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Intelligent Patient Education: Saving Time and Increasing Nurses Efficiency

Rafat Rezapour-Nasrabad[1]

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Editorial

Abstract

Background: Patient education completes value chain process in presenting therapy and care services to patients. Thus, it is necessary to use the latest technologies in patients' education. The present study aims to design an educational software to provide the verified scientific, educational and care data of the patients.

Methods: The software is performed in three stages: 1- Formation of databases including the nursing care based on the latest educational and care standards 2- Design an intelligent software to present care education based on nursing process 3- For pilot study, the relevant software is installed on some systems and it is used in at least three hospitals.

Results: The mentioned software presents valuable data in accordance to the needs of patients. Some of the advantages of this software include: Customization of education as their reading is easier; Simplicity of use with software can increase the availability of data for the patients; This software helps the nurses to guide the patients to receive the trainings in each stage of care process.

Conclusion: Implementation of intelligent education system of patient reduces the frequency of visit to health centers and unnecessary admissions and this effectiveness cost of this system can save time and energy of disabled patients and increase the efficiency of nurses.

Keywords: Patient education, Electronic, Nursing, Intelligent

Citation: Rezapour-Nasrabad R. **Intelligent Patient Education: Saving Time and Increasing Nurses Efficiency.** Int J Body Mind Culture 2017; 4(Suppl 1): S1-S3.

Introduction

Today, one of the practical applications of technology is consistency of specialized knowledge with information technology in health sector. Since 1960, the computer experts have determined that computes with high speed to perform the complex commands can help the physicians in diagnosis and treatment of diseases (schoof, 2014).

Now, some software including MYCIN, ABEL, CASNET have presented consultation in infectious diseases, eye diseases, etc. and it is useful in clinical decision making for diagnosis and treatment of diseases. Patient care is not an exception and with the development of technology and information systems, care services are presented effectively to the patients and their family. Despite the significance of this issue, there is no software to present consultation to nurses

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or patients in our country. Thus, the design of such system is useful for the patient and users and can help the nurses for decision making in care services (Adrian, 2015).

The patient education completes the process of value chain in presenting therapy and care services to patients. Thus, it is necessary to take benefit of the latest technologies to present the services.

Today, based on the shortage of skillful nursing force and increasing requirements of society to specialized services of nurses and high quality services, we need to design an information system based on the required skills to present consultation and educational services independently (Robert, 2011). Despite this fact that in our country, the performance of nurses on education and care decision making is based on traditional methods, accepting the formation of nursing information system in future to use nursing knowledge as systematic to transfer a part of decision making to decision making technologies to respond the increasing demands of patients can lead to some changes in this regard. In 2004, in three educational hospitals in Greece (Athens), software was designed based on the standard information systems in diagnosis, planning and implementation of nursing actions and the results were analyzed (Robert, 2010). This study was carried out on 120 admitted patients and nurses of hospital. After the software installation and its use by the participants (1.5 hour), they were asked to complete a questionnaire regarding the access to the required information, their update nature and system speed. The results showed that according to the majority of users, this software was easy to use and their required data were provided (Krames, 2009). The present study aimed to design educational software to provide and verified scientific, educational and care data of patients.

Methods

The main purpose of this study is the design of web-based educational software in some special diseases to provide the verified scientific, educational and care data in according to the demands of the patients.

The special purposes of the study include the followings:

- Using standard diagnosis of nursing with the collaboration of experts and NANDA and NIC systems and their formation based on nursing process
- The increase of self-care of patients
- Reduction of work load of nurses
- The increase of quality of education and reduction of error

In this study, the software design is performed in three stages:

1- Formation of database including the medical diagnosis and nursing care (first phase: Diabetics, heart and blood pressure) based on the latest care and educational standards and survey of professional experts and cares coding.

2- The intelligent software design to present care education based on nursing process (assessment, problem diagnosis, planning, care and evaluation)

3- For pilot study, the relevant software is installed on some systems and it is used in at least three hospitals. The method is user-based.

