capability of health care sectors to reduce cost of the medical services.In this paper, we define computerized accounting systems from the point of view of health informatics. Also, the challenges and benefits of supporting CAIS applications in hospitals of Saudi Arabia. With these elements, we conclude that CAIS in Saudi Arabia can serve as a valuable tool for evaluating and controlling the cost of medical services in healthcare sectors. Supplementary education on the significance of having systems of computerized accounting within hospitals for nurses, doctors, and accountants with other health care staff is warranted in future.

Keywords. Accounting information system; Saudi Arabia; Technology, hospitals.

Introduction

Globalization, technology, communication, and intangible assets are shaping and impacting our world gradually. Information technology now lies at the heart of almost every organisation and every business across the globe. However, it is reflected differently at every stage [1]. The implementation of computer technology has made a huge impact globally alongside making a vast transformation. The capacity to generate quality information on top of accessing it has become a fundamental feature at present. Healthcare sectors and other organizations are applying innovation for improving their procedures, services, and processes to achieve performance excellence [2]. The significance of information system is often shown by budgets. Integrated healthcare delivery networks are oftenwilling to allocate ittowards the expenditures of information system. The computer technology and its evolution has entirely transformed accounting systems, and financial outcomes within hospitals. This is mainly based on how much

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an individual invests on or improves the transformed accounting systems. The introduction of computerized accounting information system (CAIS) in Saudi Arabia may lead to cost effective accounting operations in the hospitals. In this paper, we define computerized accounting systems from the point of view of health informatics. Also, the challenges and benefits of supporting CAIS applications in hospitals of Saudi Arabia.Focusing this research on accounting system in the Saudi Arabia will add significant value to future studies in this field.

1. Methods

An electronic search for articles and reports was performed using PubMed and Google scholars. The search terms included a combination of key words such as accounting information system, Saudi Arabia, Technology, and hospitals. Moreover, the research articles were also searched from cross reference list for ensuring and extending a thorough literature search. Different themes emerged as a result of this literature review.

2. Accounting practices in Saudi Arabia

Accounting practices are vital to the issues of implementing purchaser-provider administrations within healthcare sectors in Saudi Arabia.Introduction of accounting in the hospital settings rendered the practice of medicine more standardized, calculable and visible [3]. Technology is progressing to be applied within healthcare sectors and other businesses [4], due to which majority of nations have moved away from the routine usage of pen as well as paper in order to adapt accounting software. It helps to facilitate generation with accurate, quick, and quality financial reports. On the other hand, limited consistency is coupled with irregularities registered in the technological field due to other security related concerns. Hence, handicapping the daily usage of the computerized accounting system. Previous evidences mainly evaluating the impact of utilizing technology to produce financial reports are inadequate [5].

3. Computerized Accounting Information System (CAIS)

CAIS is a “computer based technique” for tracing “financial transactions” established on IT resources. This system providesassistance in processing financial data that can be used for external and internal decision making. In the past, the accounting accomplishments; after or during industrial revolution and later being tested, turned to a debatable concern among users, accountants, and academics, who were clienteles of accounting information. Accounting information clients mainly seek for other solid and comprehensive informational sources [6].

3.1. Significance of Accounting Information Systems

Accounting information systems and its characteristics are very important because it subsists inside an organization to control all its activities [7]. Computerized accounting is designed to integrate and automate all the operations of a firm, such as inventory, finance, sales, purchase, and manufacturing. The importance of an efficient and precise accounting system is shown by its capability to help all institutions, by contributing to reduce cost,helps in quick decision making,automate generation of standard reports,increases visibility,reliability, and improves thequality of services. Some of the benefits of using computerized accounting systems include:

- Audit details and trials can be maintained automatically.
- Financial statements can be generated simply by selecting suitable menu items.
- A computerized system aids to retrieve the most contemporary data for accounting rapidly for example, up to date sales figure, client's payment status, and current inventory.
- One can keep data confidential by taking benefit from different security password system being provided by majority of the accounting programs.

Sacer and Oluic [8] claimed that this system is vital to prepare "quality accounting information". The IT applications often impacts an organizational operations. Organization requires a full understanding of their technological role on the processes of an institution. System of accounting information is usually backed up by appropriate information technology that is a cornerstone in theeconomy of innovative knowledge.

3.2. Security Threats and Challenges of CAIS Application

Cases in practice on top of research have progressively made apparent the security needs of CAIS [9]. Abu-Musa [10] offered empirical proofs of substantially alleged threats concerning CAIS in the Saudi Arabian societies, by utilizing a sample from four hundred firms. From an identified list of CAIS, security threats were provided, with conclusion including factors such as, misdirecting prints, unauthorized document visibility, destruction and suppression of outputs, log-in credentials sharing (password and ID's), other malicious programs, introduction of PC viruses, accidental data destruction, intentional and accidental employees' entry of bad data were found to hold most meaningful threats to security of accounting system.

3.3. Cost Reduction through CAIS

El-Dalabeeh [11] addressed the role of "computerized accounting information systems" in decreasing the cost of medical services at "King Abdullah University Hospital" in Riyadh, Saudi Arabia. Outcomes of this study confirmed that system of computerized accounting plays a critical role in reducing the cost of medical services in comparison to the non-computerized systems.

4. Conclusion

This review intended to examine the challenges and uses of "computerized accounting system" and its implementation in Saudi Arabia. CAIS plays an effective and substantial role in offering all decision making levels with precise, accurate, and timely information that helps healthcare firms to take accurate decisions. It alsoundertakes daily maintenance to reduce the medical service cost being offered to the patients in Saudi hospitals. Hospitals in Saudi Arabia are recommended to progress its work processes with regards to the computerized accounting information systems. Since, several challenges and security threats impedes CAIS implementation in Saudi Arabia therefore, future research should focus on conducting additional studies on factors for adopting computerized accounting information systems, to the areas which were not included in the review for getting the real picture. Supplementary education should be provided on the significance of having systems of computerized accounting within Saudi hospitals to nurses, doctors, cashiers, accountants together with other health care staff.

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A Review of the Factors Associated with the Adoption of Accounting Information Systems in Gulf Countries

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Abstract. This review attempts to elucidate the significance of accounting information systems within healthcare settings in the Gulf regions. Information and communication technologies (ICT) has provided accounting system the ability to help an organization use and develop computerized systems to record and track financial transactions. Accounting information systems, if well implemented, can permit healthcare sectors in the Gulf regions to produce reports that can support the decision making process. Additional abilities of an accounting information systems include faster processing, enriched accuracy, amplified functionality, and improved external reporting. Training of hospital staff can help in enhancing the use of accounting information systems in gulf hospitals.

Keywords. Health Informatics, Accounting information system; Gulf Countries

Introduction

Healthcare organizations use accounting information systems (AIS) to measure their financial performance by categorizing all of its transactions such as liabilities, assets, purchases, and sales in a way that adheres to a specific accepted and standardized format [1,2]. Health care organizations in the Gulf countries rely on information as the basis for making decisions. Furthermore, information derived from AIS is also imperative for financing, service delivery, education and training, research, and policy developments [3,4]. This review attempts to elucidate the significance of accounting information systems within healthcare settings in Gulf countries. It also highlights the factors associated with the adoption of accounting information system in the Gulf regions.

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1. Status of Accounting System in Gulf Cooperation Council (GCC)

The Gulf Cooperation Council (GCC) was initially founded in the year 1981, across Middle East. It includes the Eastern region of the Arab world specifically, the Arabian Gulf which includes the State of Kuwait, State of Qatar, Sultanate of Oman, Saudi Arabia, Bahrain and United Arab Emirates. These states formed an alliance for an economic and security co-operation [5]. Limited research studies are available on the use of AIS in hospitals within the gulf region. Previous studies have primarily focused on the aspects that influence the success of AIS in industries other than healthcare [6-8].

2. Computerized Accounting Information System

ICT has helped to improve the field of accounting in healthcare by automating information capture and use [9]. Hand written financial statements, manual spreadsheet, together with paper ledgers have been converted into computerized systems that can rapidly demonstrate an individual transactions into financial reports. The majority of the prevalent AIS can considerably be tailored to certain companies or industries. AIS permit an organization to form individual reports in an adhoc fashion to help inform management decision making. Lawson [10] projected that accounting systems within healthcare sectors need to serve 3 purposes:

- Promoting cost efficiency within hospitals regardless of sacrificing the service quality of an institution
- Permitting a hospital to optimize its resources by means of service line management
- Highlight opportunities for incessant improvements within the hospital operations.

Some of the benefits of the computerized accounting systems (CAIS) within healthcare settings can be stated as follows:

2.1. Amplified Functionality

CAIS have considerably improved the accounting division's functionality within health care sectors in gulf regions by boosting the timeliness of accounting information. Through making improvements in the timeliness of financial information, accountants can develop operations that offer supervision and management of the current operations. Such financial reports have been improved by market share reports, departmental loss and profits, cash flow statements, and computerized systems that are comparatively more accessible with the computerized systems [11].

2.2. Improved Precision

Most of the CAIS have balance measures and internal checks to ensure that all accounts and transactions in the hospitals are accurately balanced before the financial statements are made. Computerized systems do not allow journal entries to be out of balance when posting, ensuring that individual transactions are properly recorded [12]. "The precision is improved efficiently by limiting the number of accountants that have access to financial information. Limited access to information for accountants guarantees that financial information can be adjusted mainly by qualified administrators or supervisors.”

2.3. Faster Processing

CAIS permits accountants to process huge quantity of financial information besides rapidly processing it via accounting systems. Faster time to process for discrete transactions has limited the volume of time required to close out every period of accounting. Year-end or end of month closing periods can be specifically taxing on accounting divisions, which results in high labor expense on top of longer hours. Limiting this course of time helps the health care organizations to control cost, by increasing overall efficiency of healthcare. Moreover, faster processing of the data entry in the data collection forms within hospitals in gulf can be ensured.

2.4. Improved External Reporting

Reports given out to the stakeholders and external investors are substantially improving by CAIS. Improvements in reporting permits an investors to examine if an organization is a virtuous investment for growth opportunities, with having a prospective to be of high value. Healthcare sectors in gulf countries often use such financiers for equity funding, which they utilize for expanding.

3. Factors affecting adoption of computerized accounting system

The GCC countries have turned into a global magnet for foreign capital due to an attractive environment which is considerably subsidized by means of modern infrastructure, but similarly facing numerous global and regional challenges that often cast a shadow on the economic development processes within GCC regions [13]. These include but are not limited to sluggish growth in the economy, fluctuation of currencies, and oil prices, secured environment in various neighboring counties, destabilization of secured and political environments, which have slowed the roll out of AIS within GCC hospitals [14]. Even when a healthcare sector in Gulf countries invest in staff trainings for improving a certain criterion, it is noticeably a different aspect for the professional in these settings to adapt to these fluctuations. In areas when staff within an organization is not willing to go along with the changes being made, and are unresponsive, they turn out to be less productive, due to which, obvious advantages gained due to the adoption of accounting system would be suppressed.

4. Conclusion

Advancements in the information technology within Gulf regions have enabled the healthcare settings to computerize their accounting system. Accounting information systems are considered to be computerized due to significant technology improvements. As AIS are being computerized, accountants are gradually gaining expertise to utilize such systems. The utilization of accounting information system are considerably bringing opportunities to the gulf regions for healthcare settings to accomplish the functions of accounting more efficiently and effectively. Application of accounting information systems for performing transactional functions has provided Gulf healthcare organizations a chance to advance toward paperless agencies, which will help them operate more efficiently. AIS can offer health care settings with opportunities to control costs of medical services. Future work should study the impacts of AIS on healthcare organizations within the Gulf region, especially, as it relates to management decision making, cost control, and patient care.

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Critical Issues in Evaluating National-Level Health Data Warehouses in LMICs: Kenya Case Study

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Abstract. Low-Middle-Income-Countries (LMICs) are beginning to adopt national health data warehousing (NHDWs) for making strategic decisions and for improving health outcomes. Given the numerous challenges likely to be faced in establishment of NHDWs by LMICs, it is prudent that evaluations are done in relation to the data warehouses (DWs), in order to identify and mitigate critical issues that arise. When critic issues are not identified, DWs are prone to suboptimal implementation with compromised outcomes. Despite the fact that several publications exist on evaluating DWs, evaluations specific to health data warehouses are scanty, with almost none evaluating NHDWs more so in LMICs. This paper uses a systematic approach guided by an evaluation framework to identify critical issues to be considered in evaluating Kenya's NHDW.

Keywords. LMICs, health data warehouse, evaluation,

Introduction

Bill Inmon defines a data warehouse as "subject-oriented, integrated, time variant and non-volatile collection of data in support of management's decision making process" [1]. It should however be noted that a data warehouse is not a hardware or software product that can be purchased off-the-shelf in order to provide strategic information rather it is a computing environment that enables users to find strategic information and make informed decisions [2-3]. NHDWs promise improved efficiencies, better decision-making and better healthcare outcomes. For this reason, LMICs are beginning to deploy NHDWs in order to tap these benefits.

The premise of implementing NHDWs lies on the net benefit of having these systems for decision-making at multiple levels. However, for these benefits to be achieved, ample infrastructure, financial resources and skilled human resource are needed, most of which are often insufficient in LMICs. Given the novelty of NHDWs in LMICs, multiple issues arise that pertain to the optimal approaches for their design, implementation and use. By its very nature, implementing a NHDW is a complex undertaking, which brings up a multitude of issues. As such, an approach that looks at evaluating different aspects of NHDWs would serve the purpose of identifying grey areas that need improvement as well as uncovering potential opportunities and critical issues.

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In this paper, we use a systematic approach guided by an evaluation framework to identify critical issues to be considered in evaluating NHDWs. We apply this framework to Kenya's NHDWs, as a case study of how novel evaluation approaches for NHDWs can be applied. Data for Kenya's NHDWs is primarily derived from nationally implemented Electronic Medical Record Systems (EMRs). EMRs have been rolled out in nearly 650 public health facilities [4].

1. Methodology

Several approaches exist that aim to evaluate DWHs against a set of criteria and quality factors. However, evaluation frameworks that are specific to NHDW are largely unavailable. HDWs are more complex than traditional DWHs, hence evaluation methodologies need be specific or existing ones for DWHs need to be adapted for these systems. Our desk reviews revealed that there currently exists no comprehensive analyses that focus on identifying critical issues in evaluating a HDWs within an LMIC setting. To identify critical issues relevant to NHDWs within LMICs, a systematic approach is needed.

For the purposes of this paper, we used the evaluation framework in [5], from among several frameworks, given its comprehensiveness and adaptability for identifying key aspects relevant to assessing DWHs. We used the four dimensions within this framework to demonstrate how critical issues can be identified when evaluating a NHDW (Figure 1). Kenya, which has a NHDWs, was used as a case study for identifying the critical issues against the identified framework. Other supporting bodies of work, such as the case-based surveillance SWOT analysis in the Kenya NHDW [6], helped frame the analysis. In addition, we also leveraged guidance on architectural framework data warehouses for developing countries to help with identification of critical issues [7].

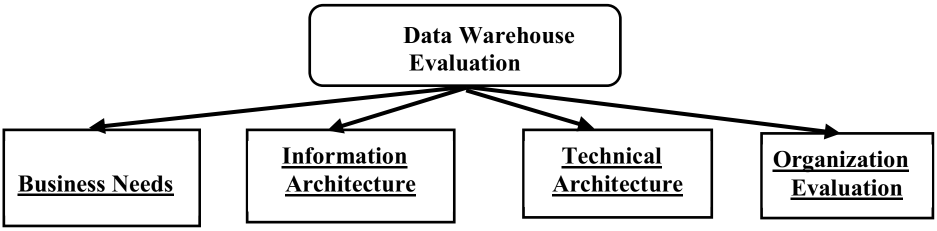

Figure 1. Dimensions for evaluating a data warehouse as in [5].

2. Results: Critical Issues to Consider

2.1. Intrinsic aspects of data quality

There are several dimensions that are intrinsic to data quality some of which include interpretability, usefulness, accessibility and believability [8]. Given that data quality focuses on multiple dimensions, objective evaluations (based on the data sets) and subjective evaluations (based on perceptions of stakeholders) need to be taken into account [9]. Discrepancies occur in both subjective and objective evaluations when the stakeholders perceive the quality of data to be high when in fact it is not.

In the case for Kenya, several deficiencies lead to poor data quality from within primary data sources into the NDWH, including: insufficient identifiers at the point of care, suboptimal data validation mechanisms, inadequate data entry personnel compromising timeliness and inadequate infrastructure at multiple levels. When the numbers of data clerks entering data into Electronic Medical Records (EMRs) from paper-based records are few, data is prone to numerous inconsistencies and errors. In addition, some paper records are illegible due to poor handwriting and damage. Kenya still does not have unique patient identifiers, often resulting in duplicate records and occasionally multiple identifiers per individual [6]. There have also been cases where the lack of utilization of best practices, such as for data backup, have also led to loss of data and consistency issues [6]. Comprehensive data quality evaluations thus remain a key component of NHDW assessments.

2.2. Accessibility and Security Issues

Accessibility is vital in NHDWs and for primary data sources that feed into the NHDW, ensuring that there are no barriers that limit authorized users to access data at any given time while limiting unauthorized users from gaining access to the data. In many cases, EMRs that feed data to the NHDWs in Kenya depend on reliable internet connectivity [6]. Unreliable connectivity can affect timeliness of data into the NHDW. Data is also collected and sent back to the data warehouse using flash disks (sneakernet) [6]. This use of flash disks can pose a significant threat given that flash disks are susceptible to virus attacks. Robust access security measures often also do not exist at facility level, ranging from physical security, routine security checks, and access controls.

2.3. System Integration and Interoperability

Efforts to incorporate data from primary sources in NHDW comes with a fair share of challenges. Several EMRs are currently implemented in Kenya, each with a different data models. Further, many of the EMRs do not use clinical messaging standards such, as HL7, making the upfront work of integrating their data into the NHDW quite challenging. Efforts are being made in Kenya to harmonize and integrate laboratory, pharmacy and EMR sub-systems whose data are integrated into the NHDW [6].

Another challenge that comes with integration of data from primary sources into the NHDW is the absence of semantic interoperability. Although most of the EHRs are based on a common platform, the use of different dictionaries has made sharing of data an issue between the different EMRs. However, there have been efforts made towards formulation of a solution that takes up a harmonized approach to semantic interoperability [10].

3. Discussion: Effect of Critical Issues on Evaluation

3.1. Business needs and Information Architecture

It is important that business requirements are defined and met during establishment and implementation of a HDWs [3]. This will enable evaluations conducted to examine whether the defined business requirements were considered during implementation or whether the output matched the defined requirements [5]. Feasibility, completeness and documentation of logical data structures need to also be examined and their alignment to business requirements analyzed [5]. The need for enhancement of data quality, integration and operability of the EMRs are important requirements and recognized aspects in the implementation of the Kenya NHDWs [6,10,11]. It is important that evaluation examines intrinsic aspects of data quality, taking into consideration the effect of insufficient identifiers, human resources, and infrastructure.

3.2. Technical Architecture and Organization Evaluation

Hardware and software components along with the network infrastructure ought to be evaluated in order to identify potential risks, constraints and their impact on performance, maintenance and scalability of the NHDW. Therefore, use of “sneakernets” and insufficient infrastructure ought to be considered when evaluating the Kenya NDWH and the effect these factors may have on its scalability.

4. Conclusion

Evaluation of NHDWs is important and ought not to be ignored. Appropriate attention need to be accorded to critical issues in establishing NHDWs in LMICs and how they can be investigated systematically when conducting evaluations. These evaluations need to be deliberate and systematic, guided by well-defined frameworks.

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A Review of Current Patient Matching Techniques

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Abstract. As healthcare organizations strive to improve quality of care and patient safety, it becomes paramount that they identify patients correctly and match records accurately both within and across institutions. Continuous care and population health benefits can be optimized when providers can have a comprehensive view of a patient's health record through seamless health information exchange. Various patient matching techniques have emerged to facilitate accurate patient identification. In this paper, we present a review of existing patient matching techniques, analyzed based on accuracy, cost and execution time.

Keywords. Patient matching, unique patient identifiers, biometrics, algorithms

Introduction

Patient identifiers help to link patients to their health information within a healthcare facility and across health care systems. Accurate and unique identification of patients is essential in ensuring that the right care is provided to the right patient to assure quality and safety. A patient matching error could result in compromised safety, potentially risking a patient's life. Further, poor matching can lead to multiple records for the same patient.

There exist variants of patient identification and record linkage techniques broadly classified under unique patient identifiers and algorithms, most of which use deterministic or probabilistic statistical matching approaches. However, research shows that there is no universally perfect patient-matching algorithm regardless of the level of sophistication [1], as numerous factors can impact performance. Given the inherent limitations of patient matching methods, healthcare industry players are on the lookout for the best and most efficient matching techniques that suit individual settings. This paper reviews patient matching techniques implemented in several international health care systems over the last 10 years, with an emphasis on accuracy, cost and performance.

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1. Patient Identification and Matching Systems

In an effort to identify each patient uniquely, various techniques have emerged utilizing common data elements related to the patient (patient identifiers) such as demographics and related attributes – examples include name, gender, date of birth, address and national identifiers, among others. According to Dixon [2], the main attributes of ideal patient identifiers are uniqueness, ubiquitous and their unchanging nature.

1.1. Unique Patient Identifiers (UPIs)

There are several nationwide initiatives towards realization of Unique Patient Identifiers (UPIs) to cover entire populations. The World Health Organization gives guidelines on generation of UPIs [3]. Unfortunately, the challenges around generating and implementing UPIs often lead to limited implementations within institutions or facilities, rather than more broadly. Privacy concerns are often cited as the major drawback to implementing UPIs across healthcare system networks [4]. Despite these concerns, ample evidence demonstrates the great potential for UPIs to improve patient safety and care efficiency.

1.2. Name Comparison Techniques

Name matching is a process that determines whether two name strings are instances of the same name. The two main approaches to name matching with varying degrees of complexity are Phonetic algorithms and String Similarity indices (pattern matching). While Phonetic algorithms index words by their pronunciation and hence are language dependent, Similarity indices algorithms qualifies the difference between strings [5]. Soundex code algorithm, Metaphone, and Phonex are among the best-known phonetic algorithms, while Levenshtein, Jaro, Jaro-Winkler and Hamming Code are examples of Similarity distance algorithms. In an effort to improve matching accuracy, algorithms employing a combination of phonetic and distance-based algorithms have also been employed, as well as comparison of more than one attribute. In general, the accuracy of matching algorithms based on name comparison techniques is affected by errors and variations in names especially during exact matching as opposed to approximate matching techniques [6]. Misspellings, name transposition, and linguistic differences across languages can significantly affect performance of these algorithms. Reported accuracies of Phonetic systems range from 89% to 96% [7].

1.3. Biometric Identification Systems

Deficiencies in UPIs and name matching algorithms have led to exploration of the role for biometric-based approaches for patient matching. Biometrics technology focus on personal traits of the individual [8]. Common human traits used in biometric identification systems include fingerprints, retina, iris, face, signature, and gait, among others. Biometric identification is deemed superior to other forms of identification techniques because biometrics are more difficult to 'steal, exchange or forget'. The accuracy of a biometric identification system is measured through false acceptance rate (FAR), false rejection rate (FRR), and 'Failure to enroll' values. These rates are in turn determined by a score generated based on the degree of similarity between the extracted and stored feature. While biometric devices rely on widely different approaches and modalities, their operational process is largely the same, namely: enrolment where the key features are extracted and matching where the created template is compared against the stored feature. Unimodal biometric systems utilizing a single feature can have limitations such as noisy sensor data, distinctiveness ability, and lack of universality of biometric trait, sometimes leading to unacceptable FAR and FRR [9]. Recently, multimodal biometric approaches, incorporating two or more biometric features, have been used and demonstrated significant improvements in accuracy. Palm vein, iris pattern and fingerprint are the most common biometrics features used in healthcare identification solutions, but fingerprint and palm vein may not work well in some situations, such as for newborns.

1.3.1. Fingerprint Recognition Systems

The fingerprint identification systems use an individual's fingerprints that are unique even between twins. Fingerprints are the oldest and most widely used biometric marker, and have low implementation costs. Fingerprints are used in multimodal with face modality to overcome false negatives rate for individuals whose work involves hand labour [10].

1.3.2. Iris Recognition Systems

Iris recognition algorithms employ methods of pattern-recognition and mathematical modeling based on high-resolution images of the iris. A major advantage of iris scans over other biometric methods is their high resistance to false matching due to a high degree of distinctiveness compared to all other human features [11]. A number of researchers have proposed fingerprint and iris multimodal biometric systems using varied fusion techniques for improved FAR and FRR [11].

1.4. Relative Performance of Biometric Identification Systems

The performance of any biometric identification system is assessed by its accuracy, speed, storage, cost and ease of use. While it was possible to get accuracy measures of different biometrics from studies as shown in Table 1, cost and execution times are hardly reported. The cost factor includes acquiring the sensor and implementing the identification system.

Table 1: Recognition rates for different biometric modalities. Sources: [9-11]

Biometric Modality	Accuracy
Fingerprint	FAR = 0.00001%
Iris	FAR = 1 in 1.2 million
Iris + Fingerprint	FRR = 0.5%
Face	FRR = 2.25 % - 7.29%
Voice	FRR = 1% - 60%

Algorithm execution times are determined by the computing processor speed, machine configuration, the algorithm itself and the volume of patient identifiers being compared.

2. Discussion and Conclusion

Compared to other patient matching techniques, biometrics approaches are generally deemed highly reliable at uniquely identifying individuals. An ideal patient matching technique exhibits best results when overall accuracy is high, execution times and implementation costs are low. For biometrics systems, accuracy is high or acceptable when the associated cost of FMR error is low. The costs of the biometrics hardware continue to decrease due to advancement in technology, making these increasingly appealing. Despite the benefits biometrics systems have over other patient matching techniques, their adoption is hampered by stigma given their association with government surveillance. Cultural objections, privacy concerns and additional infrastructure needs also affect adoption. Mobile technology penetrance, with devices now fitted with facial and fingerprint readers will likely revolutionize adoption of these technologies in the healthcare space for identification.

Patient matching is critical to patient safety, high quality care and health information exchange. Optimal and scalable patient matching approaches need to adopted in a way that suits each care setting, with special attention paid to the accuracy, cost and execution time of the algorithm, and with a sensitivity to cultural and infrastructure constraints.

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On Methodological and Technological Challenges for Proactive Health Management in Smart Homes

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Abstract. Health management in smart homes has advanced during the last years. With proactive health management in such environments further progress for health prevention and care is to be expected. Challenges for proactive health management in three areas are summarized and briefly discussed: pattern recognition and machine learning, information privacy and user-oriented design, and sensor-enhanced health information systems architectures.

Keywords. Active homes, ambient assisted living, health-enabling technologies, machine learning, pattern recognition, information privacy, sensor-enhanced health information systems, user-oriented design.

Introduction

For health-enabling and ambient assisted technologies, clear progress could be observed during the last decades [1-2]. This progress mainly comprised the *use* of information and communication technologies. Persons‘ homes can now be transformed into smart homes, with the potential of becoming an additional ‘institution for health care’ [3-4]. This development is of specific importance for senior citizens [5], with their homes now becoming part of health information systems [6-7].

For future research in this field, it is evident that further proof of diagnostic relevance and therapeutic efficacy is needed [8]. For considering current methodological and technological developments, inter- and multidisciplinary research in the fields of computer science, information systems engineering, and medical informatics is valuable. For instance, recent methodological and technological developments on active

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homes, proactively considering and adapting to a person's needs, may further contribute to managing of health care.

In the context of such proactive health management in smart homes, we highlight current challenges in three areas the authors are doing research in since several years. We focus our report on methodological and technological challenges for

- pattern recognition and machine learning (section 1),
- information privacy and user-oriented design (section 2), and
- sensor-enhanced health information systems architectures (section 3).

1. Challenges in Pattern Recognition and Machine Learning

A first challenge is the detection and modelling of a person's context (descriptions of her/his situation dependent, e.g., on time, place, and health) and a person's needs or wishes depending on the respective context (e.g., turning the heating up or down or suggesting a beverage). For that purpose, different kinds of sensor measurements have to be analysed and combined, which often do not allow for direct conclusions on actual situations or even particular persons. Moreover, a proactive home has to identify and model changes in a person's behaviour – not only singular events, such as in the case of persons suddenly stumbling and falling down, but also long-term changes due to ageing or increasing dementia. Methodically, these challenges could be addressed with probabilistic modelling techniques [9] and techniques for detecting concept shift or concept drift in observations originating from time-variant processes [10,11] in combination with appropriate techniques from the field of activity recognition [12,13]. Additionally, changes of hardware configurations (e.g., modifications of multimodal sensor systems) have to be taken into account.

To serve a wish or a requirement, a proactive home has to come to a decision, often in an autonomous way (e.g., messaging of relatives, switching lights on or off). Moreover, a proactive home faces the challenge of anticipating a resident's need (e.g., by advising physiotherapy driven training units). Methodically, this necessitates appropriate forecasting techniques based on the above models of contexts and requirements.

Finally, due to the weak relation between sensor observations and a person's actual wishes and needs (even if many and reliable sensors are used), it is necessary to involve the residents of a proactive home in a learning and decision process. This can, in principle, be done in various ways, either, explicitly by asking appropriate questions (e.g., "Was it OK for you that I turned the heating up?") or implicitly by considering a resident's actions (e.g., the resident turns the heating off again). Methodically, this challenge requires new active learning techniques [14] – possibly in combination with reinforcement learning approaches – with new selection mechanisms that decide when a person's implicit or explicit feedback is needed for learning. Moreover, learning in a proactive home also includes unlearning or forgetting due to the time-variant nature of this kind of machine learning problem.

2. Challenges for Information Privacy and User-Oriented Design

Smart homes will only become truly effective for proactive health management once their residents are aware of their information flows and enabled to operate them. Purposeful design of smart homes requires that homes are not only enriched with passive technology, but that residents are enabled to understand and trust their systems and to actively engage with them. Thus, from an information systems engineering perspective, two salient challenges for proactive smart homes are usability and information privacy.

Usability is not only a prerequisite for information privacy management. Usability is important for smart homes because residents cannot benefit from smart homes if they cannot use them. Usability is concerned with the effectiveness, efficiency, and user satisfaction of information systems [15]. To develop usable smart homes, residents should be consulted already during initial design phases and be constantly involved in the development process [16]. Salient challenges for usable smart homes are support for the diversity of devices residents may want to use, the technical complexity of smart homes that needs to be hidden from residents without prohibiting them from operating their smart home as desired, and the high volume of collected information that must be brought in a form supporting residents in proactive health management.

Beyond usability, dedicated attention to information privacy is important for proactive smart homes because they introduce a sensor infrastructure to residents' homes that, albeit collecting valuable information for health management, introduces information privacy risks. These risks cannot entirely be mitigated by information security measures, such as encryption, regular security upgrades, or rigid authorization schemes. The main challenge is to allow residents to assess whether treatment of information by their smart homes concurs with their information privacy preferences. Information privacy is a context-dependent concept [17] so that information privacy preferences do not only differ between residents but also change over time. Accordingly, proactive smart homes have to cater to the different information privacy preferences of their residents. This cannot be accomplished by simply providing a privacy policy [18]. Instead, smart homes require dedicated components for information privacy management that allow their residents to track information flows and control information processing in a way that is usable and does not surpass their technological literacy.

3. Challenges for Sensor-Enhanced Health Information Systems Architectures

Here challenges occur in the context of care processes. We have to expect that relevant data becomes part of a person's health record. Such data typically results from diagnostic or therapeutic procedures in health care settings. Usually, data are document-based.

In smart homes, however, data is produced as continuous data streams [19]. Several, additional methodological and technological problems occur because these health information systems are transinstitutional [20]. Home environments must also consider different levels of maintenance (see, e.g., the GAL-NARTARS study [21]). In [22], some of these challenges are presented with perspectives on how to solve these new requirements, which also have to be considered for proactive homes.

4. Discussion

We are aware that in this article we are mainly raising challenges without presenting solutions. These challenges are covered from three perspectives – the three disciplines, the authors represent. We are convinced that inter- and multidisciplinary research will help to overcome the mentioned problems and that we may so contribute to better health prevention and health care. Because of this we will continue to collaborate and want to encourage other research groups to also do such joint research.

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Clinical Decision Support in GPIT Certified Practice Management Systems*

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Abstract. This research has focused on identifying the current level of Clinical Decision Support Systems (CDSSs) within the current five certified Practice Management Systems (PMSs) that are provided to General practitioners (GPs) in Ireland. In this research, we also have conducted a survey questionnaire to explore the familiarity, perceptions and attitudes of GPs towards the current level of CDSSs functions within the five certified PMSs. From the current research results and in the light of its findings, a conclusion and proposed recommendations are provided.

Keywords. CDSS, EHR, Primary care, General Practitioners

Introduction

Clinical Decision Support Systems (CDSSs) are a computer software programs that were designed to aid clinical decision making about individual patients [1]. CDSSs provide several methods of decision support, including alerting the practitioner of critical values, reminding them about overdue preventive health tasks, providing advice for drug prescribing, suggestions for various active care issues and critiques with regards to existing health care action [2].

There are approximately over 2,800 General practitioners in Ireland working in 1,300 general practices provide primary care services for around 90% to 95% of all health care and personal services [3], 80% of those general practices are computerized and use a software practice management system (PMS). All PMSs used by GPs in Ireland must go through a mandatory certification process by the National General Practitioner Information Technology group (GPIT) [4]. GPIT is an organization funded by the state to ensure that all available software products adhere to the minimum functional standards. Currently, there are five PMSs which are certified by the National GPIT group. These five systems are ComleteGP, Helix Health One, Helix Practice Manager, Socrates and Medtech32. As a result of the research conducted on these five systems, the author found that there are no data on the current level of CDSSs offered by the five certified PMSs, and the research question posed was “What is the minimum level of CDSS that Electronic Health Record PMSs should provide in order to support GPs in the Irish health care system?”

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In order to answer the question posed, this research aimed to focus on identifying the current level of CDSSs provided within these five certified PMSs. As this is the first attempt of its kind, the author aimed to do the following: Identify the current level of CDSSs functionality within the current five certified PMSs by performing an identification of the functions of each system, explore GPs' familiarity and evaluations towards the current level of CDSS functions that are provided to them and understand their perceptions and requirements regarding the improvement/enhancement of these functions, and propose recommendations regarding a National Clinical Decision Support System which comprises the minimum level of CDSS that should be provided in order to support GPs in Ireland.

1. Methods

The type of method used in this research was the mixed method because there was a need for both qualitative and quantitative approaches for this study. The qualitative approach in this research involves literature review research to gain an understanding of the current situation of the primary care sector and the level of utilization of CDSS by GPs in Ireland. This approach is also used during the course of the **systems' identification**. Systems' identifications were performed using actual demos and available electronic documents from suppliers' websites and various literature reviews. The aim of this identification is to explore and examine clinical decision support functions that are provided in the five certified PMSs. The quantitative approach involved **survey questionnaires** and their statistical analysis. Based on the information found on GPIT website, 22 surveys were distributed randomly to 15 general practices and medical centers in County Limerick, Ireland. The target population was the GPs who are using one of the five certified PMSs. The total number of surveys completed and returned was 17 out of 22 with an overall response rate of 77%. The participants in this survey were as follow: Socrates users (n = 8) Helix Health One users (n = 7), and Helix Practice Manager users (n = 2).

1.1. Survey Design:

Extensive research was conducted in the literature to formulate and develop questions that can fulfil the objectives of this research. A 14-question survey was formulated and developed using similar studies [5] [6] [7]. For this research, the survey questionnaire was categorized into 6 themes:

- GPs' familiarity with the clinical decision support functions,
- GPs' perceptions regarding the clinical decision support functions
- GPs' attitudes towards the current level of clinical decision support functions
- GPs' attitudes towards the Alerting and Reminding support functions
- The guidelines for drug and disease management in the PMSs; when are they updated?
- Accessibility to internet-based medical libraries

Each theme comprises one or more questions and the majority of them were in the form of Likert scales. For some themes, open ended questions were added for questions that may require answers that were comprised of more than one word.

2. Results

2.1. Systems' identification:

The aim of this identification is to explore and examine CDSS functions that are provided in the five certified PMSs These functions are: Alerting, Reminding, Critiquing, Interpreting, Predicting, Diagnosing, Assisting and Suggesting. These functions were initially formulated from the research in the literature reviews on the common clinical decision supports functions [1]. As the results of the identification carried out and the analysis of the five certified PMSs, we conclude that:

- All the five PMSs provide: Alerting, Reminding, and Assisting support functions.
- The features provided within each function vary from one system to another.
- Socrates GP PMS offers the greatest level of CDS functionality.
- Medtech32 PMS offers the poorest level of CDS functionality.
- Diagnosing support function is not available in any of the five systems.

2.2. Survey questionnaire:

From the survey questionnaire conducted with GPs, we conclude that:

- The average level of GPs' familiarity with the CDS functions is as follow: for users of Helix Practice Manager it is 90%, while for users of Socrates it is 71.42%, and it is 47.5% for users of Helix Health One.
- 47% of the users of PMSs wanted to see both the Alerting and Assisting support functions to be improved in their systems.
- The GPs' perceptions towards CDSS functions are explored and can be summarized into four functional types: Interpreting, Suggesting, Diagnosing, and Assisting support functions. From the author analysis, these are the most needed functions for GPs.
- From the investigation on how the guidelines are keep current, 6% said "constantly", 44% said "periodically", 19% said "rarely", and 31% were "not sure"
- 100% of the users of PMSs declared that their systems do not provide an access to internet-based medical libraries or other medical information resources.

3. Discussion

This research has concluded that the functional capability of the CDSSs within the five PMSs is varied, and more work is needed to be undertaken in terms of maturing these CDSS functions. Apart from the survey conducted in this research, the familiarity level amongst GPs indicates a lack of utilization of the current CDSS functions. The author deduces that much of this is due to a lack of training which is shown in the investigation that GPs who is most familiar with CDSS functions are the ones who had got previous training. In relation to the research question posed, and based on the findings, this research recommends establishing a National CDSS that provides the adequate level required to support GPs in the Irish health care system. We recommend that the proposed

NCDSS shall be a web-based stand-alone system which then be integrated to the current PMSs by achieving the data level interoperability to ensure accurate decision support is provided. The NCDSS shall also use a central repository to help exposing advance analytics for knowledge-based CDSS functions. Based on the research findings, the research proposes the minimum level of CDSS functional capability required in the NCDSS and suggest that it comprise the following CDSS functions: Alerting, Reminding, Critiquing, Interpreting, Predicting, Diagnosing, Assisting and Suggesting. The alerting function shall provide real-time event-driven alerts such as alert for new exam results that were recently imported and can provides alerts for values of laboratory or any exam results that are out of range. Reminding function in the proposed NCDSS shall provide a mechanism for reminding both GPs and patients about vaccines that are due as well as prescription refills without the need for the patient's record to be opened. Critiquing function should be able to provide critiquing support during the ordering entry process based on up-to-data clinical guidelines using its central repository as well as other related external repositories. The predicting function shall provide online risk assessment tools that are fully integrated into the patient's records to provide more accurate and reliable estimates. The interpreting function should be able to provide electrocardiogram ECG readings, as this has become a commonly needed test in the Irish general practices. The diagnosing function in the NCDSS shall provide a mechanism for generating a list of potential diagnoses using patient-specific data such as sings, symptoms, laboratory results and medical history and use evidence based clinical guidelines for diagnosis to aid GPs in the differential diagnostics tasks. The assisting and suggesting functions in the NCDSS shall provide a mechanism for tailoring the ordering of drugs based on patient-specific data and the use of evidence based clinical guidelines to reduce the potential of incidence of medication errors and suggests alternatives when the drug prescribed has side effects or has been withdrawn from the market.