The participants of the study are 30 nurses and patients.

The nurses and patients are invited to work with the software. After giving the required education, the participants are asked to give explanations to the administrators regarding the method to work with the system and the probable problems. Each user responds the questions on content and application of software. A questionnaire was provided by the researchers including the questions of the presented information, language, relevant images, educational quality and its process by the patient and nurse, the method of presenting the system guidance and the effect of the presented information and the motivation of the users for re-use of the system and demographic data of the participants.

All participants are asked to complete the questionnaire in the first time after working

with the system. Some of the required data in the questionnaire include as follows:

User's demographic data: Effectiveness of the system performance as the data entry time, data loading time, information management and easy to use with control panel of the quality of presented data by the system.

The language of existing data in the system and easy perception

Some of the ethical issues considered by the researcher include:

- All participants participated in the study based on their personal satisfaction.

- Explanation was given regarding different aspects of study.

All participants can leave the study environment at any time.

Results

The patients' education is one of the concerns of nurses. The mentioned software presents valuable data in accordance to the demands of patients. Some of the advantages of this software include:

- Customization of education as their reading is easier.

- Simplicity of use with software can increase the availability of data for the patients.

- This internet-based software helps the nurses to guide the patients to receive the trainings in each stage of care process.

For easy use of this software, the nurse or patient dedicates less time for learning the methods.

Discussion

The implementation of intelligent system of the patient education reduces the frequency of visit of patients to health centers and unnecessary admissions and effectiveness costs of this system can save time and energy of disabled and the efficiency of nurses is increased (Kish- Doto, 2014). This study attempts to introduce an intelligent system of patient education for further studies.

Conflict of Interests

Authors have no conflict of interests.

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Automation of Knowledge Work in Medicine and Health care: Future and Challenges

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Mini Review Article

Abstract

Increment of computing speed, machine learning and human interface, have extended capabilities of artificial intelligence applications to an important stage. It is predicted that use of artificial intelligence (AI) to automate knowledge-based occupations (occupations such as medicine, engineering and law) may have an global enormous economic impact in the near future. Applications based on artificial intelligence are able to improve health and quality of life for millions in the coming years. Although clinical applications of computer science are slow moving to real-world labs, but there are promising signs that the pace of innovation will improve. In the near future AI based applications by automating knowledge-based work in the field of diagnosis and treatment, nursing and health care, robotic surgery and development of new drugs, will have a transformative effect on the health sector. Therefore many artificial intelligence systems should work closely with health providers and patients to gain their trust. The progress of how smart machines naturally will interact with healthcare professionals, patients and patients' families is very important, yet challenging. In this article, we review the future of automation of knowledge enabled by AI work in medicine and healthcare in seven categories including big medical data mining, **c**omputer Aided Diagnosis, online consultations, **e**vidence based medicine**,** health assistance, precision medicine and drug creation. Also challenges of this issue including cultural, organizational, legal and social barriers are described.

Keywords: Automation of Knowledge work, Artificial intelligence, Medicine, Healthcare, Future

Citation: Majidfar F. **Automation of Knowledge Work in Medicine and Health care: Future and Challenges.** Int J Body Mind Culture 2017; 4(Suppl 1): S4-S10.

Introduction

In recent years advances in increasing the speed of computing, machine learning and human interface , have extended capabilities of artificial intelligence applications to an important stage. It is predicted that use of artificial intelligence to automate knowledge-based occupations (occupations such as medicine, engineering and law) may have annual economic impact of $ 5.2 to 6.7 trillion dollars in 2025 (Manyika et al., 2013).

Now computers can act according to unstructured instructions and respond to simple questions and even have accurate judgments. They can identify patterns and relationships in big data. Also they can

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interpret the human speech and wishes and even understand vague commands by advanced interface.