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Chapter III

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Semantic Web, Reusable Learning Objects, Personal Learning Networks in Health: Key Pieces for Digital Health Literacy

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Abstract. The knowledge existing in the World Wide Web is exponentially expanding, while continuous advancements in health sciences contribute to the creation of new knowledge. There are a lot of efforts trying to identify how the social connectivity can endorse patients' empowerment, while other studies look at the identification and the quality of online materials. However, emphasis has not been put on the big picture of connecting the existing resources with the patients "new habits" of learning through their own Personal Learning Networks. In this paper we propose a framework for empowering patients' digital health literacy adjusted to patients' currents needs by utilizing the contemporary way of learning through Personal Learning Networks, existing high quality learning resources and semantics technologies for interconnecting knowledge pieces. The framework based on the concept of knowledge maps for health as defined in this paper. Health Digital Literacy needs definitely further enhancement and the use of the proposed concept might lead to useful tools which enable use of understandable health trusted resources tailored to each person needs.

Keywords. eHealth literacy, Personal learning environments in Health, PLE, service user

Introduction

The knowledge existing in the World Wide Web is exponentially expanding, as new knowledge is created by continuous advancements in health sciences. On the other hand the use of technology and the Internet increased throughout the world and among patients as well. It has been identified in 8 member states of the European population that almost half of the population has a poor or problematic level of health literacy [1] while over a third of U.S. and Canadian adults have basic or below basic health literacy [2], [3]. To this extent, around 60% of people in the EU have used the Internet to search for health-related information [4], over 30% of the responders were dissatisfied.

A Personal Learning Network (PLN) can be described as an informal learning network that consists of "a set of connections to people and resources both offline and online", in which "we can learn anytime, anywhere, with potentially anyone around the world who shares our passion or interest" according to Richardson and Mancabelli [5]. The patients' driven online support networks are continuously increasing and play a more

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central role into patients’ health care [6]. There are a lot of efforts trying to identify how the social connectivity can endorse patients’ empowerment [7], while other studies look at the identification and the quality of online materials [8]. However, emphasis has not been put on the big picture of connecting the existing resources with the patients “new habits” of learning through their own PLN.

Algorithms and models for health-trusted information have been proposed [9], [10], but the acquisition in practice are lacking in terms of how users are searching information. When they are in a dedicated portal they are more likely to work effectively, but when they do it randomly through search engines the information is random.

At the same time, the use of the Reusable Learning Object (RLO) has been proved to be an essential tool for health knowledge acquisition [11] and they can defined as 'interactive, multimedia web-based resources based on a single learning objective which can be used in multiple contexts' [12].

A “knowledge map” may have multiple definitions, but within this paper concept it will rely on the idea of learning dependency or prerequisite knowledge similarly to Gordon [13], that draws on the ideas of what knowledge is and on spatial representation structures. Knowledge representation in the semantic web can be done through ontologies, as the one proposed in mEducator [14] to describe the medical education resources and connection with the Linked Open Data Cloud can be achieved through multiple instances [15].

In this paper we propose a concept framework for empowering patients’ digital health literacy adjusted to patients’ current needs by utilizing the contemporary way of learning through Personal Learning Networks, existing high quality learning resources and semantic technologies for interconnecting the knowledge pieces.

1. The Fruits in The Basket

A PLN can be considered the most contemporary means of learning for patients since it can provide active collaboration anytime. It encompasses all the possible knowledge that exists on the web following learners’ individual way of learning. In order to be achievable and applicable into practice the learner must be a mature learner, be able to perform critique to the offered knowledge and among others (in respect of each individual case) to be able to identify and understand health related knowledge; to create and maintain a supportive network; and to be digital literate. In order to identify the medical knowledge needed the user should know what she is looking for. Is the user able to critique the validity of the information on the resource? Is the resource health trusted? Can the user understand the resource; in what depth? Is there a necessity for prior knowledge in order to understand the resource? How the learner found the prior knowledge? All these questions can lead the user, looking for health trusted information, into an endless loop of information seeking and understanding through their PLN.

Analysing the knowledge for a specific health theme that the user desires to acquire, based on Gordons proposal [13], prior knowledge or supporting knowledge is needed in order to be understandable the desired knowledge. At the same time, knowledge desired can be linked with different resources (educational resources, videos, conversations, forums, tweets etc.) for each one of the learning objectives (Figure 1 A and B). Using the mEducator scheme/ontology we can describe the resources in machine readable way, at least all those created purely for health education.

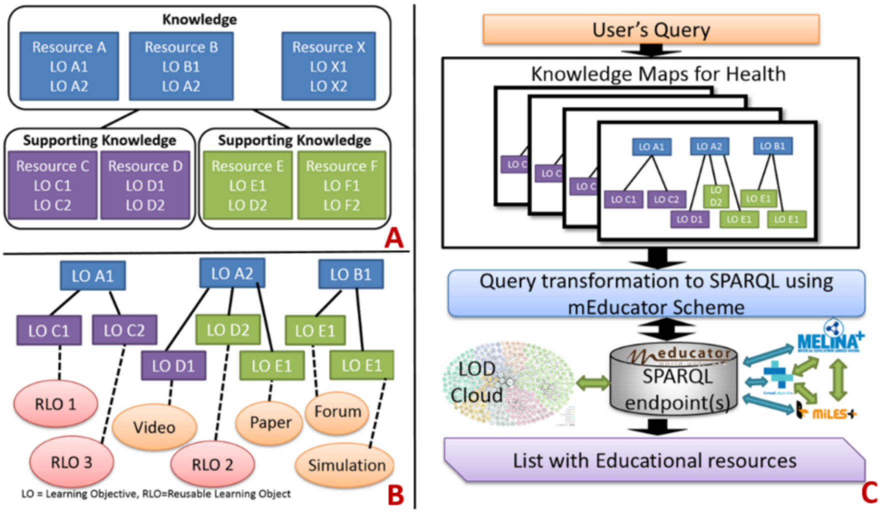

Figure 1. A and B: Knowledge Maps for Health Concept. C: Abstract Framework for Knowledge Maps for Digital Health Literacy (Used LOD cloud diagram 2014, by Schmachtenberg M. et al, http://lod-cloud.net/).

As depicted in Figure 1A, each of the resources may have one or more learning objectives, while some of them might be duplicated and covered from more than one resource. Thus, we can easily result in a knowledge map of learning objectives (Figure 1B). In this knowledge map, the dependences between learning objectives are identified. Each learning objective can be connected with a learning resource through the appropriate mechanisms similar to the proposals in [10], [14]. The big advantage of RLOs is that they have a single learning objective which can be used in multiple contexts and thus they can be reused in many different health themes. A Personal Learning Network can be enhanced by the use of the “Knowledge Maps for Health”. Since PLN is not a specific environment, but an aggregator of tools that the user uses to acquire knowledge, the “Knowledge Maps for Health” could be offered as an additional tool with which the user will be able to signpost to different resources in order to understand the theme/ resource/ dialogue that she selects to read. Thus, the framework can be utilised in the following steps: Initially, the user performs a query. The appropriate knowledge map is selected and based on its learning objectives a SPARQL Query is formed. This query reaches both the mEducator endpoints, but also the Linked Open Data cloud. A list of resources is returned and the links with a short description is provided to the user. An abstract representation signposting key concepts is depicted in Figure 1C.

1.1. Scenario of Use

Katerina wants to find out what HIV is. The information that she finds out in a web site is saying that “HIV is a virus that attacks the immune system, and weakens your ability to fight infections and disease…”. But then she is not sure what an immune system actually means and she looks at Wikipedia. Then it starts to become more complicated because she is not aware of what the differences between the innate immune system and the adaptive immune system are. Thus, she chooses to use the Knowledge Maps for Health app in order to point her out to different resources. She looks for: “what is HIV” and a list of different resources in hierarchical list appears. In this list of resources Katerina selects the links for the one that she does not have the knowledge of.

2. Discussion and Conclusion

In this paper, our aim was not to provide the technical details of such concept, thus we consider a number of other limitations. As with all the tools within a PLN, users must select to use it. Marketing and linking with resources (including networks) that they already use may increase the visibility of the provisional tool. That contradicts with the concept of creating qualitative and health trusted resources (e.g. RLOs). Recent advancement though revealed great acceptability of such resources [11].

Health Digital Literacy is an open research field and despite the fact that a lot of studies already exist there is a continuous need to fill in the uprising gaps. We are aiming to develop the aforementioned concept and test it in order to provide another tool in the PLN of the users. Health Digital Literacy needs definite further enhancement and the use of the proposed concept might lead to useful tools which enable use of understandable health trusted resources tailored to each person's needs.

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Healthy, Sick, Dead – An Educational Blueprint to State Transition Disease Modelling

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Abstract. Disease Modelling of chronic diseases such as diabetes or asthma plays an important role in medical decision making. State transition models are the most frequently used method. The objective is to illustrate the elements and the most important underlying procedures for designing a decision analytic Markov model with only three-states. Method: Being "healthy" can be interpreted as a norm state, being "sick" as a temporary state and "dead" as an absorbing state. Transitions with accompanying transition probabilities that allow a cohort of model objects "to flow" between the cumulative exhaustive and mutually exclusive states complete the model structure. Half-cycle correction helps in overcoming the fitting problem of the discrete time valuation of Markov models. A model with the three states healthy, sick and dead is the easiest way to define a reasonable model that covers almost all aspects of a Markov disease model. The absorbing state dead helps in terminating a model. The temporary state sick acts as an event counter and the state healthy serves as a reservoir of modelling objects. The definition of the number and length of cycles completes the definition of a simple state transition model. Additional supplementary material with a functional sample model is provided.

Keywords. Computer simulation, decision analysis, markov processes, chronic diseases

Introduction

Disease Modelling obviously represents the state-of-the-art when it comes to considering the future outcomes and the related costs of chronic diseases such as diabetes mellitus, asthma, and increasingly cancer (1). These long-term diseases bring sequels and cannot be observed over the entire duration of the disease by prospective clinical trials. Thus, it is necessary to support the methods of evidence-based medicine with the forecasts of computer simulations - so called disease models. Most of these analytic models are based on state-transition structures that are computed using Markov processes (2). The objective is to illustrate the elements and the most important underlying procedures for designing a good decision analytic Markov model in only three-states.

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1. Methods

Four elements constitute the structure of a state-transition model: states, transitions, model objects and probabilities

States define the course of a disease in a logic sequence of possible disease pathways. States must be defined mutually exclusive, yet cumulative exhaustive ("no gaps, no overlaps") meaning that all states of a model together describe the complete set of possible disease outcomes (3).

Transitions are the logic connectors between disease states. In theory, there exist n^2 transitions for n states in Markov models. Obviously, it is not reasonable to consider all notionally possible transitions. For instance, being "dead" means that one cannot leave this state anymore. Many diseases such as myocardial infarction lead to defect healing and one cannot return to being as healthy as before.

It is patients that are normally the **model objects** in medicine and in health-economics who carry certain modifiable (e.g. smoking) or persistent (e.g. genes) health risks that increase or decrease the occurrence of disease related states and thus the "speed" of the transitions within a disease pathway. These persons run the risk of developing defined medical outcomes such as a worsening of the disease or even dying.

Probabilities describe how quick transitions are being made between a model's states. These probabilities may remain constant over time. If all probabilities do so one speaks of a Markov chain model. Yet, constant probabilities are only justified when there is sound evidence of a linear frequency of events e.g. when a constant incidence rate exists. Most diseases change considerably over time though. For instance, late complications of diabetes such as renal failure, retinopathy or a diabetic foot syndrome develop more frequently with longer duration of diabetes. Also, the general mortality increases with the age. Then, the probabilities must change over time which is implemented typically as a time-dependent function or as a table look-up with time being the table index.

Figure 1 illustrates a state transition diagram based on the three states "healthy", "sick", and "dead". Important relations exist between the pathways and the states: Typically, a person starts in the state "healthy" it may then proceed to the state "sick" and afterwards may return to being healthy again or it progresses to the state "dead". In the latter case, we speak of a disease-related mortality. The transition of the state "healthy" to "dead" is called an unspecific or general mortality.

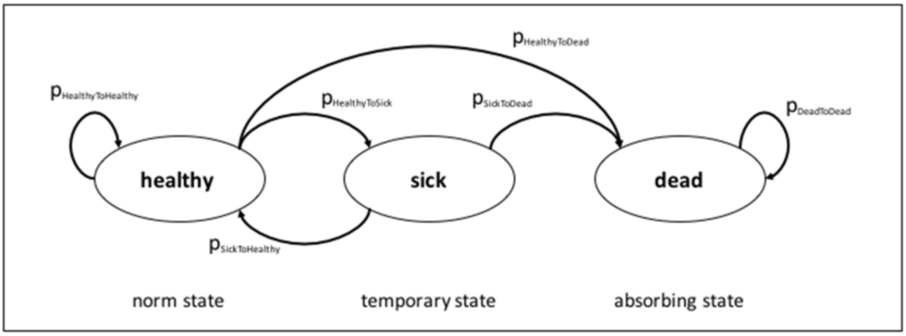

Figure 1. Three types of Markos states.

Obviously transitions from the state “dead” back to life are not reasonable. Therefore, the probability of remaining “dead” is 1 or 100%. The probability to remain “healthy” depends on the transitions to “sick” or to “dead”. Therefore, the probability to remain healthy is 1 minus the other probabilities (Formula 1).

$$pHealthyToHealthy = 1 - (pHealthyToDead + pHealthyToSick) \tag{1}$$

The simulation in a Markov model runs in discrete time steps that (exceptions exist) have equal length – the so-called cycles. As simulation is applied in first place to chronic diseases the most frequently used cycle length is years. One could also use smaller or longer time periods.

1.1. Cohorts

Patients or model objects that carry certain relevant characteristics are called a **cohort**. Markov models are performing cohort simulations. When a pre-defined cohort does not change in numbers it is called a “closed cohort”. “Open cohorts” can include new patients (e.g. newborns, new disease cases) and are often times used for epidemiologic studies. Markov models do not simulate single persons, but the one cohort that represents the average of all characteristics of the model objects. In cohorts where absorbing states such as “dead” lead to changes in the relation of other important characteristics (e.g. the sex distribution) it might be advisable to split the cohort into separately handled sub-groups such as “men” and “women”.

1.2. Different types of states

Being “dead” is a special state. Reaching it means never leaving it again. This type of state is therefore called an **absorbing state**. There exist other possibilities for absorbing states. For instance, “healed” or “lost to follow-up” are also absorbing states. Absorbing states are important for models with a defined number of model objects. Sooner or later all objects will get trapped in such a state that takes out these objects from the simulation. Absorbing states therefore may help in terminating a simulation.

In Figure 1 the state “sick” is special as it has no transition back to its own meaning that a patient can be sick for exactly on cycle length and then is forced to leave again. This construction is called a **temporary state**. A row of at least two temporary states after each other is called a **tunnel**. Tunnels are a good way to model time dependent changing probabilities. For example, the mortality of stroke is highest around the short-term event and then decreases over time to lower values. A temporary state always acts as an event counter. The sum of all objects entering a temporary state is the cumulated incidence of this health state.

Tunnels are the most frequent occasion for using cycles with shorter length as for the rest of the model structure. For example, hypoglycaemia is a frequent complication of diabetes mellitus treatment. One could create within a larger model a tunnel of four temporary states “hypoglycaemia 1 – 4” that last for three months each. With this design, up to four events could be considered even though the diabetes model uses annual cycles. The state “healthy” has transitions going away, directed to it and a transition back to it. This is called a **norm state** or normal state.

1.3. Half-cycle correction

Markov models approximate continuous functions such as a decreasing survival over time in discrete time slices. This leads to a fitting problem as the Markov model counts one value for exactly one cycle either at the end or at the beginning of a cycle. The longer the cycles and the greater the changes within one cycle the larger is the fitting problem. The solution is to shift the reading point to the middle of a cycle. This can easily be achieved by subtracting (4) or adding half a cycle at the beginning and the end of the observed simulation period. This procedure helps in correcting the area under the curve. To achieve a better fitting of the cycle values to the natural function a within-cycle correction can be applied (among others) by noting half of the difference of two following cycles (5). It should be noted that half-cycle correction cannot be applied in all circumstances. For instance, fixed costs such as per capita fees could have a decision-analytic importance. Then, a correction would be counterproductive and both variants with and without correction should be calculated.

1.4. Decision making and models

The future remains uncertain yet important decisions have to be made today. With the increasing availability of health data and the secondary use of clinical databases the prerequisites for building models have improved a lot. One therefore can expect that modelling will be used more frequently in medical decision making and this knowledge should be included to the curricula of life science education programs.

2. Conclusion

A model with the three states healthy, sick and dead is the easiest way to define a reasonable model that covers most aspects of a Markov disease model. The absorbing state dead helps in terminating a model. The temporary state sick acts as an event counter and the state healthy serves as a reservoir of modelling objects. Together with the definition of the number and length of cycles the definition of a simple state transition model is complete. Additional supplementary material with a functional sample model is provided at: https://www.prosit.de/index.php/ICIMTH2017.

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Plagiarism Detection by Online Solutions

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Abstract. The problem of plagiarism represents one of the burning issues of the modern scientific world. Detection of plagiarism is a problem that the Editorial Board encounters in their daily work. Software solutions represent a good solution for the detection of plagiarism. The problem of plagiarism will become most discussed topic of the modern scientific world, especially due to the development of standard measures, which rank the work of one author. Investment in education, education of young research personnel about the importance of scientific research, with paying particular attention on ethical behavior, becomes an imperative of academic staff. Editors have to invest additional effort in the development of the base of reviewers team as well as in their proper guidance, because after all, despite the software solutions, they are the best weapon to fight plagiarism. Peer review process should be a key of successful operation of each journal.

Keywords. plagiarism, plagiarism detection, software solutions.

Introduction

Plagiarism (the most common ways to compromise the academic integrity of the author) is illegal trespassing of spiritual ownership i.e. any use of other people's ideas, opinions or theories, either literally, or paraphrased, which does not mention the author or source of information. The Office of Research Integrity describes plagiarism as theft or misappropriation of intellectual property and the substantial unattributed textual copying of another's work [1]. The phenomena of plagiarism applies to unreferenced published or unpublished data that belong to someone else, including applications for grants and a publication submitted in a different language [2]. The three most common and most serious forms of scientific dishonesty are inventing and restatement of results and plagiarism in proposing, conducting, reviewing and reporting the results. Questionable procedures in science are misrepresentation, inaccuracy and bias. Scientists who do not adhere to the principles of scientific research integrity publish papers which do not contribute to science and do not increase the overall knowledge, so their work does not have a real value. The aim of this paper is to show the role of information technologies in the detection of plagiarism. This paper aims to put the point on the sensitivity of the software solutions themselves, and how much they really support the academic community. Differentiation of software solutions is shown in this paper so it provides the academic community a single view of available options. The issue of plagiarism in the medical world, due to the development of medical science as well as from need to

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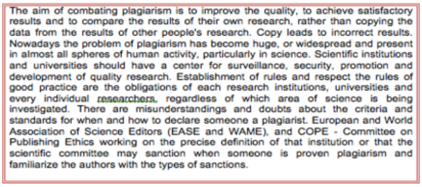
increase the quality of assessment of patient and the advancement in the academic community, is of crucial importance. The problem of plagiarism detection is shown from the standpoint of the editorial board of the journal, especially in multilingual publishing. This paper also represents the guidance for IT professionals to improve already existing solutions.

1. Errors in science

Errors in science are classified as follows: honest mistakes (reputable), which are the definitions of unintentional, accidental, and very often inevitable, but are related to the risk of work and unfair errors (disreputable) constitute willful disregard and violation of the methodological rules and ethical norms. The third group, called "gray zone" includes cases of violating of principles of good scientific practice that cannot be characterized as intellectual dishonesty, but are not completely devoid of it and these techniques involve "tuning" of the data (trimming) or “cooking "("scam") [3]. Fang *et al.* did a detailed review on over 2000 retracted articles indexed by PubMed which revealed that only 21.3% of retractions were attributable to error, while the rest (67.4%) of retractions were attributable to misconduct, including fraud or suspected fraud (43.4%), duplicate publication (14.2%), and plagiarism (9.8%) [4, 5]. In recent years, the German political scene shook the affair type doctorate - plagiarism. One of the world's leading journals Science published two papers (2004 and 2005) of the famous South Korean professor Huang Wu-Suk and his associates on the first cloning of human embryos and isolation of stem cell lines. World public was impressed, and soon after, was shocked. In fact, it turned out that the results of these papers were falsified, including photos. The former political star and one of the most popular German politicians Karl-Theodor zu Guttenberg, a former minister of defense and a possible candidate for the Christian Democrats for Chancellor instead of A. Merkel, resigned when it was found that nearly 3/4 of his doctorate was copied without citing sources. John Dárselo was young and successful cardiologist who in a three-year period (1978 to 1981), with 47 co-authors, produced 109 publications and his colleagues discovered fabricated data in one of them and official investigations discovered more in other publications [3].

2. Online solutions for plagiarism detection

Text of the following article "Plagiarism and scientific research and publications and how to prevent it" [6] was analyzed through online software options to detect plagiarism (Table 1).



The aim of combating plagiarism is to improve the quality, to achieve satisfactory results and to compare the results of their own research, rather than copying the data from the results of other people's research. Copy leads to incorrect results. Nowadays the problem of plagiarism has become huge, or widespread and present in almost all spheres of human activity, particularly in science. Scientific institutions and universities should have a center for surveillance, security, promotion and development of quality research. Establishment of rules and respect the rules of good practice are the obligations of each research institutions, universities and every individual researchers, regardless of which area of science is being investigated. There are misunderstandings and doubts about the criteria and standards for when and how to declare someone a plagiarist. European and World Association of Science Editors (EASE and WAME), and COPE - Committee on Publishing Ethics working on the precise definition of that institution or that the scientific committee may sanction when someone is proven plagiarism and familiarize the authors with the types of sanctions.

Figure 1. Text that was used to detect plagiarism [7]

Table 1. Online software options for plagiarism detection

Name of software	Description	Percentage of plagiarism
Double Checker	allows testing on plagiarism, as direct text, as well as document (no registration is required during first use).	100%
CopyLeaks	after registration, users can upload their document, than the document can be searched that would indicate the existence of plagiarism.	It does not allow text input for search. Registration is needed.
Paper Rater	rather limited search tool, simple interface.	75%
Plagiarism	allows testing on more than 190 languages. Limited edition if used without registration.	100%
PlagiarismChecker	easy to use, with a very good interface.	100%
Plagium	free version allowed search, good interface.	100%
PlagScan	after registration it enables the user to scan text, there is no version that allows testing without registration.	100%
PlagTracker	enables the detection of plagiarism, solid interface	100%
Quetext	easy to use, rather limited interface.	0%

Software options (programs), which after registering and installing the program (they are more reliable, much better designed and more affordable to the user and they are also used in professional scientific world, by the editors and reviewers) allow the detection of plagiarism are shown on Table 2.

3. Plagiarism, the problem of the modern scientific world

The seriousness of plagiarism is reflected by searching the Medline database, where more and more authors write on the given topic. All online solutions for detection of plagiarism, as well as programs that detect plagiarism, are not perfect, but they can show you if there is a direct copy of the text.

Table 2. Online software options for plagiarism detection

Name of software (program)	Description	Percentage of plagiarism
Viper	quick search tool, with quite simple interface, and is well adapted to the user. It allows the detection of documents.	100%
iThenticate	currently the most used network service is CrossCheck (iThenticate) for search and examination of the similarity of the text received the work with texts.	100%
Turnitin	software detects plagiarism, paraphrasing and similarities of submitted articles, which are compared to the database of available articles over the Internet and with the private base of already submitted articles.	100%

It should be noted that in the Anglo-Saxon vocabulary, there is a huge number of synonyms, so a single sentence, though not written in the same style and in the same words, it can be in certain terms a plagiarism, respectively for stealing someone's idea or patent. The development of software solutions, which could detect it, is actually a utopia, and very difficult to implement. Editors and reviewers have problems to detect plagiarism, if article is published before in some language which is not so common in use. The fact that a paper is published in more than one language, i.e., in Chinese and in English, is not an excuse for double publication [7]). Unfortunately then plagiarism is very difficult to detect. A number of meta-analysis, combining the results of studies, sometimes really do not bring anything new to the scientific community, but the process of content analysis, statistically is correct, which again represents a problem to the editor. The fight against plagiarism should be lead on a much greater level than the national level, because that is the only way to eradicate this problem.

4. Conclusion

Although well-developed software solutions for plagiarism detection exist, the problem of plagiarism will become most discussed topic of the modern scientific world. In the end, plagiarism is difficult to detect and poses significant threat to the health of scientific literature. Mostly, the plagiarism is suspected by reviewers and their expertise in a particular field helps them catch subtle defects easily. Investment in education, education of young research personnel about the importance of scientific research, with paying particular attention on ethical behavior, becomes an imperative of academic staff. Editors have to invest additional effort in the development of the base of reviewers' team as well as in their proper guidance, because after all, despite the software solutions, they are the best weapon to fight plagiarism. Peer review process should be a key of successful operation of each journal.

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Professional Values Among Female Nursing Students in Saudi Arabia

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Abstract. Professional values are essential to nursing practice because they guide standards for working, provide a structure for evaluating behavior, and influence decisions making. The purpose of this study is to explore the perception of Saudi female nursing students on professional values and to assess the correlation between their perception of professional values in relation to their year of academic studies. We used a cross-sectional descriptive study where a survey was administered to 150 Saudi female nurses living in Riyadh. Results show that Saudi female nurses have a high perception of professional values relating to confidentiality, privacy, moral and legal rights, health and safety, and the work environment. Whereas Saudi nursing students have a low perception for participating in professional nursing activities, utilizing research in practice, peer review, public policy, and engaging in on-going self-evaluation. There was positive correlation between different professional values and academic years. The highest correlations were for the items related to caring and trust more than activism because nursing students at higher academic levels viewed the relationship with patients as more important than advancing health care systems through public policy, research, and professional organizations. In conclusion, nursing program administrators should put emphasis on improving the development of professional values through a role modeling approach to promote activism and professional values through the arrangement of meetings, exchange forums, and conferences with other nurses, managers, policy makers, innovators, and researchers within the nursing field.

Keywords. Professionalism, Nursing Values, Female Students, Activism, Caring.

Introduction

The adoption of Nursing Professional Values (NPVs) result in improved patient care, patient safety and job satisfaction among nurses. NPVs encourages nurses to strive in the implementation and use of best practices in the nursing profession [1]. NPVs must be included in nursing curriculums in Saudi Arabia and around the world and ensure that nurses are applying NPVs in their daily work [2]. Understanding the perception of professional values by female nursing students regarding managing care, competent practice and professional image is essential and may provide worthy information for educators of nursing in designing more functional teaching techniques [3]. Students professional values are effected by personal and social values and they change and

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expand by education, clinical and personal experiences. According to Secrest et al. in 2003, there is a significant difference between freshmen and senior's perceptions regarding NPV [4]. Another study reported that NPVs is higher among students who choose nursing as a career comparing them to those who do not [5]. Moreover, the authors reported that NPV is found to be higher among nursing students who are planning to peruse their higher education studies in comparison to those who do not [5].

According to the literature, few researches in Saudi Arabia have addressed the issue of professional values. There was only one study conducted in Saudi Arabia which aimed to assess psychometric properties of nurses' professional values scale [6]. However, none of these studies aimed to assess NPVs among nursing students.

The aim of this research study is to identify the perception of female nursing students relating to professional values. A secondary objective of this study is to measure the correlation between the student academic year and their perception of NPVs.

1. Method

We used a quantitative descriptive cross-sectional approach to the study. The participants' inclusion criteria were: being Saudi female nursing student and being at least in their third year of study. We used a convenience sample of enrolled bachelors nursing students. A self-administered questionnaire, namely, Nurses Professional Values Scale (NPVS) was used in this study. The NPVS was developed by Weise and Shank [7] then translated to Arabic language [6] namely, Nurses Professional Values Scale- Revised (NPVS-R) [6]. The NPVS-R includes 26 items. Each item of the NPVS contains expressive statement that reflects the interpretive statements of the Code of Ethics of the American Nursing Association. Each statement is scored on a 5 Likert-scale. The NPVS was designed with five factors supported by psychometric evaluation. Those factors were caring, activism, trust, professionalism, and justice. Permission to conduct the study was obtained from the Institutional Review Board (IRB) of university under study. Informed consent was gathered for the survey. Confidentiality and withdrawal from the study as preferred was assured to the students.

2. Results

The response rate for the questionnaire was 72% (n= 108). The participants background information included academic year and age. There were 32% (n=35) students from the 3rd year, 35% (n=38) students from 4th year and, 32% (n=35) from the internship year. With regards to age, there were 8% aged 20 years old, 20% aged 21 years old, 24% aged 22 years old, 25% aged 23 years old, 19% aged 24 years old and 3% aged 25 years old. When the respondents were asked: Do you have a desire to study nursing, (92%) answered by (Yes) and only (8%) answered by (No).

The weighted average of NPVS-R was (4.09) with a standard deviation of (0.53). Table 1, highlights the results of rank order of the five highest and five lowest mean scores of perceptions of professional value where the highest average was awarded for the maintenance of patient confidentiality with a mean of (4.7), followed by safeguarding a patient's right to privacy with a mean of (4.6), and last by the protection of moral and legal rights of patients with a mean of (4.57). The highest four main scores were the items related to caring. The lowest average was for participation in public policy decisions affecting distribution of resources had a mean of (2.98). Participation in peer review, participation in nursing research and/or the implementation of research findings, engagement in on-going self-evaluation and participation in activities of professional nursing associations had respective means of: (3.00, 3.58, 3.61, and 3.67 respectively).

Table 1. Rank order of the five highest and five lowest scores of perceptions of professional value

items		Factor	Mean
Maintain confidentiality of patient.	Highest scores	Caring	4.72
Safeguard patient's right to privacy.		Caring	4.61
Protect moral and legal rights of patients.		Caring	4.57
Protect health and safety of the public.		Caring	4.55
Initiate actions to improve environments of practice.		Professionalism	4.52
Participate in public policy decisions affecting distribution of resources.	Lowest scores	Activism	2.98
Participate in peer review.		Professionalism	3.00
Participate in nursing research and/or implement research findings.		Activism	3.58
Engage in on-going self-evaluation.		Trust	3.61
Participate in activities of professional nursing associations.		Activism	3.67

In terms of the correlations between the perceptions of professional values and academic year, the highest mild positive significant correlation was for the promotion of equitable access to nursing and health care and the protection of health and safety of the public with (r= 0.288), while the lowest mild correlation was for the item practice guided principles of fidelity and respect for person with a score of (r= 0.112), knowing that, correlation is significant at the 0.05 level.

3. Discussion and Conclusion

Nursing professional values were measured in this study from the perspective of the female Saudi students. The total mean of professional values among students in this study was considered significantly high which affirms that the nursing college under study adhered to the essential standards of preparing nursing students for practice and support in their professional values.

The students in this study rated the items related to caring as the highest. This may be because caring is considered by students as the major role of nurses and the spirit of nursing practice. Moreover, the nursing program may affect the students caring values and behaviors [5]. These results confirm the importance of including competencies regarding ethics and moral concepts in any nursing program. Also, NPV should be practiced through and delivered courses and in clinical practice settings. Safeguard patient's right to privacy was ranked as the second major professional value. Similar studies [1] reported that healthcare professionals have a high belief in values relating to the patient’s security. In fact, it cannot be ignored that Muslim countries in general and especially Saudi female nursing students demonstrate high level of privacy as a patient’s essential rights which is mainly influenced by religion and culture beliefs.

Moreover, to protect the moral and legal rights of patients the third item according to this study results and other studies such as Rassin (2008) confirmed that nursing professional values are referred to as standards and principles that define professional manners, influence moral judgment, and provide direction to practice [8]. The lower scoring domains and NPVS statements address nursing issues outside the nurse-client relationship such as public policy, environment, professional nursing organizations, and peer review. Recently, national and international calls are made for nurses from many nursing organizations to look beyond their individual patient relationships, elevate their profession, and influence healthcare reforms. In order to meet these calls, nursing students will need to view professionalism and activism as equally important to caring.

In terms of the correlations between the perceptions of professional values and academic year. The highest correlations were for items related to caring and trust, more than activism. This may because nursing students at higher academic levels viewed the relationship with the patients as more important than advancing health care systems through public policy, research, and professional organizations.

Finally, the results of this research may help nursing program administrators to put emphasis on improving the development of activism and professional values. A role modeling approach may help to convince students on the importance of these values by arranging meetings, and forums with faculties, national and and international nurse's pioneers in research, and activities in public policy. Also, giving the students chances to complain when appropriate, participate in peer reviews, self-evaluations, and lead professional nursing events and activities could help them to feel the importance of these values.

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The Guiding Role of a Paradigm in Informatics Education and Research

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Abstract. This study presents the current status of a paradigm used in informatics education and research in the health and human services fields. The aim is to synthesize the research focuses of students' theses and evaluate the current situation. The paradigm models informatics research. The research focus, questions and applied research methods were coded for 144 Master's degree theses. Based on the results, the theses could easily be coded for the paradigm concepts and research focuses. The most often used concept was *data*, which was connected to steering and organizing information management in work processes.

Keywords. education, paradigm, informatics, curriculum, thesis

Introduction

According to the International Medical Informatics Association (IMIA), as of spring 2017, there were 44 academic institutions providing health and biomedical informatics education. [1] The history of health and biomedical informatics education can be traced back to the 1960s, when computerized information systems were implemented in hospitals [2]. This gave rise to a great need for learning and education started to evolve in the form of integrated courses, continuing education and finally degree programs [3].

The first recommendations on education in health and medical informatics were published in 1999 by the IMIA Education Working Group and were updated in 2010 [4]. These recommendations guided the establishment of the Master's degree program in health and human services informatics at the University of Eastern Finland (UEF) in 2000. The wide scope, covering both health and social care in informatics education, is based on the health and social care service system in Finland, which has been integrated at the regional level. Further, it has been an advantage for graduates to work in the integrated sectors when developing and designing digital service systems for society. [5] The program was among the first to obtain the endorsement "IMIA accredited", meaning that the international criteria for the evaluation had been met [6].

This paper describes the development of a paradigm to teach and study health and human services informatics. The aim is to synthesize the research focuses in students' theses and evaluate the present situation that the paradigm describes.

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1. A Paradigm as a Basis for Informatics Education

In the framework of health and biomedical informatics, the field of health and human services informatics (HHSI) has its origin in the implementation of information and communications technologies in the health and social sciences. As an interdisciplinary major, HHSI especially applies management, computer and information sciences [7]. It is understood as the management of information resources of an entity, e.g., of an organization, covering the activities, actors and methods in the production of health and welfare services for the public and private sectors and organizations. Resources are understood as data repositories, systems, applications, devices, communications tools and models, and, most importantly, people as sources and utilizers of information.

Based on Kuhn's theory, either as a conceptual or operational model, a paradigm should answer the following questions: what should be studied and investigated; what kind of questions should be presented and studied; how are these questions proposed; and how are the results interpreted? [8] For the development of curricula, an HHSI paradigm was developed around four core concepts to define the body of knowledge in informatics. (Figure 1) *Data* is understood as the hierarchical continuum from data to wisdom. *Action* means the planning, implementation, evaluation or use of services. *Actor* means a user or producer of health and social care services. *Technology* means social and technical procedures used in processing, analyzing, storing or retrieving data related to actions.

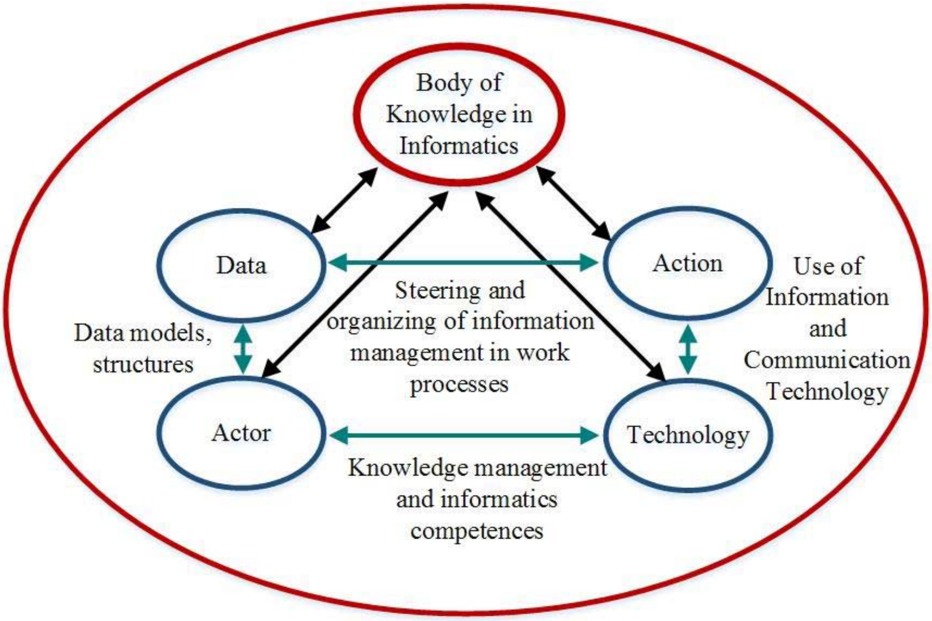

Figure 1. The paradigm for health and human services informatics: main concepts and research focus.

Further, to guide research in the informatics field, the core concepts' entities were connected to constitute four research areas: 1) Steering and organizing information management in work processes; 2) Use of Information and Communication Technology

(ICT); 3) Knowledge management and informatics competences; and 4) Data models and structures. The paradigm has been used in teaching the theoretical foundations and research methods in HHSI and for supervising Master's degree theses. The Master's degree thesis is a compulsory part of the curriculum and its scope is 30 ECTs[2] of the whole 120 ECTs during the two-year study program.

2. Aims of the Study

The aim is to synthesize the research focuses in HHSI students' Master's theses and to evaluate the present focus of research that the paradigm describes. The purpose is to find out how students' theses relate to the core concepts and research focuses of the paradigm of health and human services informatics. The further aim is to discover focuses that are not represented in the present paradigm.

3. Materials and Methods

The data consisted of accepted Master's degree theses (n=144) from the HHSI program at UEF in the years 2002–2016. Most of the theses were written by a single student. Only five of them were written as a collaboration of two students. Data in the following categories were extracted from the theses using a tool: year of acceptance, theoretical background, purpose, questions, data source, collection and analysis, and study context.

The research purpose and questions were coded based on the paradigm concepts and focuses. At the beginning of the coding process, the first author pilot-tested the coding scheme with 30 theses. The authors, who were all familiar with the coding categories and contents, discussed the coding rules many times when applying the paradigm while teaching. Two authors completed the coding independently. The inter-rater reliability was 84%, with the differences being due mostly to disagreements about the preliminary concept. The data were analyzed using descriptive statistics. The results are presented in our narrative description of the analyses.

4. Results

The majority of the theses (n=105) were empirical, featuring data collection by various methods (e.g., surveys, interviews, registry data). Although the permission process is very strict and it is time-consuming to use register data, especially from patient records, 31 studies were based on data analyses.