Applications based on artificial intelligence are able to improve health and quality of life for millions in the coming years. Although clinical applications of computer science are slow moving to real-world labs, but there are promising signs that the pace of innovation will improve. In the near future AI based applications by automating knowledge-based work in the field of diagnosis and treatment, nursing and health care, robotic surgery and development of new drugs, will have a transformative effect on the health sector. Therefore many artificial intelligence systems should work closely with health providers and patients to gain their trust. The progress of how smart machines naturally will interact with healthcare professionals, patients and patients' families is very important, yet challenging.

Automation of knowledge work

Advances in hardware and software have opened up possibilities to automate routine cognitive tasks' 'for the process of knowledge. The intelligent softwares that can process large data sets using unstructured commands and subtle judgments and have the ability to learn 'on the run' are an important step toward the automation of the work of knowledge. Automation of routine work knowledge also offers a premise of any access to smart tools and experts to non-experts. Biomedical industry and health care are more important domains where rapid advances in the automation of work second generation of knowledge can have a significant impact. At the same time, as there are very few routine tasks in the biomedical industry or health-care professional in comparison with others, will also be a difficult feat to achieve (Naik & Bhide, 2014).

AI and automation of knowledge work

Artificial Intelligence (AI) is defined as computational procedures for the automated processing of perception, learning, reasoning and decision-making (AAAI, 2009, p. 1). Artificial intelligence is taken as a system that mimics the solution of complicated problems by humans during the course of life (Kornienko et al., 2015).AI is a general term that involves the use of a computer for intelligent behavior model with minimal human intervention (Peek et al., 2015). Artificial Intelligence should be distinguished from other concepts of intelligence such as business intelligence or technology intelligence (Majidfar et al., 2013; Tagva et al., 2014).

Algorithms of Artificial Intelligence (AI) of knowledge have benefited in fields such as law and financial services for the automation of knowledge work. These algorithms are able to analyze multiple financial news, announcements and press releases, make decisions regarding its commercial importance and then act on it faster than any other human operator (Manyika et al., 2013). In the same way Machine-learning techniques such as networks of deep learning are key implementers of the automation of the work of knowledge. We spend large amounts of time in search of the literature in the life sciences domain. To reduce the time required to extract the necessary information from the articles, several methods are developing for the automated extraction of knowledge; based on syntax trees and natural language processing. An example is SENNA 'emantica removal uses a neural network architecture" using semantic relationships using a verb-candidates (Barnickel et al., 2009). In the same way, to analyze and manage unstructured data through the use of statistical methods such as latent semantic indexing (LSI), Bayesian modeling and neural network approaches are also being developed to increase the automation of work of knowledge (Chen et al., 2013). The coming years are likely to see progress on the issues of machine learning, artificial neural networks and smart programs created to mimic the ability to resolve human problem (Barrat, 2013;

Napolitano and Jiang, 2012; Chen et al., 2013; Naik & Bhide, 2014).

AIs can be programmed to achieve some of the goals given. Current AIs have narrow scope, while a hypothetical *superintelligence* would be more effective than human beings in the achievement of almost any goal(Pueyo, 2017). AI experts surveyed in 2012/13 are assigned a probability of 0.1 to cross the threshold of the human level intelligence by 2022, 0.5 by 2040 and 0.9 by 2075 (Muller et al., 2016). The European Commission has recently launched the € 1 billion Human Brain Project with the intention to simulate a complete human brain as soon as 2023, but their chances of success have been questioned (Nature Publishers, 2015), and *superintelligence* is believed to be more easily attainable by the engineering of its first principles than by simulation of the brain (Bostrom, 2014).

To address the issue of AI, the distinction between strong and weak notion of AI is essential (Pueyo, 2017). Strong AI involves a system with human intelligence or superhuman in all facets and today is pure fiction. Currently, only the weak notion of AI is of interest for commercial applications. This concept describes AI in terms of specific tasks that require individual human capabilities, for example, visual perception, context of comprehension, probabilistic reasoning and complexity (Russell and Norvig, 2010). In these domains, machines far outweigh the human capabilities. However, smart technologies are not capable of running smart tasks as ethical judgments, symbolic reasoning, management of social situations or ideation (Brynjolfsson and McAfee, 2014).

AI impact on medicine and healthcare

Biomedical industry and health care are the most important domains where rapid advances in the automation of knowledge work can have a significant impact (Naik & Bhide, 2014).The term is applicable to a wide range of medicine such as robotics, medical diagnosis, medical statistics, human biology, up to and including "omics" of today. AI in medicine, which is the focus of this review, has two main branches: physical and virtual. The virtual branch includes approaches to learning deep computing information management for the control of health management systems, including electronic health records and address of doctors in their treatment decisions. The branch of physics is best represented by the robots used to help the elderly patient or surgeon treating physician. Also incorporated in this branch are nanorobots directed, an exclusive system of delivery of new drugs. The social and ethical complexities of these applications require more thought, proof of its medical usefulness, economic value and the development of interdisciplinary strategies for their wider application (Peek et al., 2015).

The future directions of AI and automation of knowledge work in medicine

Automation of knowledge work in healthcare and medicine enabled by weak notion of AI in the near future will have following seven main directions:

Big medical data mining

Big Data is driving a revolution in information technology and communication. Big data methods are applied in various areas such as meteorology, experimental physics, finance, telecommunications, military surveillance and informatics management. Also the life and biomedical sciences are massively contributing to the Revolution of Big Data, due to the absorption of registry systems (EHR) electronic health in clinical practice, due to the advances in the technology of genome sequencing and the projection of digital image, and because patients are now co-produce health-related data via mobile devices and laptops. Personalized Medicine, which requires the integration of "omic" data with clinical data, require in-depth research efforts and interdisciplinary in different areas such as

data structures and indexing structures for the biomedical domain, distributed and parallel (bio-), new data models and query languages for biomedical databases huge and heterogeneous. In addition, other application areas such as the commercial domain have developed methods of storage of information and analysis that seem mature enough to move the biomedical domain, where some requirements are even more challenging. Among them we mention here temporary multidimensional OLAP Analysis, design of temporary data storage, data mining and visual mining, integrated mining and analytical environments (Peek et al., 2015). Recently, Google DeepMind has announced its second collaboration with the NHS, working with Moorfields Eye Hospital in east London to build a machine learning system which will eventually be able to recognize sight-threatening conditions from just a digital scan of the eye (The Guardian, 2016). DeepMind is used to extract the data from the medical records for the purpose of providing health services faster and better (Mesko, 2016).

Computer Aided Diagnosis

Computer-aided diagnosis (CAD) has become a part of the routine clinical work for detection of breast cancer on mammograms at many screening sites and hospitals in the United States(Birdwell et al, 2005; Cupples et al, 2005; Dean et al, 2006; Gilbert et al, 2008; Morton et al 2006).

The computer output for CAD is used as a "second opinion" in assisting radiologists' image interpretations. The computer algorithm generally consists of several steps, which may include image processing, image feature analysis, and data classification by use of tools, such as artificial neural networks (ANN); these may be referred to as artificial intelligence Most publications on CAD have been concerned with 3 organs—the chest, breast, and colon—but other organs, such as brain, liver, and skeletal and vascular systems, also have been subjected to CAD research. The detection of cancer in the breast, lung and colon is commonly achieved through screening examinations. (Shiraishi, et al., 2011).it is expected that, in the future, many CAD schemes for detection and/or differential diagnosis will be developed for clinical use in various fields.IBM "Sieve" is a "Wizard" with analytical, reasoning and a wide range of clinical knowledge. Sieve is trained to assist in clinical decision-making in radiology and cardiology. The "cognitive health assistant" is able to analyze radiological images to observe and detect problems more quickly and more reliably. On the other hand, deep learning can easily handle a wide spectrum of diseases throughout the body and all the modalities of image (x-rays, CT, etc..) Enlitic, which also aims to pair deep learning with large amounts of medical data storage for the diagnosis of advance and improve patient outcomes, formula the advantages of deep learning **(**Mesko, 2016**).**

Online consultations

A recent study suggests that routine for certain diseases, at least, "see" a doctor online could be as effective as to see a doctor in person. In the study, patients with sinus problems and bladder infections were able to obtain a diagnosis simply by updating their profiles with a description of their symptoms and conditions. The only notable difference was a higher probability of antibiotics prescribed (Mehrotra et al., 2013).