The most often used HHSI paradigm concept in the theses was *data* (n=59), which was connected to *steering and organizing of information management in work processes* (n=52) as the research focus (Figure 1). The concept *action* (n=37) as the joint entity for concept *data* was the second most often used concept. In the paradigm, the concept *data* is associated with the focus *data models and structures* (n=19), which represents a minor research focus in this analysis. In this research focus, *data* is connected to *actors*. Table 1 below presents the concepts and study focuses in order of magnitude.

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[2] European Credit Transfer and Accumulation System

Table 1. Statistics on the main concepts and research focuses

Main Concept	n	%	Study Focus	n	%
Data	59	41	Steering and organizing information management in care processes	52	36
Action	37	26	Use of ICT	40	28
Actor	25	17	Knowledge management and informatics competencies	33	23
Technology	23	16	Data models and structures	19	13
TOTAL	**144**	**100**	**TOTAL**	**144**	**100**

5. Discussion and conclusions

The HHSI Master's program follows the IMIA recommendations for educational curriculum structure and content [4]. The paradigm developed over the years guides research, education and students' learning objectives. In the program, students can choose their research topics voluntarily. In recent years, the digitization of health and social services has progressed actively in Finland [5]. Thus, this may also be reflected in the topics of students' theses, aims and questions.

The results show that students' theses have focused on widely different research areas. However, *steering and organizing of information management in work processes* and the concepts *data* and *action* as study objects refer to recent ICT reform in Finland. The surveyed research applied mostly qualitative methods to explore phenomena in health and social care informatics. Limitations must be considered. This study focuses only on one university program with small amount of thesis. It would be interesting also to analyze international Master's and doctoral degree programs to see what kind of conceptual models and structures are used in education and research, e.g., among IMIA academic institutions. [1,4].

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Health Informatics and Wellbeing by Enhanced Knowledge Formalisation

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Abstract. Only once we agree upon our understanding of what words really mean can we debate whether a concept, represented by those words, is or not well represented significantly in specific application. In a previous paper we presented an innovative point of view on deeper wellbeing understanding towards its increased, effective Health Informatics and clinical usage and applications. Medicine was always the art and science of healing. The science became more and more a mechanistic technology; the art was dropped altogether. Uncertainty-as-problem in the past is slowly morphing into the evolutive concept of uncertainty-as-resource. The key change performance factor is education, distinguishing from classic, contemporary education and a new one, based on a more reliable control of learning uncertainty. Conceptual clarity, more than instrumental obsession (so typical of this particular time) is necessary. In this paper, we present the main concepts of fundamental biomedical enhanced knowledge formalisation for Health Informatics and Wellbeing of the future.

Keywords. Health Informatics, Wellbeing, Conceptual Clarity, Healthcare.

Introduction

Only once we agree upon our understanding of what words really mean can we debate whether a concept, represented by those words, is or not well represented significantly in specific application. In a previous paper we presented an innovative point of view on deeper wellbeing understanding towards its increased, effective Health Informatics and clinical applications [1]. In that paper, we define one-word "wellbeing" as a brand new science, based on multidimensional conceptual clarity, reliable information uncertainty management and information conservation by a Post-Bertalanffy Systemics framework [2,3]. Conceptual clarity and predicative competence are the fundamental components for managing information more effectively than past approaches for promoting innovation and creativity [4].

As far as the last decades are considered, the most pervasive development of science goes under complexity theory, however defined. Both complexity and chaos converge on showing the unavoidability of uncertainty, whether it is embedded into feedback cycles and emergence or in the infinite precision of initial conditions. But, uncertainty-as-problem in the past is slowly morphing into the evolutive concept of uncertainty-as-resource by ontology uncertainty management (OUM) system [3].

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However, the 2016 study appeared in the British Medical Journal brings to light some of the consequences of the obsolete, industrial-mechanistic medical practice [5,6], anticipated by the review article "Death by Medicine", in 2004 [7] and the related book [8]. Challenged by conditions beyond the traditional boundary of illness, even medicine is discovering that the living is less simple than what the traditional physics paradigm implies [5,6]. In this paper, we present the main concepts of fundamental biomedical enhanced knowledge formalisation for Health Informatics and Wellbeing of the future.

1. Current Healthcare Living Understanding

Those who study the living with the purpose of understanding its irreducible condition cannot afford the simplifying effort of ignoring the whole, as does reductionist-based physics. Human dedication to understanding the world, within which the living unfolds, eventually crystalizes in revolutionary views. But nothing comparable, not even the famous DNA helix, is on record in explaining life itself. The beginning of life is still in the fog of confusion as the beginning of our universe. The attempts to start life from non-life, almost as seductive as alchemy (Newton was one of its proponents) was long ago, persist through new technologies and Venter's claim is only one among many [9,10]. They entail a rather disconcerting surrender, celebrated as victory: since the living itself is embodied in matter, the more physics we know, and the more physics-based biology we use, the better we will understand life. Nobody ever proved this reduction. The fact that the living, in addition to the constraints of physics, is subject to contingent rules of behavior is usually brushed aside. Everything that can be fitted to the time series describing the functioning of a machine operates under the expectation of perfect repetition. Certainly, nothing is cause-free; rather, in the living causality is expressed in forms that no longer submit to the time sequence characteristic of determinism. The living is the domain of "repetition without repetition" [11], i.e., non-monotonic change.

Nevertheless, simpler explanations afford the immediacy of practical methods, sometimes informed more by urgency than by anything else. The reductionist-deterministic paradigm indeed led to significant technological and pharmaceutical progress. But this does not eliminate the need to understand complexity. Leibniz [12] seems among the first to examine science from a complexity perspective. In his view, laws should not be arbitrarily complex. If they are, the concept of the law becomes inoperative. A clear criterion (or criteria) for identifying it is more urgent than ever before, if we want medicine to overcome the limitations inherent in its mechanistic practice. However, complexity, as consubstantial with the living, is of high-order consequence for medicine. If the living, in particular the human being, is complex, knowing the medical subject, in its complexity, is of practical importance for Health Informatics. As a matter of fact, a science of the living can only be holistic, because the dynamics of the living is the expression of its change as a whole over time. The holistic view entails the fact that the reductionist method will always return a partial understanding of the process [13]. The causality specific to interactions in the living includes, in addition to what Newton's laws describe quantitatively, the realization of meaning in connection to the possible future, i.e., anticipation [14].

However, we have to take into account that the notion of anticipation is used currently in medicine with a very precise description attached to it. In medicine, anticipation describes a genetic disorder passed from one generation to another, each time at an earlier onset (the so-called trinucleotide repeat disorders, such as Huntington disease, myotonic dystrophy, dyskeratosis congenital, etc.). For Health Informatics, the operational definition of anticipation, advanced in this paper, underlines and explains, after the fact, the choice made by medical practitioners in trying to understand how the trinucleotide repeat occurs and what is involved in the production of the mutant protein. This expression of anticipation is such that it covers the entire life of the individual: from conception to death. From this perspective, medicine, in its reductionist, industrial procedures, "heals" today and produces invalidity of deeper levels tomorrow. For the Health Informatics and Wellbeing of the future, the anticipatory endowment should translate into the practical consideration informed by the shared awareness of both the patient and physician. The surprising fact is that the idea that medicine's fundamental perspective might be deficient has not led practitioners to question it, and has not resulted in a vigorous attempt to change it.

2. Conceptual Clarity Needed

It took over 200 years (more precisely, since Newton, Descartes, and Laplace) for scientists and scholars to realize that the beaten path at best offers partial answers (often wrong) to the question of what change means in the living. Indeed, life is the expression of the complex nature of the living. The living adapts to a variable world, and interacts with it. Life is interaction. No two individuals are the same, no two medical conditions are identical. The fact that experiments are carried out and presented as trustworthy validations corresponds to the illusion that reductionist-deterministic science generates significant knowledge for the individual. This "data-and-experiment cult" is rather a component of the politics of science than an intrinsic part of it. Generalizations built upon statistical averages and probability distribution defy the nature of the entity subject to knowledge acquisition. A doctor will not better address a patient's health condition based on averaging. As a sound example, we can go back to 1975 [15], with benzodiazepines, which trigger aggressiveness instead of acting as tranquillizers. It is a known fact that the same medication can be beneficial to some and (highly) detrimental to others: the "paradoxical effect" of medication. Living processes have multiple outcomes, some antagonistic to the same perturbation. These are very concrete aspects of practicing medicine without looking through the "eyeglasses" of classic physics or chemistry. The patient's unique profile should be the source for describing his condition. Medicine ought to comprehend the non-deterministic nature of both health and disease for each unique subject.

Indeed, changes due to physical forces applied on cells (e.g., a cut or a blow) and genetic processes governing all dynamics are interwoven. As a recent, meaningful example, we can recall genetic manipulation. Shinya Yamanaka discovered in 2006 a way to reprogram adult cells into embryolike ones, called induced pluripotent stem (iPS) cells, a find that has revolutionized the stem cell field. It brought Yamanaka the Nobel Prize in physiology or medicine, in 2012. Nevertheless, physical-chemical manipulation has so far proven to be less successful. In 2014, he had to retract his findings and to apologize [16]. Conceptual clarity, more than instrumental obsession (so typical of this particular time) is necessary. Those who practice medicine, and even more those who contribute to a science of medicine meant to overcome the limitations inherent in generalizing physics (and the notion of machine) in the living domain will agree on the need for conceptual clarity.

3. Conclusion

The key change performance factor is education, distinguishing from classic, contemporary education and a new one, based on a more reliable control of learning uncertainty. Distinguishing building on sand from building on rock for Health Informatics! Education has to be reconceived from the ground up: solid scientific education, in both the physics of the world and in the biology grounded in anticipation, is required. This in itself is a high-order endeavor, since schools continue to indoctrinate new generations in the classic "religion of physics".

Medicine was always the art and science of healing. The science became more and more a mechanistic technology; the art was dropped altogether. If some medical practitioners are better than others on account of more than the equipment they have access to, it is considered as incidental. Unfortunately, to identify medical talent, dedicated to patient wellbeing, is a function abandoned, since universities and medical schools are not really lacking applications and the academic and medical establishments defend their ROIs (Return On Investments).

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Relational Algebra in Spatial Decision Support Systems Ontologies

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Abstract. Decision Support Systems (DSS) is a powerful tool, for facilitates researchers to choose the correct decision based on their final results. Especially in medical cases where doctors could use these systems, to overcome the problem with the clinical misunderstanding. Based on these systems, queries must be constructed based on the particular questions that doctors must answer. In this work, combination between questions and queries would be presented via relational algebra.

Keywords: decision support systems, relational algebra, ontologies, spatial chartography

Introduction

A Decision Support System (DSS) is a powerful tool for researchers to choose the correct decision based on their final results. This kind of system combines important information that could be for facilities researchers to decide through a quicker and efficient way [1-4]. Based on this information, these decisions especially doctors would find interesting for the final analysis of their results, improves this final clinical decision. A Spatial Decision Support System (SDSS) could be defined as a system which combines information, including the geographical parameter for the conducting decisions [5]. The aim of the current paper is to present a combination between questions and queries using relational algebra.

1. Methods

Based on these systems, queries must be constructed considering particular questions that doctors have to answer. Combinations between data, questions and queries may define the ontologies of a decision support system, which are giving the structure of the clinical data inside the database.

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Ontologies could be constructed by lexicographical structures of the knowledge presentation in the system. These structures are combined with others, with the final purpose of exchanging information between them, under particular relationships [2].

The easiest relationship that could be considered, would be the binary relationship, where R can be a set of binary relationships involving the sets of entities U and V (Figure1) [6-8].

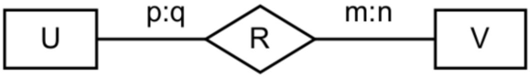

Figure 1. Binary Relationship Model

The set of relationships R from U to V is [6-8]:

1. one-to-one if $p = 0$, $q = 1$ and $m = 0$, $n = 1$;
2. one-to-many if $p = 0$, $q > 1$ and $m = 0$, $n = 1$;
3. many-to-one if $p = 0$, $q = 1$ and $m = 0$, $n > 1$;
4. many-to-many if $p = 0$, $q > 1$ and $m = 0$, $n > 1$.

2. Relational Algebra

Based on previous articles [2,9], a binary relation model for particular query could be presented (Figure 2):

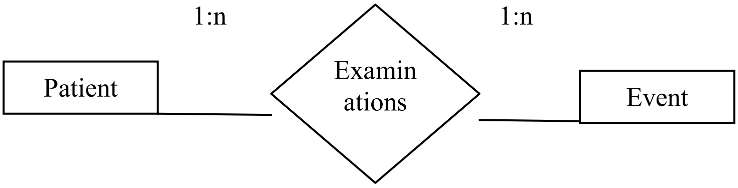

Figure 2. Binary Relationship Model Connection

The Projection is an operation denoted by the Greek letter pi (Π). A projection of a relation onto a subset of its attributes, is a relationship between some of the attributes of the columns (meaning that some columns are left out). The syntax of the operation is given by [6-8,10]:

$$\Pi_{\text{list of attributes}}\,(\text{relation})$$

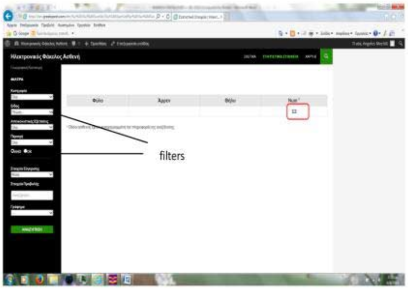

Figure 3. Example for Selection Operator

Selection condition is given by operators “and” or “or”. Example for “or” operator in the real time adaptive spatial decision support system is given in Figure 3a. All the cases that fulfil the criteria can be demonstrated in a map.

3. Conclusion

Ontology represents the relationship for the exchange of information, considering specific queries under information analysis. Based on this analysis, lexicographical operators could be set to justify the relation between various ontological queries. A connection between ontologies and queries could be bypassed by using the relational algebra operators.

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Validity of Scientometric Analysis of Medical Research Output

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Abstract. The aim of this paper is to point out the errors in scientometric analysis of an author's work, as well as the inconsistency of Google Scholars when performing such analyzes. Development of information technology has led to the development of the scientometric analyzes, which already have great significance for many decisions in the academic medical community, and represents a cross section of work of an author. Scientometric indices in the medical community become a tool in selecting the management of institutions, as well as membership in many academies. This paper should be a basis, as well as guidance in the development of a better and more accurate algorithm for more accurate analysis of the work of authors, and should also point the importance of accurate citations during writing scientific papers. The lack of selectivity of Google Scholar, and the possible individual manipulation of content, implies the need for further development of these platforms, so that the scientometric analysis can become a valid tool in the academic community.

Keywords. scientometric analysis, Google Scholar, ORCID number.

Introduction

Reference to source of citations is stated in the text, immediately before or immediately after the quoted text, depending on the quotation rule. Basic methods of citation are: citation by the principle author – date, numeric type of citation and mixed type. All accepted systems of citation have in common data accuracy and uniformity. Citation should only be done on published data, other data should be avoided. Care should be taken when citing old information (of cited literature), which is different from the type of the source: original article, doctoral dissertation and master's thesis - up to 15 years, scientific books and scientific monographs -up to 10 years, review articles - the latest literature up to 5 years and textbooks and other types of articles – up to 20 years and more. The aim of this paper is to point out the errors in scientometric analysis of an author's work, as well as the inconsistency of Google Scholars when performing such analyzes. Development of information technology has led to the development of the scientometric analyzes, which already have great significance for many decisions in the academic medical community, and represents a cross section of work of an author. Scientometric indices in the medical community become a tool in selecting the man-

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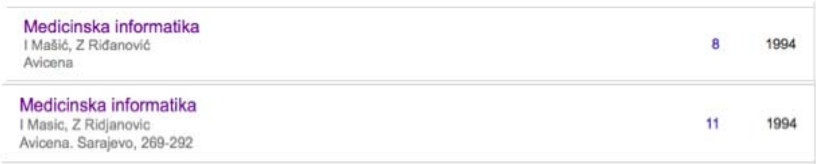
agement of institutions, as well as membership in many academies. This paper should be a basis, as well as guidance in the development of a better and more accurate algorithm for more accurate analysis of the work of authors, and should also point the importance of accurate citations during writing scientific papers.

1. Citation analysis

Based on the cited literature scientometric indicators can be used to analyze and evaluate the work of researchers, institutions, regions and countries. Scientometric indicators of work of an author, in addition to the number of citations which is a priority in the modern scientific community, are: H index (indicator for quantifying the research output of scientists - such as the number of publications, the average number of citations and the sum of all citations) [1,2]. Portal webometrics.info regularly provides lists in which they rank the authors based on the h index (taking into account the authors whose h index is over five). All analysis are conducted on the basis of the profile on Google Scholar platform, where the profile must be public (the condition that the profile is public is that the profile is verified via mail of the institution of the author). Scientific impact measures are increasingly being used for academic promotions, grant evaluations and evaluation of job vacancy of candidates (they are also being used for the evaluations of university departments and research centres) [3].

2. Un (validity) of online platforms (Google Scholar) for scientometric analysis

Google Scholar project or platform Google Scholar enabled a comprehensive approach to the list of articles of an author, and allowed access to the number of citations of one article, and based on the information found on Google Scholar creation of many list is enabled, in order to rank authors in a certain field. Main key of accuracy of Google Scholar is proper citation. A problem that originated incorrect citation of the book "Medical Informatics" by Izet Masic and Zoran Riđanović was shown in Figure 1. The book is kept as two different works, and has different number of citations. If we know what follows the H index and i10 index, such errors can certainly make a mistake when ranking the authors by mentioned indexes.

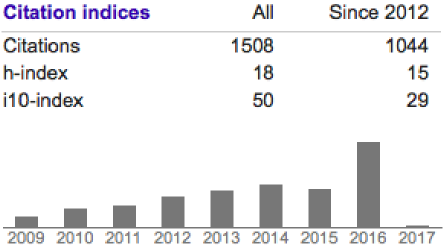


Medicinska informatika
I Mašić, Z Riđanović
Avicena
8
1994

Medicinska informatika
I Masic, Z Ridjanovic
Avicena. Sarajevo, 269-292
11
1994

Figure 1. Error in citation led to the book being cited twice, as two separate works

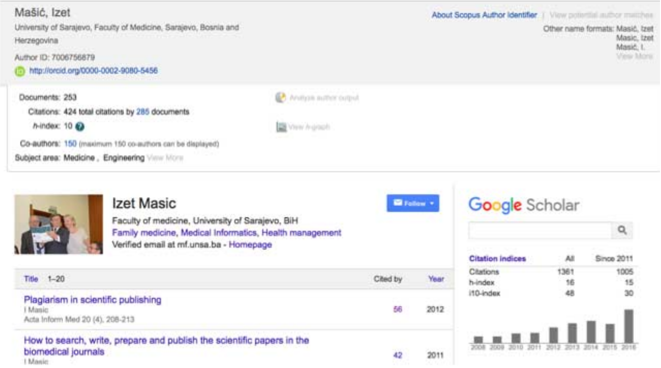
If we consider the work of one author, who has 40 years of experience in scientific publishing of articles, and get insight into the information provided by Google Scholar (citations, h-index, i10-index) (Figure 2 shows that more than 70 percent of citations are after year 2011) that leads to the conclusion that Google Scholar is still quite selective portal and it does not take into account years prior to digitization of content, and based on that it can lead to different performance rating of one author.