Other examined the effectiveness of the "clinical virtuwell online" (Courneya, et al., 2013). The virtuwell online clinic diagnoses and treats the common conditions such as flu, deer tick bites and yeast infections. The review of the 40,000 cases found that the clinic online reduces costs by $88 per visit compared with the traditional visit in addition saving patients' time and inconvenience. 98 percent of the patients gave the virtual visit a grade of "would recommend". The British subscription, online medical consultation and health service,

"Babylon" launched an application in 2016 that offers medical consultation AI based on the personal health history and medical knowledge. Users report the symptoms of their illness to the application, which is checked against a database of disease through voice recognition. Taking into account the patient's history and circumstances, Babylon offers an appropriate course of action. The application will remember also to patients take their medication and follow-up to know how it feels (Mesko, 2016).

Evidence based medicine

Clinical practice guidelines have been widely accepted as tools for the dissemination of evidence of clinical studies and to support clinical decision making. This is likely to change in the near future. But guideline development, dissemination and application of are still on paper, manual and processes very laborious. At the same time new evidence is piling up faster and faster and in increasingly large volumes. With the widespread adoption of EHR systems in clinical practice, there is a great opportunity to optimize the production of evidence in support of the clinical decision-making (Peek et al., 2015). IBM Watson launched its Special program for oncologists, which is able to provide the clinical treatment options based on evidence. Watson of Oncology has an advanced ability to analyze the meaning and context of structured and unstructured data in clinical notes and reports which may be critical to select a treatment. Through the combination of file attributes of the patient with clinical expertise, external research and data, the program identifies possible plans of treatment for a patient (Mesko, 2016).

Health assistance

Molly first nurse virtual world developed by the Sense.ly medical start-up. It has a friendly, smiling face, coupled with a pleasant voice and its sole purpose is to help people with monitoring of your condition and treatment. The interface uses machine learning support to patients with visits to the doctor between chronic conditions. Offers personalized follow-up, tested and follow-up care, with a strong focus on chronic diseases. In addition, there is already a solution to monitor if patients take their medications of truth. The application of AiCure supported by the National Institutes of Health using a smartphone, webcam and AI independently confirm that patients receive their prescriptions, or with better conditions, helping to make sure that they know how to manage their condition (Mesko, 2016).

Precision medicine

Artificial intelligence will have a great impact on the genetics and genomics as well. Deep genomics aims to identify patterns in large data sets of genetic information and medical records, in search of mutations and the links to the disease. Inventing a new generation of computational technologies that can tell the doctors that will happen within a cell when the DNA is altered by genetic variations, whether natural or therapeutic. At the same time, Craig Venter, one of the fathers of the Human Genome Project is working on an algorithm that could design the physical characteristics of the patient based on their DNA. With his last company, human longevity, he offers to his patients (especially rich) complete the sequencing of the human genome coupled with the exploration of the entire body and very detailed medical check-up. The whole process allows point cancer or vascular disease in its early stages (Mesko, 2016).