Citation indices	All	Since 2012
Citations	1508	1044
h-index	18	15
i10-index	50	29

Figure 2. Information provided by Google Scholar on the work of one author

Three widely used bibliometric databases for analysis and evaluations of citations and the h index are Web of Science (Thomson Reuters), Scopus (Elsevier), and Google Scholar. Although Google Scholar and Scopus seem to provide higher numbers of citations there is mixed information on the h index) [3,4]. Work of the author of this article is also analyzed, and different values were obtained (Figure 3), and the fact is that Scopus is quite selective, but it is still not clear whether it is more valid. One of the major problems is the method of verification of Google Scholar, for whose activation of profile is required mail address of the institution where the author works. However, one should take into account a number of researchers in later years, who are not interested in this kind of self-promotion, and lists that are made without them, are not valid and are not a realistic indicator of the development of a certain field in one state.



Mašić, Izet
University of Sarajevo, Faculty of Medicine, Sarajevo, Bosnia and Herzegovina
Author ID: 7006756879
http://orcid.org/0000-0002-9080-5456

Documents: 253
Citations: 424 total citations by 285 documents
h-index: 10
Co-authors: 150 (maximum 150 co-authors can be displayed)
Subject area: Medicine , Engineering

Other name formats: Masić, Izet
Masic, Izet
Masić, I.

Izet Masic
Faculty of medicine, University of Sarajevo, BiH
Family medicine, Medical Informatics, Health management
Verified email at mf.unsa.ba - Homepage

Title 1–20	Cited by	Year
Plagiarism in scientific publishing I Masic Acta Inform Med 20 (4), 208-213	56	2012
How to search, write, prepare and publish the scientific papers in the biomedical journals I Masic	42	2011

Citation indices	All	Since 2011
Citations	1361	1005
h-index	16	15
i10-index	48	30

Figure 3. Comparison of Scopus and Google Scholar compared to scientometric parameters

Manipulation is often possible when creating the profile, so a lot of inconsistencies in the information can be seen. Google Scholar collects information on internet, and from address that are not most credible, and as such, is accessible to manipulation of content. Emilio Delgado Lopez- Cozar, Nicolas Robinson-Garcia and Daniel Torres-Salinas made an experiment, they created six documents authored by a faked author and uploaded them to a researchers personal website under the University of Granada's domain. The result of the experiment meant an increase of 774 citations in 129 papers, increasing the authors and journals H index. These experiments have proven the numerous shortcomings of the Google Scholar and displayed the possibilities of artificial increasing of H index and i10 index. The problem arises also in the fact that many software work on the basis of information that offers Google Scholar (Publish and Perish), so they also give the wrong information. Sometimes the same names of the authors, are an additional problem, so we come to the conclusion that the identification number of an author (The Open Researcher and Contributor ID (ORCID)), should become a requirement when publishing a paper, because it is the only way to make a distinction between authors, and to conduct analysis of the work of one author in the right way. ORCID is aimed at registering scholarly contributors and averting the persistent ambiguity of recorded author names (registry is growing fast and integrating with other ID-generating platforms, thereby increasing the functionality of the integrated systems) [5]. A way to boost the h index is by self-citation (Hyland found that self-citation is 12% of all references in biology, engineering and physics, compared to 4% in sociology, philosophy, linguistics, or marketing [4,5]). The fact is that it is needed to consider self-citation when making various list according to scientometric data.

3. Conclusion

The validity of the scientometric analysis of author's work is questionable, due to the inconsistency of the platforms that conduct this analysis, as well as to the wrong citations. The lack of selectivity of Google Scholar, and the possible individual manipulation of content, implies the need for further development of these platforms, so that the scientometric analysis can become a valid tool in the academic community.

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Knowledge, Attitude and Practice Tools for Health Education Among Diabetic Patients

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Abstract. Health education is an integral part of self-management programs and an important element for the control and effective management of any chronic disease including diabetes. Patient Knowledge, Awareness, and Practices (KAP) are considered to be the most important factors for assessing the results of health education in patients with diabetes. In order to develop such health education models, it is important to have a validated and reliable tools which asses a diabetic patient's knowledge, attitude and practice. The aim of this study is to systematically review the literature on KAP assessment tools regarding health education among diabetic patients. The researchers conducted a systematic literature review using MEDLINE database from 1980 up to 2016. A developed search strategy was conducted by the researchers for MEDLINE and EBESCO. Of the 94 articles identified only 16 articles fully met the inclusion criteria. This review identifies useful assessment tools of KAP regarding health education for diabetic patients which will help to improve strategies in regards to assessing KAP for diabetic patients worldwide. The KAP assessment tools should be: carefully developed, user friendly, evidence-based, valid and reliable.

Keywords. Knowledge attitude and practice, KAP, systematic review, diabetic tools.

Introduction

Chronic diseases such as diabetes are major causes of death and disability worldwide. Chronic diseases are among the most common and costly disease plaguing the healthcare system [1]. In the Kingdom of Saudi Arabia, the incidence of diabetes has risen dramatically in recent years. In 2009, the prevalence of diabetes was 30% among Saudi nationals [2]. Chronic diseases including diabetes can lead to a common set of challenges for patients, their families, and health care systems. These include: dealing with complications, symptoms, disability, and emotional and psychological impacts.

Health education (HE) is an integral part of self-management programs and an important element for the control of diabetes. Also, this includes patients understanding of their disease management.

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A structured HE model for patients should consist of a curriculum; a mechanism for conducting and delivering the program; content, learning resources, and educational tools; feedback, evaluation and monitoring.

Patient Knowledge, Awareness, and Practices (KAP) are considered to be the most important factors for assessing the results of HE in patients with diabetes. Therefore, in order to develop such models, it is important to have validated and reliable tools which evaluate diabetic patients' knowledge, attitude and practice regarding HE. In this article, the researchers systematically review the literature on KAP assessment tools to evaluate HE among diabetic patients. Such a review can help improve strategies for assessing KAP for the of diabetic patients in Saudi Arabia and worldwide.

1. Methods

The databases used were Medline in EBESCO and Pubmed (1980 to 2016). All searches took place in February and March of 2016. The search strategy used the following key words: "health education or patient education", "Diabet*", "knowledge and attitude$ and practice". To be included in the review, the retrieved articles had to be: Quantitative in nature where the articles had to use survey methods to assess KAP assessment tools in diabetes patients; reporting psychometric tools and questionnaires as evidence of validity assessment; describing all the KAP assessment tools; written in the English language.

The inclusion process took place by screening for articles title and abstract and full text review. The researchers then independently reviewed the full text to exclude articles that did not fulfil the inclusion criteria. Thematic analysis was conducted on the eligible studies. The researchers then abstracted the following information from each article: article title, author names, year of publication, journal name, summery of the assessment tools used to evaluate KAP and validation of the assessment tools used.

2. Results

There were 16 eligible studies which used questionnaires as a tool to evaluate diabetic patients' KAP regarding HE for diabetic patients. The highest number of questions used to evaluate KAP regarding HE was a total of 141 questions [3]. These questions were divided into 7 domains which included the assessment of KAP. Another study assessed KAP with 51 questions, while another study used 33 questions [3]. The least numbers of questions to asses KAP regarding HE among diabetic patients were seven questions including: 5 questions on knowledge, a questions on attitude and a question on practice [4]. Last, a study had 12 questions [5] and another had15 questions related to KAP [6]. All included studies used questionnaires as an assessment tool to asses KAP among diabetic patients. This included cross-sectional and longitudinal studies. There were neither qualitative nor experimental studies included. The number of participants included in the studies varied from a sample size of 28347 [4] to a sample size of 67 [7]. Therefore, the generalisability of published data is limited to those studies with small number of participants. According to the results, most of the studies were conducted in Asia, primarily in India [4,8]. Few studies were done in the Middle East [6,9] and no studies in Saudi Arabia were found. Therefore, more studies are needed to be conducted worldwide in order to address the assessment of KAP assessment tools globally and its influence on culture factors. Interestingly, the number of questions used to asses KAP among diabetic patient varied between studies from 7 questions [4] to 141 questions [3]. Therefore, future research to develop critical appraisal checklists for assessing KAP tools evidence of validity assessment is needed.

3. Discussion and conclusion

Patient knowledge, awareness, and practices are considered to be the most important factors for assessing the results of health education in patients with diabetes. This systematic literature review identifies useful assessment tools of KAP for diabetic patients. The assessment of KAP regarding health education for diabetic patients should be carefully made user friendly format, evidence-based, valid and reliable. Therefore, in order to develop such models, it is important to have validated and reliable tools which evaluate diabetic patients' knowledge, attitude and practice regarding HE. The aim of this study was to systematically review the literature on tools used to asses KAP among diabetic patient health education. This systematic literature review provides researchers with a summary of KAP assessment tools which will help to improve strategies regarding assessing diabetic patients' health education worldwide. This review will help to improve strategies relating to diabetic patients health promotion in Saudi Arabia a worldwide. This systematic literature review included only articles that were published which may result in publication bias. Only articles written in English language were included which means that there might be other relevant articles that we might have missed.

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Actions to Empower Digital Competences in Healthcare Workforce: A Qualitative Approach

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Abstract. While healthcare systems are taking advantage of the ICT to improve healthcare services, healthcare workforce needs additional competencies in order to continue the provision of the best achievable care. In this paper emphasis is given to an active research effort taken during the MEI2015 Conference. Based on hands-on group-work, participants identified the actions needed to boost the acquisition of IT competences by healthcare workforce and collaboratively indicated the most important actions. The leading priority actions were integration of IT into Curriculum, continuous IT/eHealth training at the work place, raising awareness of IT competences, participatory decisions for actions, match healthcare applications to users' own context, inclusion of professionals in the development of eHealth projects. Interestingly, the proposed actions coupling the outcomes of another study following a different methodology, but also support the cooperation opportunities on IT skills for healthcare workforce. The latter formed a set of recommendations which were proposed within the CAMEI coordination and support action of EC-FP7.

Keywords. IT skills, eHealth skills, healthcare workforce, eHealth competences

Introduction

Technology increasingly penetrates in our everyday life. Healthcare systems are taking advantage of the information and communication technologies in order to improve healthcare services and cut down economical costs. While different types of technology are being adopted into the healthcare systems, the healthcare workforce has to learn to work with each of them. However, the healthcare workforce needs to foster their eHealth competencies in order to continue the provision of the best possible care [1].

There are a few initiatives trying to boost the eHealth knowledge of healthcare workforce. The EU and the US through "Memorandum of Understanding between EU and US" [2] and the "Transatlantic eHealth/health IT Cooperation Roadmap" [3] set as a priority to enhance the IT competencies of the healthcare workforce, while AHIMA

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and AMIA focused to health informaticians or to competences related to EHR [4]. The IMIA working group proposed recommendations on Education in Biomedical and Health Informatics setting the scene [5], in which a survey was based, aiming to define primary roles in health informatics for nurses [6].

The CAMEI (www.camei-project.eu) FP7 coordination action [7] aimed, among other objectives, to record strengths, weaknesses and competencies of the means that the healthcare workforce acquires IT skills in the EU and USA. An analysis [8] of the EU-USA cooperation opportunities on IT skills for healthcare Workforce revealed a great exploitation potential for training healthcare workforce mainly along three areas: technology standards; strategic R&D; and educational activities. Further to this a recent study [9] proposed a list of prioritised actions to improve the EU healthcare workforce IT skills and competences, by asking the participants to evaluate the actions according to 4 criteria: feasibility, effectiveness, deliverability, and maximum impact on IT skills improvement. In this paper, further support is provided by a piece of active research carried out within a hands-on workshop in an international conference, namely, the 2nd International conference on Medical Education Informatics (MEI2015).

1. Methodology

Within MEI2015, the CAMEI project organised a workshop in order to identify the actions needed in order to boost the acquisition of IT competences by the healthcare workforce. The participants at the beginning of the workshop were provided by a one slide presentation on the CAMEI action taken between EU-US to enhance the IT competencies of the healthcare workforce [10]. Then the thirty (30) participants were divided into five (5) groups. Each group was provided with a board, pens and sticky notes. Firstly, each participant asked to write one action needed in order to empower digital competences in the healthcare workforce per note, and stick it to the group board. In each note the participant had also to write her working title. There was no restriction on the number of actions that each participant could write. Five (5) facilitators were in the room providing explanations where needed. The duration of this stage was about twenty (20) mins. Then each group was asked to discuss the recorded actions and signpost the most important for them as a group. This action took about five (5) mins. Each group then was asked to present their ideas to the other groups and a discussion took place on challenges and cooperation willingness and opportunities.

2. Results

The top priorities/actions per group and professions engaged are presented in Table1.

Table 1. Top actions to empower digital competences in the Healthcare Workforce

Group 1	Profession
• Include all groups (Education, Clinical, IT,…) in the decision making process and do the groups and their opinion visible • Sharing Information is most important. If you don't tell anybody about what you are doing nobody will use your offers and you won't get funding • IT solutions should be friendly and consider my "own" context • Include Pedagogy, IT and Content together in the project	• eLearning Developer • Hospital Manager • Communication officer • Nurse • Project Coordinator

Group 2	Profession
• To inform the healthcare workforce what is ICT and why they need it • Validation of the aim of an eHealth initiative – are they valuable? Then we can raise awareness of ICT. • Increase of the connection between perspective and learning approaches • Find out what they want to fund(include knowledge - Team up with “friends” with proven track record in delivering work – Methodological / vision novelty	• Engineer • Healthcare Educator • Researcher • Head of eLearning unit
Group 3	**Profession**
• To create workplace oriented IT environment – to make work easier • Prepare IT Educational facilities for patient • Better infrastructure • Workshops and training • Integration IT in Curriculum – Local Evidence in Hospitals • Recognition of IT specialist importance in healthcare profession	• Medical Teacher • Family carer • health care professional • Researcher
Group 4	**Profession**
• Met-design of IT tools in Healthcare – Better Systems – Educating professionals through the development process – Test systems before realise them in the real world • Teach/train IT skills to staff (Nursing, Doctors, Pharmacist, etc.) when they are students)- The earlier the better • Collect data, create databases • Prepare Students before getting into work- then continue with CPD • Prepare relative (to the basic preparedness) to circumstance(student -> professional) course in IT skills(context medicine)	• Developer, • Health Informatician • Project Manager • Learning technologist • IT technician
Group 5	**Profession**
• Define the competencies and the process that they can acquire • Define pedagogical models to train the staff • Improve the current programmes in terms of management and introduce new course • Include IT Education in Medical programmes syllabus • Well defined and distribution of resources – Sharing-> use of known standards – pedagogically models • Improvement of Health care Management – Medical staff Education – Better IT solutions • The year around training of the personnel in IT matters	• Medical Doctor • Nurse • Health Informaticians • Academics

3. Discussion and Conclusion

All the groups included a variety of participants including a good mix of policy makers, physicians, nurses, academics, health informaticians and other stakeholders leading to the belief that their opinions were representative of the envisaged aim. It is also notable that the composition of the different groups, played an important role in the prioritised actions need to be taken in order to empower digital competences in the Healthcare Workforce. Thus, Group 1 had a more managerial approach, giving emphasis to participatory decisions for actions, by sharing information of individuals and fit the healthcare applications to users own context. Group 2 had a more educational approach by raising awareness of the healthcare workforce on the need of IT competences and enhancing the links between perspective and learning approaches. Emphasis on the integration of IT into Curriculum, but also providing continuous IT training at the work place was central to Group 3, 4 and 5. According to group 3 and 5 views the workplace should be enhanced by better IT infrastructures. The Group 4 having a strong technological background element also suggested the education of the professionals through the development process, while group 5 signpost also the need of the pedagogical models suitable for existing staff and the need to define the actual competencies for the training. The suggested actions coupling the priorities identified in [9] following the Child Health and Nutrition Research Initiative methodology for priority-setting: appropriate training; integrating eHealth in curricula; involving healthcare workforce in the eHealth solution development; improving awareness of eHealth, and learning arrangement.

Some of the actions were heading towards collaboration opportunities, as expected, since that was also an aim of this activity, enabling participants to create clusters and identify potential streams of funding. The suggested actions back up some of the cooperation opportunities on IT skills for healthcare workforce proposed in CAMEI [8]: develop a regularly updated joint IT skills registry for healthcare workforce, develop a common approach for certification of IT skills for healthcare workforce, Open and Flexible Education models and initiatives, harmonize the regulatory guidelines for how IT skills programmes are financed. It is already evident from this work that further coordination and implementation of the proposed actions to empower digital competences in the Healthcare Workforce are needed indeed.

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Managing Information More Effectively in Health Informatics Applications

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Abstract. Conceptual clarity and predicative/impredicative competence are the fundamental components for managing information more effectively in Health Informatics, Healthcare and Medicine applications, while promoting innovation and creativity. Medicine was always the art and science of healing. The science became more and more a mechanistic technology in Healthcare; the art was dropped altogether. But uncertainty-as-problem in the past is slowly morphing into the evolutive concept of uncertainty-as-resource. The key change performance factor is education, distinguishing building on sand from building on rock for Health Informatics! Conceptual clarity, more than instrumental obsession (so typical of this particular time) is necessary. In this paper we present how to take advantage from their fundamental properties.

Keywords. Health Informatics, Medicine, Healthcare, Conceptual Clarity, Impredicative Systems.

Introduction

Conceptual clarity and predicative/impredicative competence are the fundamental components for managing information more effectively in Health Informatics, Healthcare and Medicine applications, while promoting innovation and creativity [1]. Challenged by conditions beyond the traditional boundary of illness, even medicine and healthcare are discovering that the living is less simple than what the traditional physics paradigm implies and this affects health informatics deeply. As far as the last decades are considered, the most pervasive development of science goes under complexity theory, however defined. Men inevitably see the universe from a human point of view, communicate in terms shaped by the exigencies of human life in a natural uncertain environment, and make rational decisions in an environment of imprecision, uncertainty and incompleteness of information. Both complexity science and chaos theory converge on showing the unavoidability of uncertainty, whether it is embedded into feedback cycles and emergence or in the infinite precision of initial conditions. But, uncertainty-as-problem in the past is slowly morphing into the evolutive concept of uncertainty-as-resource. The key change performance factor is education, distinguishing building on sand from building on rock for Health Informatics! Conceptual clarity, more than instrumental obsession (so typical of this particular time) is necessary. Furthermore, a subtler transformation is ongoing, however. Both linear and nonlinear techniques are forms of predicative modeling. The

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difference between predicative and impredicative systems (and models and definitions) is pervasive and often considered of marginal interest in the past century [2].

1. Predicative and Impredicative Competence

According to Swiss clinical psychologist Jean Piaget, human adults normally know how to use properly classical propositional logic. He held that the integration of algebraic composition and relational ordering in formal logic is realized via the mathematical Klein group structure [3]. In the last decades, many experiments have shown most adults commit logical fallacies in propositional inferences, and so concluded that Piaget's claim about adults' competence in propositional logic was too much rationalist. Doing so, they forgot Piaget's rigorous and important analysis of the Klein group structure at work in logical and predicative competence. English talking people tend to treat conditionals as equivalences and inclusive disjunctions as being exclusive [4]. Nevertheless, the Klein group structure Piaget used can be reused to help us understand better what happens in spontaneous human reasoning and in the production of fallacies. In fact, in mathematics, the Klein four-group or "Vierergruppe", named by German mathematician Felix Klein in 1884, is a group of four transformations with four elements. The Klein four-group is the smallest non-cyclic group, and every non-cyclic group of order 4 is isomorphic to the Klein four-group. The cyclic group of order 4 and the Klein four-group are therefore, up to isomorphism, the only groups of order 4. Piaget applied the Klein four-group to binary connectives, so that a given connective is associated first with itself (in an identical (I) transformation) and then with its algebraic complement (its inverse (N) transformation), also with its order opposite (its reciprocal (R) transformation) and finally, with the combination of its N and R transformations to arrive to what logicians usually call the "dual" (D) transformation [4].

The Klein group structure generates squares of opposition (SOO), and an important component of human rationality resides in the diagram of the SOO, as formal articulations of logical dependence between connectives. SOO are considered as important basic components of logical competence and of human predicative rationality [5]. Treating conveniently neutral elements (I), algebraic complements (N) and order reciprocals (R) in an integrated structure, by a valid treatment of duals (D), would guarantee people to make logically valid classical inferences on propositions and to achieve higher conceptual clarity in Health Informatics. But the formal rationality provided by the SOO is not spontaneous and therefore, should not be easy to learn for adults. This is the main reason why we need reliable and effective training tools to achieve full propositional logic proficiency, and predicative competence in decision making, like the elementary pragmatic model (EPM) [6,7]. In fact, by an abstract point of view, EPM can be even seen as the logic description of the fundamental interaction of two purposive subjects, modeled by the interaction of two Klein groups. In other words, EPM can model all the elementary narrative and rhetoric articulations between two rational, interacting subjects reliably and clearly. Currently, the notion of reasoning or conscious reason may be interpreted in terms of the reasoning process itself being itself explicitly modeled by the reasoning agent in Cognitive Informatics [8]. In this way, we can arrive to the core understanding of "the difference that makes the difference" [9].

Furthermore, a subtler transformation is ongoing, however: a transformation working on a deeper level than the move from linear to nonlinear models and patently much less visible than it. Both linear and nonlinear techniques are forms of predicative modeling. The difference between predicative and impredicative systems (and models and definitions) is pervasive in science and often considered of marginal interest in the past century. As a matter of fact, many disciplines, including mathematics, sociology, anthropology, biology, etc., exhibit varieties of self-reference, the primary source of impredicativity [2, p.6]. Furthermore, many natural systems do indeed show forms of impredicativity, that is the presence of self-referential cycles in their constitution. Once the supporting or enabling (as well as constraining) capacity of the related environment is provided, the impredicative cycle characterizing the system proceeds in its own way. Apart from the pioneering efforts of American theoretical biologist Robert Rosen [10], and usually without his idea that impredicativity is the next paradigmatic frontier of science, the issue of impredicativity has received little attention in the past [11-14].

Unsurprisingly, many properties of impredicative systems are still unknown and suitable research programs must be developed. Specifically, from past and current scientific literature we know very little of nested or tangled impredicative systems properties, such as the organism-mind-society encapsulation [15], or the mathematics of impredicativity systems [16]. As a matter of fact, according to the author's humble knowledge, CICT (computational information conservation theory) [17] has been the only approach studying impredicative systems by an operative perspective since 1980s.

2. Conceptual Clarity

In every human sentence, the fundamental relationship between the Syntactic level and the other two, Semantic and Physical levels, is the relationship between a mathematical object and its "interpretations". For instance, the wave equation may represent the mechanical motion of a material medium or the dynamics of an electromagnetic wave: both cases share nothing else than their syntactic structured "wave" concept. A fundamental understanding in "Classical Mechanics" [18]. As a further, more interesting example, the Piaget-Klein group structure can be even interpreted as the group transformation mapping the human perception and representation of our universe, according to the Rosen modelling relation, where the encoding process is carried out by human affectors (our biological sensors) and the decoding process is achieved by human effectors (our biological actuators) [10].

From traditional information modelling point of view, the main focus is on the "direct space" (DS) representation only (Euclidean space). Nevertheless, according to CICT ODR (Observation-Description-Representation) approach [17] to grasp the full information content of our reality, DS is just half of the "outer universe" (OU) human representation (sharable representation) and its "co-direct space" (CS) is the other half, the DS natural closure. Coupled to the OU is the "inner universe" (IU) human representation (subjective representation), composed by the "reciprocal space" (RS) and its natural closure, the "reciprocal co-space" (RC), or the DS dual. DS and CS are the coupled, complementary, asymptotic components of the fundamental, irreducible dichotomy of our OU representation [19]. This fundamental representation is based on two root components: unfolded information (linear sharable information that can be communicated in a formal way by media) and folded information (complex subjective information that cannot be communicated by traditional media) [6]. DS, CS, RS and

RC are related to the four fundamental components of the Piaget-Klein group: Identity (I), algebraic complement (additive inverse) (N), order opposite (multiplicative inverse, reciprocal) (R), and dual (D) transformations, respectively. According to CICT, this is the minimum framework required to capture and to conserve full representation information efficiently [6].

3. Conclusion

We live in an age which is widely called the "Age of Information" and Health Informatics must capture as much as possible of it. Knowledge concept is useful for semantic and cognitive studies and research, mainly. Nevertheless, it is much better to consider semantic information as a material category reflecting the level of internal structural organization of any object and interrelating with domain-dependent basic characteristics (such as the energy and mass of an object). This the main reason why there are basic issues related to enhanced knowledge which still remain unresolved.

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Knowledge of Palliative Care Among Nursing Students

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Abstract. The aim of this study was to evaluate nursing undergraduate students' knowledge with regard to palliative care in Saudi Arabia. A quantitative descriptive research study was conducted by the use of validated tool. A total of 204 students were included in the study. There is little evidence in Saudi Arabia to demonstrate if nursing undergraduates receives education on palliative care. The results indicate that 57.9% of the nursing undergraduates had received educational sessions and 42.1% of nursing undergraduates did not. In conclusion, palliative care nursing education is crucial to improve quality of patient care in nursing practices. It is recommended that a palliative care education should be integrated within the nursing programme courses. Hence, in order to improve students' knowledge of palliative care, course content should cover the principles of palliative care as a part of any nursing bachelor programme.

Keywords. Palliative care; nursing students; knowledge, Saudi Arabia

Introduction

Nurses' knowledge and awareness of palliative care are critical when maintaining the highest levels of quality of care[1]. A lack of knowledge among nurses and nursing students has been reported by many scholars. Moreover, studies highlighted the need for further research on the knowledge of palliative care among students[1]. A recent study in Saudi Arabia [2] reported that Saudi nurses have a lack of knowledge of palliative care. Again, there is a need to improve nurses' and undergraduate nursing students' knowledge of palliative care concepts. In the nursing setting, palliative care consists of three main aspects, including patient symptoms, pain management and patient and family support[1]. The role of nurses in palliative care is to assess, plan and apply nursing interventions depending on patient needs and to evaluate the patients' outcomes [3]. To achieve a high quality of life for patients, palliative care focuses on managing distressing symptoms and relieving suffering as priorities of care [3]. The key factors of palliative care are symptom management, patient and family needs, an interdisciplinary approach and communication between patients and health care workers. Doctors, nurses and allied health professionals should care for patients as human beings by respecting their values, beliefs and culture[4]. There is little evidence in Saudi Arabia to demonstrate if nursing undergraduates receives education on palliative care within their courses. The aim of this research study was to evaluate nursing undergraduate students' knowledge of palliative care in Saudi Arabia.

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1. Methods

This is a quantitative descriptive research study conducted by means of a validated questionnaire. A purposive sampling technique was employed. Data collection took place in the nursing college at Princess Nourah Bint Abdulrahman University (PNU), in Saudi Arabia. Nursing undergraduate students from year 2 up to year 4 and who were enrolled to the Bachelor Nursing Program (BSN) were invited to take part in this study. A total of 204 students were included in the study. Data collection took place between April and May 2016 in the Spring academic semester. All participants (n=204) were consented before taking part in this study. IRB ethical approval from the college of nursing at PNU was obtained before starting the study. The researchers used a quantitative research method using questionnaires adapted from a previously published work [5], namely the Palliative Care Quiz for Nursing (PCQN). This instrument measures participants' knowledge of palliative care. The PCQN consists of 20 questions and each question has three choices, namely true, false or don't know. Descriptive data analysis was used to analyze the data results. Moreover, two tests were used to compare between the sample responses on the PCQN. One is a t-test that is used to compare the distribution between two-group variables (e.g. levels, whether or not you have received an educational session on palliative care during nursing studies; and whether or not you have given a course on palliative care within your nursing study). The second test was the ANOVA test, which is used to compare the distribution between variables from two or more groups.

2. Results

The total number of students were distributed as follows: 55.9% were atyear 2, 24.5% were at year 3 and 19.6% were at year 4. 57.9% of the participants had received educational sessions on palliative care in the last four years and 42.1% of them never did. In addition, 53.5% had given a lecture on palliative care within their nursing course but 46.5% had not. Clinical area placements varied among nursing students. For example, some of the nursing students were practicing in four different clinical areas at the same time, others in three different areas and some were practicing in one or two areas. These numbers were as follows: 103 students were practicing in medical wards, 75 in surgical wards, 70 in intensive care units, 27 in Orthopedics, 9 in operation rooms, 10 in pediatrics, 13 in oncology, 13 in maternities and 49 in Simulation clinical laboratories.

The PCQN scores were calculated as follows: 0 score for both wrong and I don't know answers and 1 score for correct answers. Therefore, the total score (sum of the number of correctly answered items) ranged from 0 to 20 for each questionnaire including the three domains. However, the mean was calculated separately between the categories. The total mean score was low, at 7.0 (SD 2.83), ranging from 0 to 18. The mean score was also distributed normally. Skewness was 0.309, kurtosis was 0.801, and the Shapiro–Wilk test was significant (W = 0.978, p value 0.002).

The number of correctly answered statements ranged from 25 (12.3%, statement no. 3) to 129 (63.2%, statement no. 18). The following statements were the best answered ones: no. 18 (63.2% correct), no. 4 (62.6% correct), no. 2 (58.1% correct), no.10 (49.3% correct) and no. 20 (49% correct). The best-answered statements all belong to the pain and symptom management domain. The total mean score of this domain (13 statements) was 5.19 (SD 2.11) out of a maximum score of 13. The mean score of psychological and spiritual care was 0.87 (SD 0.908) out of 3, and the mean score of philosophy and principles of palliative care was 0.98 (SD 1.149) out of 4.

Table 1 shows the first eight misconceptions about palliative care among the sample. It also shows that 4 of them fall into the pain and symptoms management category, three of them are within the philosophy and principles of palliative care category and just one falls within the psychosocial and spiritual care category which may clarify that students do not have appropriate information that belongs to the three categories. It also shows that seven out of the first eight misconceptions statements were false ones and just one statement was true and was understood by students as a false one.

Table 1. Common Student misconceptions about palliative Care

	Statement	Conceptual Category
1	The extent of the disease determines the method of pain treatment (F) statement no. 3	Pain and Symptom Management
2	Palliative care is only appropriate in situations where there is evidence of a downward trajectory or deterioration (F) statement no.1	Philosophy and Principals of palliative Care
3	Drug addiction is a major problem when morphine is used on a long-termbasis for the management of pain (F) statement no.7	Pain and Symptom Management
4	The accumulation of losses makes burnout inevitable for those who work in palliative care (F) statement no. 17	Philosophy Principals Care
5	Demerol (Pethidine) is not an effective analgesic for the control of chronic (T) statement no. 16	Pain and Symptom Management
6	The provision of palliative care requires emotional detachment (F) statement no. 9	Philosophy and Principals of palliative Care
7	The use of placebos is appropriate in the treatment of some types of pain (F) statement no. 13	Pain and Symptom Management
8	The loss of a distant relationship is easier to resolve than the loss of one that is close or intimate. (F) statement no. 19	psychosocial and spiritual care

The ANOVA test was used and it revealed that there was a significant difference between students according to Student Year (SY) of study as follows: (SY4) = 3.10, p = 0.000), (SY3) = 3.09, P = 0.000) and (SY2) = 2.07, P = 0.003). Hence, there was a correlation between the number of years' study completed by student nurses and their knowledge of palliative care. The t-test was performed to determine whether there was a significant difference between the students who had/had not received a palliative care session in the last 4 years, and this revealed a significant difference between the students who had received palliative care sessions in the last 4 yearsand those who had not (mean= 7.50, T= − 2.66, p = 0.011). In addition, there was a significant difference between the students who had or had not been given a course content on palliative care (mean= 7.69, T = −3.48, p = 0.001).

3. Discussion and Conclusion

The main aim of this study was to measure undergraduate students' knowledge of palliative care. According to the results presented, it is obvious that students' knowledge was inadequate regarding the philosophy and principle of palliative care as shown by the low average for PCQN score. This result is similar to a recent study by Al Qadire in 2014 [3]. This study used the same research instrument to evaluate students' knowledge regarding palliative care [3]. In addition, this study shows that the students had a large number of misconceptions of palliative care. For instance, they linked serious illness cases with the type of procedure used for pain treatment [3]. In addition, nursing students believed that palliative care is only appropriate for advanced illness and deteriorated cases [3]. This conclusion was also confirmed by another research study [6].

Interestingly, in this study, the number of nursing students who received palliative education was greater than the number of students who did not. However, the lack of knowledge about palliative care among students could be a result of insufficient palliative nursing teaching in the curriculum. Previous scholars stated that the number of educational hours in palliative care nursing was inadequate[6].

In this study, the nursing course content was not evaluated. However, 46.5% of students reported that during their study they did not receive palliative care education. This finding emphasizes the need for palliative care nursing education integrated within the nursing programme. Hence, in order to improve students' knowledge of palliative care, course content should cover the principles of palliative care. For example, these principles may consist of pain management and symptom control, psychological and spiritual care. Moreover, there are many studies which highlighted the importance of palliative care education to improve nursing practice [3,6,7]. Consequently, the impact of inadequate knowledge of palliative care nursing will affect nursing quality of care in the future.

In summary, there were significant differences in the mean score of PCQN for prior palliative care education among nursing students. One explanation for this is because those students came from different years of study.

It is recommended that palliative care education should be a requirement through including it as a part of the BSN courses. This can be achieved by including palliative care topics in all specialized nursing courses. More research should be carried out to assess the courses content of palliative care education in the nursing curriculum to improve nursing knowledge.

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Generics Pricing: The Greek Paradox

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Abstract. This paper explains and develops a methodological framework to help evaluate the performance of generic pharmaceutical policies and the correct evaluation of generics sales. Until today erroneous recording of generics does not help proper pricing and their penetration in the Greek market. This classifies Greece on the outliners in every study or comparison that is referred on papers or studies.

Keywords. Generics pricing, medicine's sales.

Introduction

Over the past few decades spending on prescription pharmaceuticals has increased faster than total health spending and gross domestic product in most OECD countries [1,2]. In Greece there is a lack of reliable data for the observation and projection growth in pharmaceutical expenditures. Generic medicines can play an important role in curbing rising pharmaceutical costs and their cost-saving potential is significant as they provide both a lower-priced option for prescribers and patients and a tool to drive-down prices of originator drugs [3,4].

Significant developments have taken place in most OECD settings in terms of policies favoring the uptake and use of generic medicines, including regulatory interventions on prescribing and dispensing. Yet, an assessment of how effective these measures and interventions are in promoting wider generic use at a faster pace and at reduced cost to health insurers is an issue that merits evaluation and systematic appraisal. The current paper explains and develops a methodological framework to help evaluate the performance of generic pharmaceutical policies and the correct evaluation of generics sales.

1. Methods

A literature review concerning scientific articles about pricing medicines was carried out. Also, studies from companies that collect data from medicine's sales internationally were reviewed. In addition, data were taken from the official price medicine list of Greece.

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2. Results

Generic medicines account today for 56% of all prescribed medicines but for only 22% of the pharmaceutical expenditure, or 2-4% of total healthcare costs, in Europe. Without generic medicines, European payers would have had to pay €100 billion more in 2014 to get the same level of access to treatment as we have today. The generic medicines industry has increased access to medicines by over 100% in 7 key therapeutic areas without increasing the overall treatment cost over the last 10 years [5,6]. For example, in the U.K., total pharmaceutical spending was reduced by 70% after the entrance of generic medicines. An additional 9.8% savings could be achieved if generic medicines reached 100% penetration. In contrast, in Spain, only 52% savings were achieved; however no new savings can be generated due to the fact that prices of off-patent originals now match the price of generic medicines.

Despite the lower cost of generic medicines, price savings are achieved mainly where competition is encouraged—meaning that pricing structures are not regulated. (Indeed, the free-market pricing system in the U.S. appears to yield the highest off-patent efficiency of any market.) In most EU markets, the price of the off-patent product is commonly lowered significantly, either through competition from the generic version or because authorities force a price reduction. In addition, the entry of generic medicines may also precipitate enforcement of a price reduction on originator brands in some countries. This generates significant savings, even though the generic medicine share may actually be low [5]. The mapping of Greek legislation for the health sector included 155 laws and regulations. Legislation included laws, legislative decrees, presidential decrees, and ministerial/joint ministerial decisions.

According to the recent law 4337/2016 the price of one off patent medicine is predicted to be at the 50% of the price of an originator medicine while a generic is at the 65% of the price of an off patent medicine. However the Ministerial Decision 28408/19.4.2016 states that generics can't be more expensive than the off patent medicines, identifying that the pricing as it is implemented in Greece, does not always comply with the law 4337/2017. Even after the implementation of the ministerial decision, it is observed that some generics medicines are more expensive than off patent medicines up to 30%. With the new proposed pricing the difference between the above categories can reach the percentage of 100%. Likewise the corresponding medicine in Spain costs 66% cheaper. The official justification during pricing is that the certain medicine is not declared as reference product or that there was no price found at the first distribution of the generic medicine. With that excuse, generics of wide use and high cost are sold up to 300% more expensive. This is the main reason why Greece had only 12.4% of sales generically available within 3 months after loss of exclusivity [6].

The same time over 75% of generic sales were attributed to medicines that had generic entry in the UK 3 months after loss of exclusivity, followed by Finland (71.6%), Germany (71%), France (65.1%) and Denmark (60.4%) but the share of sales that did not have generic entry 24 months after loss of exclusivity was lowest in Denmark (9.6%), the UK (11.4%), and Germany (14.7%) and highest in Greece (58.8%), France (32.2%) and Portugal (29.9%) [4]. The pharmaceutical industry makes a significant contribution to GDP, employment and economic health, and constitutes a prominent and growth-enhancing area of economic activity in Greece.

The economic and social importance of this sector increases the need for consistently applied rules and regulations, which must find a balance between efficiency, effectiveness and inclusive growth. Currently, competition appears hindered by legislation restricting various aspects of pharmaceuticals, creating differential treatment of economic agents and legal uncertainty ex. pricing mechanisms do not allow generics to exploit their price advantages OECD data show that health expenditure in Greece, both private and public, declined significantly in the past few years of the economic crisis. On the other hand, the share of pharmaceutical expenditure in total health spending was relatively high. In 2014, it stood more or less at the same levels with 2009. In this respect, Greece ranked second among OECD member countries, only surpassed by Hungary. Pharmaceutical expenditure reached a peak in 2011 (34.8% of total health expenditure) and has been on a downward trend since, accounting for 28.4% of total health expenditure in 2014. Nevertheless, this remains well above the OECD average (16.3%) and the EU average (17.1%), reinforcing the fact that a relatively high fraction of health expenditure is captured by pharmaceutical products [7].

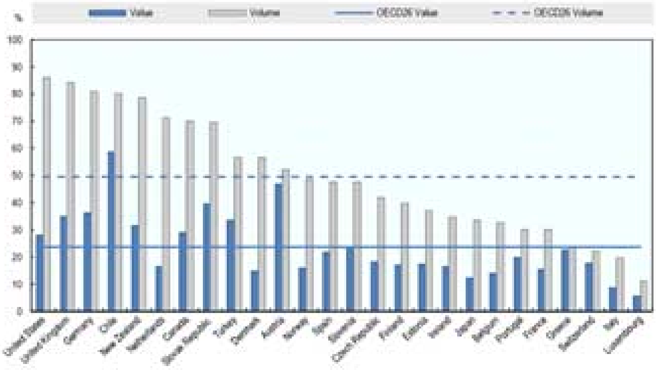

Figure 1. Share of generics in the total pharmaceutical market, 2015 (or nearest year).

As shown in Figure 1, Greece is very close to the average share among OECD countries according to the sales values of generics while is behind (less than half) according to the sales volume. Greece, is the only country that the percentages of sales values and sales volume are almost equal.