Drug creation

Development of pharmaceutical products through clinical trials take sometimes for more than a decade and costs thousands of dollars. This accelerate and make more profitable would have an enormous effect on the health of today and of how the innovations reach the medicine every day. Atomwise uses supercomputers that eradicate the therapies of a database of

molecular structures. Last year, Atomwise launched a virtual search of existing drugs, insurance which could be redesigned to treat the Ebola virus. They found two drugs predicted by AI technology of the company that can significantly reduce the infectivity of the Ebola virus. This analysis, which normally would have taken months or years, was completed in less than a day. Another good example for the use of big data for the management of patients is the health of Berg, a biopharmaceutical company headquartered in Boston, which mines the data to find out why some people survive diseases and thus improve the current treatment or create new therapies. Combine the AI with biological data of patients to define the differences between healthy and respectful environments with the disease and helps in the discovery and development of drugs, diagnostics, and healthcare applications(Mesko, 2016).

Future Challenges

Some important questions come to mind with automation of knowledge work (Naik & Bhide, 2014):

Is computational intelligence greater than human intelligence?

Can we be sure that the computational intelligence will produce knowledge free from error?

It is wise for us to rely on computational intelligence and if so, is there a limit to our dependence?

Can we take on decision-making machines for human beings depend on meta cognitive processes, knowledge and sense of intuition?

And the most important thing will be harmless?

What do we need to use all of the capabilities of computational intelligence, simply because we can?

The following suggestions could avoid the future challenges of the application of AI in medicine (Mesko, 2016):

1. Creation of ethical standards that are applicable to and binding for any health care professional 2. Gradual development of the AI in order to allow time for the allocation of possible drawbacks 3. Acquisition of basic knowledge by medical professionals: about how AI works in a medical environment in order to understand how such solutions could help in their daily work

4. Getting accustomed to the artificial intelligence by patients: and discovering its benefits for themselves

5. Making more communication toward the general public on the potential benefits and risks of the use of IA in the medicine by AI developers.

6. Performing all the steps needed in order to be able to measure the success and effectiveness of the AI system in health institutions.

Conflict of Interests

Authors have no conflict of interests.

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Mechanism of microRNAs Regulation and Function them in Recognition and Treatment of Cancer

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Mini Review Article

Abstract

Background: Despite of all the efforts and studies conducted on diagnosis and treatment of cancer, this disease still has many of losses annually. Cancer is a multifactorial disease that is incidence of genetic and environmental factors are involved. MicroRNA of (micro ribonucleic acid) group of non-coding RNA that have been preserved during evolution. miRNA also like that mRNA By the enzyme RNA polymerase II transcription and after the capping mechanism and Polyadenylation (Pre-miRNA) obtained that by two cutting successive reactions, mature miRNA produced and through the connection to 3'UTR, mRNA target gene affects on it.
Methods: For investigate from the articles in the database such as pubmed, Google Scholar, …. Were taken to this study we used.
Results: MicroRNA can be alter gene expression after transcription that is action in most cases performed through two way decomposition and or inhibit the translation of target gene mRNA. MIR in various cancers could have role oncogenes and tumor suppressor genes (Tumor suppressor) and also in cell cycle, cell death, apoptosis, differentiation and cell proliferation and drug resistance have an important role and can stop the progression of cancer and Hence as biomarkers for the diagnosis and treatment of cancer are available.
Conclusion: MIR expression in various cancers decreases or increases, which in most cases increase the expression of a MIR cause to reduce expression of a gene targeting and vice versa. Hence further studies about this great group of micro RNA are important and can be investigated.
Keywords: microRNA, Cancer, Oncogene, Gene expression

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Introduction

Since the discovery of the first micro-RNA molecules to date about 20 years have passed and research in this field has grown considerably. microribonucleic acids (micro RNA),are Noncoding ribonucleic acids that are evolutionarily conserved (24). miRNA (micro RNA), As regulators of gene expression was identified in 1993, Which was initially in nematode worm was discovered