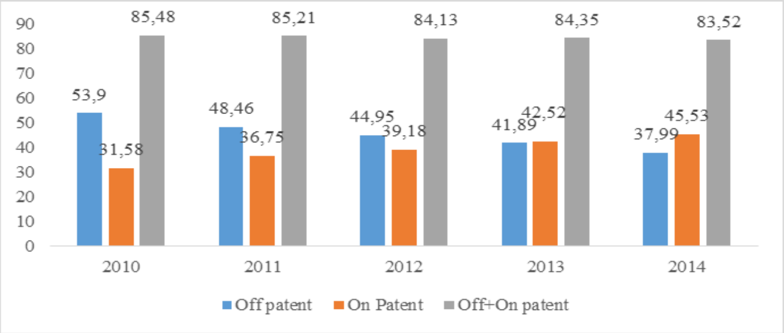

Figure 2. Off patent and On Patent Medicines Consumption (%) in value.

In Figure 2 it is also shown the paradox that during the financial crisis, the percentage in values of the sum of on patent and off patent medicines is almost stable and ranges respectively from 83.52% to 85.48%. On the other hand units that a decrease in off patent medicines is followed by an increase in on patent medicines and not by generics. Despite that ascertainment, the existing pricing process in Greece introduces pricefloors defining which generics are eligible for a downward price revision and a maximum reduction percentage of 15% to severe price reductions. The latter has the side-effect of reducing consumers' willingness to purchase generics by aligning their prices with the prices of their direct competitors.

3. Discussion

In conclusion, in order to be able to compare generics' sales data in Greece and make right calculations, we must certainly consider the prices of the off-patent medicines which are very close to the generics' (or even more expensive) deterring patients from buying them. Finally, the official records of medicine consumption must be published by the National Health Insurance Provider (EOPYY) and the National Organization for Medicines (EOF) so that they can always be available for the government, companies, patients and Institutions in order to be headed to the right direction of using generics.

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Continuous Education in Community Nursing with the Use of Health Informatics

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Abstract. Continuous Education can make a significant progress in any professional scientific discipline such as Nursing, which is constantly evolving. The main purpose of this paper is the review of contemporary literature in relation to the continuous education in community-nursing, with the use of health informatics. Additionally, these reasons are examined for which, nurses attend or not programs of continuing education. Finally, Accreditation, Interdisciplinary Education and Nursing Education to provide in the best possible way the necessary knowledge to students, is highlighted.

Keywords. Continuing Education, Community Nursing, Health Informatics

Introduction

As technology and informatics are evolving every day even more and the new studies programs bring-up new data, the knowledge that every person has acquired from the basic education, either through a university degree or via a postgraduate program of studies, becomes restricted. It is crucial, that people from every professional field must undergo a lifelong education. Healthcare specialties, therefore, such as Community-Nursing are rapidly evolving, demanding continuous updating and training of their staff. It is an inclusive terminology which refers to all kinds and types of education that every employee can have. This includes the educational lessons a person can take, after having completed the level of basic education. To put in simple words, the term refers to every form of education, provided to professionals. It is noteworthy to mention that, many vocations demand from their members to attend continuing educational programs, in order to maintain their certificates and their licenses [1]. Furthermore, continuing education plays a determinant role in community nursing. Continuous education also combines primary health with nursing practice, health informatics and public health.

Community Nurse and Health Informatics Nurses are Responsible [2]:

- To evaluate the health level and health needs of the patients.
- To refer them to the proper services.
- To provide counseling and psychological support to people in need.

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- To prescribe medicines when this is allowed and needed.
- To act independently within a scientific framework.
- To provide accurate data to supervisors and superiors.
- To be informed properly and accurately.
- To function as a source of specialized knowledge and instructions of clinical nursing practice within the healthcare group.
- To acknowledge the social existing, political and economic factors.
- To provide support and knowledge to nurses and health-care professionals, with the use of health informatics [3].

The procedure which the student's satisfaction is connected with the course has to be evaluated, with the different procedures taking place during the lesson. The provision for healthcare services has been improved, though the provision of systematic nursing courses, technological schools, university level nursing and finally with postgraduate studies, reinforcing the contribution of continuous education [4]. Furthermore, Health Informatics represents these applications of computer-information technologies, specifically to support the health-information and the accurately communication-needs of the patients them-selves.

The health-informatics perspective can provide insights and options to improve each of the seven ongoing-elements of any public health-community nursing intervention.

These include the following:

- Planning and System Administration-Identifying information and sources,
- Health Data-Collection-Identifying potential bias associated with different collection methods.
- Health Data-Management-Identifying ways to share data across different computing/technology platforms.
- Information Analysis-Identifying appropriate statistical and visual applications.
- Interpretation-Determining usefulness of comparing information with other data sets.
- Dissemination-Recommending appropriate displays of information for users to reach the intended audience.
- Application(s) to Public Health Programs-Assessing the utility of having the health-data directly into information systems that support public health interventions and health information elements or standards.

1. Materials and Methods

The significance of the community-nurse in the provision of qualitative healthcare-services is very important. Study and further analysis of continuous education programs are available in community nursing and health informatics studies, such as postgraduate and doctoral programs, seminars, etc. offering important and specialized scientific support in community of health-care. Computer networks and telecommunications provide particular support, enhancing the collaboration among care-providers and patients.

2. Results

Nowadays nurses are not properly trained in relation to the practical part of the profession. Due to the gap between practice and education, nursing practice is unable to keep up within the rapid changes of research and technology. According to it, time consuming procedures of patient's registrations and examinations are reduced, mistakes are avoided, money is saved, drugs abused controlled, provided that the health professionals have the knowledge or that they attend programs or courses of continuing education in order to update their learning and practice.

3. Discussion

Continuous Education can be either voluntary or obligatory. Concerning voluntary continuous education, there are many reasons why someone may or may not take part. Some of the motives are the clinical responsibilities, the increase of professional opportunities and the update of the knowledge. Some of the deterrent factors are the cost, the family-care, the lack of information for the available programs, the inability to apply for a leave in the workplace and finally the lack of payment and funding. Taking into consideration the above, some thoughts accrue and there are suggestions for being capable of ameliorating the future of the Community Nursing and Health Informatics Fields.

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Accreditation and Certification in Health Informatics: Principles and Procedures

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Abstract. Accreditation is an important process ensuring quality of academic programs in Biomedical Informatics. Certification ensures standards in knowledge and skills of professionals in Health Informatics. The process of Accreditation is analyzed for its pros and cons. Procedures are applied to ensure the completion of accreditation of a program is transparent, objective and leads in quality qualifications. Finally, the logistics required for Accreditation are calculated in terms of human resources as well to meeting cost expectations.

Keywords. Biomedical and Health Informatics Education, Accreditation, Certification

Introduction

Accreditation is a diligent evaluation and monitoring peer review process assuring that educational programs and institutions meet academic standards and operational integrity and quality. There is a great number of European Universities and Institutions implementing and having established programs (undergraduate and postgraduate) in the field of Biomedical and Health Informatics. A mechanism should be applied by EFMI to accredit those programs, since EFMI is the European scientific body of Biomedical and Health Informatics, where all national associations have joined in our Federation (EFMI). This accreditation will provide European added value to the programs, be supportive of cross-national mobility and be complimentary to the required national accreditations processes. [1-4]

Certification is a credentialing process that demonstrates and honor qualifications that an individual can perform a specific professional role, or set of tasks. Certification in Health Informatics is a requirement for many professionals in many clinical institutions in a number of countries. Specifically Clinical Health Informatics is a special concern, as many professionals who are using or implementing health information systems or applications or instrumentation in their professional life. Even those professionals having acquired earlier degrees in Health Informatics or in related fields is required to update and certify their current knowledge and skills. Therefore, eligibility and content requirements combining 1) Clinical practice focus, 2) Education, and 3) Significant experience in real-world health informatics accomplishment is urgently needed to ensure qualified expertise and develop "best practices". EFMI as the scientific federation in this discipline has the obligation to offer certification processes and

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certify the professionals of the current skills in the field of Biomedical and Health Informatics.

1. Methods

A SWOT analysis methodology is applied to understand the strengths of organizations, such as the European Federation for Medical Informatics for implementing accreditation of programs and certifications for individuals. The methodology analyses also the opportunities, the weaknesses, and the threats.[5-6]
A. Strengths. EFMI is a European federation of national associations situated in most European countries. The scientific and professional community of Biomedical and Health Informatics is reflected in EFMI as it is yearly depicted in the MIE Conferences.
B. Opportunities. Very few Universities/Institutions with programmes in the field of Health Informatics have been accredited by an International organization. Similar initiatives had little effect in Europe. In addition no Certification programmes have been established yet in Europe in our field.
C. Weaknesses. EFMI is a volunteer organization without solid professional secretariat support. Also decisions are delayed due to the internal procedures. Clear mandates should be given to the Accreditation and Certification Committee to ensure minimization of bureaucracy leading to delays in implementation and decisions taken.
D. Threats. Other international organizations, some of them, more professional ones than EFMI, have initiated similar actions and they may apply them in Europe very soon.

2. Results

For achieving the Accreditation a stepwise approach is followed:
1. The Program to be accredited applies for accreditation via its authorities (Dean, Program Director) by sending email sent to the EFMI Board. The letter is copied to the Chair of the Accreditation Committee. The request for Accreditation is dated and 'Registered'.
2. The Program is asked to prepare the Self-Assessment document in electronic version and to pay (whenever applicable) the accreditation fee. The Program may also suggest names of possible site visitors. The information about how to write the Self-Assessment document will be available at the EFMI's website.
3. The receipt of the Self-assessment document is 'Recorded' in the database and a copy of the document is archived by the Chair of the Accreditation Committee. He also checks whether the accreditation fee has been paid (whenever applicable).
4. The Accreditation committee appoints an independent chairman of the site visit committee and together with this chairman selects two other independent members from a list of possible candidates, taking the suggestions offered by the corresponding Program. All selected members should have been involved in educational programs. The Accreditation Committee checks the independency of the members by asking them to sign a statement about their independence with respect to the Program to be visited. The names of the site visit committee members are recorded in the 'Registry' and are communicated to the Program.

5. The Chair of the Accreditation Committee informs the chairman and the members of the site visit committee of their duties and the procedure. This information is also available as a document. Each site visit committee member gets an evaluation form containing the subjects and the criteria that should be judged. This form will be completed by the members individually during the site visit. During the meeting differences in opinion between the judgments of the site visit members are discussed and resolved.
6. The site visit committee decides whether the Self-Assessment document contains all necessary information. If not, the Program is asked to provide that information ready during the site visit or to be sent to the members prior to the visit. Also a date for and the duration (two/three days) of the site visit is determined.
7. During the site visit the committee discusses and interviews all relevant parties: the Program Director, the Dean, Faculty, students and others related to the Program. The committee will have access to all teaching and administrative facilities as well as to laboratories and other resources of the institute. Ample time should be available for both meetings and visits. An appropriate agreed agenda should have been prepared and arranged prior to the visit.
8. The site visit committee will judge whether the goals and objectives of the Program have been met. They complete the form by providing judgments about the subjects and corresponding criteria of the Program.
9. In an exit session this assessment will be presented by the chairman to all persons who took part in the accreditation procedure. The chairman will stipulate that the assessment is preliminary and there will be no discussion about the presentation.
10. After the site visit the chairman with the assistance of the members will prepare an accreditation report based on the preliminary assessment. In this report the final justified judgment of the subjects and corresponding criteria are presented and the final decision to award accreditation or not. The finalized report is sent to the Accreditation Committee.
11. The Accreditation Committee checks the completeness of the report and if that is OK it will send a copy to the Program.
12. The Program can provide feedback indicating possible factual errors in the accreditation report and make other suggestions. The Accreditation Committee sends the Program's comments to the site visit committee. The site visit committee will correct the factual errors and discuss the suggestions. If the suggestions are accepted they are inserted into the report. Then the site visit committee will return the report to the Accreditation Committee.
13. The Accreditation Committee now decides whether the Accreditation will be awarded. If yes, the Program is informed and is allowed to advertise their EFMI accreditation status. If not, they have the possibility to appeal. The decision is entered into the Registry. EFMI Board is notified and archives the decision in the EFMI Board minutes
14. For the Programs already Accredited by EFMI, the Accreditation Committee notifies the Program that the Accreditation period is about to expire one year before the corresponding date.

3. Discussion

Accreditation and Certification are very important processes ensuring the quality of programs, both academic and vocational, and the knowledge and skills of those graduating from those programs, respectively. International organizations, such as the European Federation for Medical Informatics may organize and monitor the processes to ensure the high quality of programs and professionals.

Acknowledgments. The author would like to the thank EFMI and the members of the task force for providing a coordinating effort to organize the AC2 initiative. This effort is continuing and the author will assist for its effective implementation.

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An Overview of the BIOMed Project

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Abstract. The purpose is to: 1) foster the national BioMedical Informatics (BMI) foundation aligning with the international medical informatics association (IMIA) in order to remodel the national strategies; 2) structure the BMHI strategic plans in Egypt and Jordan as models for other Arab States; 3) define the requirements for new joint EU-Mediterranean BMHI projects and initiatives; and 4) encourage and support the BMHI centres of excellence in Egypt and Jordan. BIOMed will synergistically apply up-to-date European and International methodologies & standards. The pre-defined challenges were integrating multiple segregated BMHI initiatives and policies; overcoming obstructions- socio, political, economic; recommendation adaptation, assessing the current and proposed solutions; defining the national health systems real demands; identifying different European best practices. Political instability in the Middle East after the Arab Spring in 2011 added further challenges as well as improved the importance of the EU-MENA (EU and Middle East and North Africa) cooperation.

Keywords. Biomedical and Health Informatics Education, Accreditation, Research and Development

Introduction

In 2004, the European eHealth Area action plan (COM 2004/ 356) focused on improving the healthcare services; defining best practices; and exchanging the knowledge between different health practitioners. eHealth's central role in the European Union's eEurope strategy is to improve the efficiency of the health system, the quality of the delivered services and accessibility of the medical data. These European Commission priorities are not only restricted to European citizens, but extended also to cover other neighbourhood regions- MPC. IMIA Strategic Plan (2007) plans to enhance the collaboration and to network biomedical informatics initiatives to maximize its impact world-wide. [1-4] BIOMed intends to integrate different European expertise in BMI in a single Comprehensive Framework that appropriately improves the eHealth implementation in the developing regions- Egypt and Jordan- reflecting on the quality of the delivered healthcare services. Therefore, the objective is to enhance the scientific collaboration between North-South Euro-Mediterranean countries in field of Biomedical and Health Informatics (BMHI).

The expected impact of the project is the promotion MEDA BMHI landscape via fostering the research & education activities, projects, centres of excellence, and national initiatives. [5-10]

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1. Methods

BIOMed development was structured into 8-Workpackages. Each Workpackage has its specific objective(s) which were to the completion of the main objectives of the BIOMed project.

WP1: Development of Methodology: to ensure the fluency and smooth progress of all WPs through the development of BIOMed Methodology, that illustrated A) the state-of-the-art of BMHI at involved MEDA countries; B) the communication plan with stakeholders, policymakers in the regions;

WP2: Toward Biomedical Informatics National/ Regional Strategic Plan: to enrich national/ regional BMHI national policies and strategies in MEDA countries. WP2 is a strategic one.

WP3: Feasibility Studies on the efficiency of the present BMI in MEDA region: to evaluate the current implemented BMHI solutions and the demands on the national and regional level.

WP4: Establishment of National Medical Informatics Associations: for the fostering of BMHI structural foundation in Egypt and Jordan.

WP5: Foster the joint RTD cooperation between EU-MEDA Countries: to initiate new RTD joint collaborative projects between partners and others.

WP6: Professional Training and Capacity Building: for improving capabilities of researchers, in both EU and MEDA countries, and their participation in the scientific communities on national, regional and international level.

WP7: Dissemination Activities (factsheet, promotional materials, website, papers, etc.)

WP8: Management and Coordination: of different project activities: RTD, promoting, dissemination related activities.

2. Results

BIOMed was carried out through around 35 very successful and productive secondments. Seconded staffs presented BIOMed in 7 international and regional conferences (i.e. International Conference on Informatics, Management, and Technology in Healthcare in Athens), gave more than 7-10 workshops and infodays in both European and Middle East countries, strategic meetings with policymakers and key stakeholders (i.e. Arab Medical Union in Cairo), publish 5 peer reviewed papers in international journals and periodic. In 2015, the consortium has been awarded the ‘best paper award’ during the ICIMTH-2015 for its new study on ‘IMIA Dynamic Accreditation Procedure: suggestions, simplicity and efficiency’ aiming to assist Arab states BMHI educational programmes to be accredited.

Among the key Deliverables in the Workpackages were: WP1: BIOMed Applied Methodology; WP2: Initial Report on BMI Vision at MEDA Region, SWOT analysis on BMHI in MENA countries and recommendations for fostering the BMHI landscape in MENA countries. WP3: feasibility study on Jordanian BMHI framework; WP4: recommendations on establishing BMHI national and regional foundations in MEN countries and database of the potential members and partner organizations; WP5: list of new cooperative joint projects between BIOMed partners; WP6: capacity building actions; WP7: dissemination actions (website, flyers, posters, and announcements in various forums); and WP8 for management and coordination.

2.1 Preliminary results of SWOT Analysis of BMHI in Egypt and Jordan.

Strengths of BMHI in Egypt: There are 91.32 million mobile subscribers in January 2012. There are 29.53 million internet users while internet penetration rate was 36.31% in January 2012. The Egyptian government has initiated several eHealth programs to afford better diagnostic and health services to a wider segment of the Egyptian society. A high percentage of young population (2011 over half of the country total population was under 24 years). The capability of this group of young people facilitates the adoption of the new technologies.

Weakness of BMHI in Egypt: Insufficient infrastructure with an adequate bandwidth for telemedicine. There is unavailability of Internet connectivity outside large cities. High cost of BMI solutions exist including equipments, transportation, maintenance and training. Resistance to change and slow clinical acceptance of telemedicine.

Opportunities of BMHI in Egypt: Meeting the needs to deliver a better healthcare service in the underserved areas. Reducing the expenses of travel costs (for both patients and specialists), time and effort. Creating telemedicine networks to facilitate communications between rural areas and healthcare professionals worldwide.

Threats facing BMHI in Egypt: Most of telemedicine projects face common problems and challenges that affect their sustainability in terms of the technical, financial, and human resources aspects. The unstable political and economic situation of the Egyptian State. High cost of telemedicine systems and solutions, especially for the poor rural areas

2.2 Preliminary results of SWOT Analysis of BMHI in Jordan.

Strengths of BMHI in Jordan: Aggressiveness to improve ICT. Jordan is notably one of the better-performing countries of the region in terms of life expectancy at birth (72 years old), adult literacy (91%), access to basic services and education (enrolment has reached, respectively, 91%, 80%, and 31% at primary, secondary and tertiary levels). High mobile penetration

Weakness of BMHI in Jordan: Weakness in the adoption of evidence based policies and decisions. There is: lack of allocations for studies and research and publishing of R&D in scientific journals; Absence of a national strategy for health information and research; Weakness in the computerization of the health system; Weakness in the electronic Modern Health Systems Applications (eHealth); Weakness in access to data and information of the private sector.

Opportunities of BMHI in Jordan: Increasing demand for workers. High educational sector involvement, especially student, teacher and Researchers of Biomedical systems and Medical Informatics Engineering.

Threats facing BMHI in Jordan: Continued dependency on external and private funding. In the area of Biomedical systems and Medical Informatics Engineering there are not PhD programs. The absence of a national reference entity for research and health studies and unclear guidelines for the investigations

3. Discussion

The BIOMed project, despite the difficulties due to the political situation in the partner's countries, managed to achieve the initial stages of an exemplary cooperation of the Mediterranean countries in the field of Biomedical and Health Informatics. The number of secondments, even if they were limited in numbers and length of stay, provided the groundwork for longstanding cooperation between Europe, Middle East and North Africa. A conclusion well accepted by the European Commission's forthcoming programs.

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