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and discussed and named Lin-4. The second micro-RNA in the same worm were named let-7(1). Then By identification widespread presence of micro-RNA in among other eukaryotes organisms, increased interest studying the regulatory mechanisms. Micro RNA has a length of 25-18 nucleotides which gene expression post-transcriptional through mRNA degradation or inhibition of their translation, are controls (15). In recent years, many different types of RNA are detected. A large group of RNA, such as tRNA, rRNA, snRNA, snoRNA, siRNA and miRNA, including functional molecules that are in the group of Noncoding RNA (ncRNAs) are placed (26). Many pathways have been identified to regulate gene expression which mediated by small ncRNA are done, such as the gene silencing pathways, methylation of DNA, gene transcription and the interference RNA (RNAi) (18). miRNA due to their the small structure and especial have high stability in various environmental conditions and also against freezing and melting frequently, more resistant than other types of RNA and unlike proteins, Unlike proteins, PH acid and alkaline and different dilutions salt are well tolerated. For this reason can they presented as an ideal biomarker. Micro RNA have a key role in many biological processes, including development, cell proliferation, cell differentiation, Apoptosis, survival and migration and in addition to DNA methylation and histone acetylation as epigenetic mechanisms have been introduced and are playing an important role in regulating gene expression (24). The role of micro-RNA gene regulation now well known and function of Micro-RNA for the development of various physiological systems and maintaining cell stability and normal functioning are it necessary. Today, the issue of study micro-RNA and identify expression and performance in wide range of human diseases including various types of cancer, infections, chronic inflammatory and autoimmune diseases is considered. Micro RNA can be as oncogenes or tumor suppressor acts through inhibition of the expression of targeted genes related to cancer (14).

miRNA in control fundamental processes cellular physiological and pathological are involved (12). MiRNA expression of suppressor tumor in various cancers is reduced, resulting in increasing the growth, proliferation and metastasis, thus restoring the expression of miRNA suppressor tumor in cancer cells could be a proper treatment option for cancer treatment have been conducted many studies in this field (13). So far more than 2500 human microRNA have been known (14). Micro-RNA with targeting mRNA target genes, causing gene silencing (6). By increasing evidence of function regulation the microRNA in of multiple biological systems, the value of these molecules as diagnostic and treatment biomarkers in different diseases such as cancer , continues to rise (16). Most of application miRNA is in the field of diagnostic biomarkers and therapeutic targets (14). The aim of this paper is to review role and mechanism of action of micro-RNA in cancer diagnosis in order to detect and early treatment of cancer patients and prevent therapeutic procedures is difficult.

Micro-RNA biogenesis: MicroRNA biogenesis takes place in the nucleus and cytoplasm. First, RNA polymerase II in core from on the protein coding genes transcribed the pri-miRNA. Pri-miRNAs hairpin structure (stem-loop) that to have the tail at end of pOly A 3' and 5'cap at the end of their CAP, pri-miRNA by a complex containing the enzyme RNAse III for cutting double-stranded RNA called Drosha and binding protein to double stranded RNA DGCR8, converted into pre-miRNA and pre-miRNA by using Exportin5 transported to the cytoplasm. Final processing in the cytoplasm by complex Dicer / TRBP on pre-miRNA is done. Dicer action led to the creation of double stranded RNA with a length 18-24 nucleotides that which is includes a strand leader (guide strand) and a strand follower (passenger strand). The strand follower is

destruct, the strand leader whit binding to argonaute protein provides silencing inducing complex miRNA (miRISC), This complex is complementary of head 3 'UTR from target mRNA, if the sequence miRNA with target mRNA is fully complementary, And connection is complete, causing destruction of the target mRNA, and if connection between miRNA and mRNA is incomplete causing translation is inhibited, so that each miRNA can targeting multiple mRNA (22,27). Figure 1 shows the miRNA biogenesis stages.

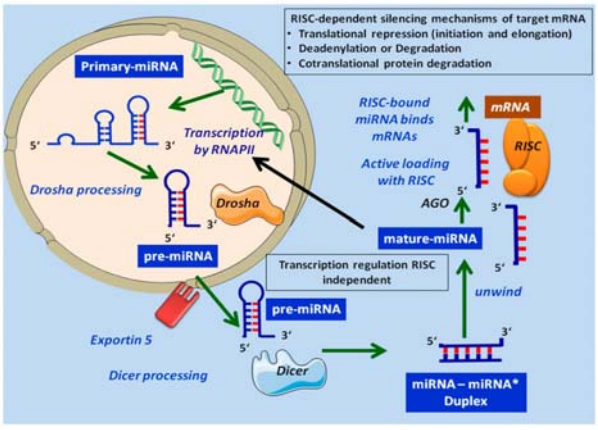

Figure 1. miRNA biogenesis stages in the core and cytoplasm

Identification of micro-RNA target molecules: One of the most important issues related to micro RNA is identify target molecules. Creating a few complementary base pairs for performance interaction between micro RNA and sequence of target molecule is essential. In most cases, Creating a complementary base pairs in 6-7 nucleotides takes place which that usually consists nucleotides 2 to 9 from end of '5 micro RNA and to this region say "seed". The rest of the micro-RNA base, are shown limited pairing capacity to the 3 'UTR sequences adjacent sites seed and the same transient connections to micro-RNA gives allow connection to multiple inner sites at a 3 'UTR. mRNA that preferentially are paired by 7-8 nucleotide from seed sequences, Based on criteria such as developmental protected target sequence and thermodynamic stability interactions taken between the rest of the Bases micro RNA and sequences on both sides in the 3 'UTR are divided. In another type of pairing target Micro mRNA: RNA take place incompelete pairing in the region of '5-seed, but by pairing an additional base in the end of '3 Micro-RNA will be compensated (29). From the different calculation methods to predict the target sites Micro-RNA is used, including computer algorithms, but since pairing with the target sequence is incomplete and limited, it is still difficult to accurately predict the sites the target micro RNA. Numerous studies and bioinformatics software to detect micro-RNA targets from the sequence seed are used. For example, 1000 micro-RNA genes for 1 percent human genome is estimated and It is likely that more than one-third of the human genome by micro-RNA to be set (2,9,10,16,17,19,15). One of the algorithms predicting target molecule, based on the pairing and protected micro-seed -RNA sequence in the 3 'UTR of different species will be designed (31).

miRNA and cancer: All cancers origin from the uncontrolled growth of cells and cell output from set correctly pathways, proliferation and differentiation. Escape from cell death, or apoptosis, mutations in beam oncogenes and creating oncogenes and mutations in tumor suppressor genes, all from the causes of cancer.

Micro-RNA interactions with target genes, determined their role in development, apoptosis, differentiation and cell proliferation and confirms the direct performance of Micro-RNA in cancer (28). After the emergence of micro-RNA in mammals and studies about the role of these molecules in cancer were conducted, proved two important issues, first, miRNA in cancer, have different expression and the second miRNA expression changes in tumor type, create a specific symptoms in each person. As mentioned above, according to the type of miRNA expression changes in cancer cells, into two groups oncogenic and tumor inhibitor or tumor suppressor was divided. MiRNA expression of oncogenes increase in tumor cells and in contrast, tumor suppressor miRNA expression is reduced in cancer cells (12). Because incorrect adjustment of miRNA

in tumor tissues can result in mutations, epigenetic changes, eliminated genomic, or changes in processing miRNA. Finally incorrect expression and or suppression of a miRNA miRNA can cause tumorigenesis or tumor progression. The use of micro-RNA to classify tumor more appropriate than mRNA, This issue due to incomplete coupling between target miRNA and mRNA. For this reason micrometer micro-RNA can be identify expression of several hundred genes and result in multiple pathways in one instance, if only require small amounts of total RNA (7).

Some types of micro-RNA act as oncogenes or tumor suppressor that called oncomir. The oncomir are present in various cancers and often in regions of the genome that have deletion, duplication, or mutations were found (32). Table 1 shows of altered expression levels of some miRNAs involved in different human cancers.

Table 1. Some micro-RNA involved in different human cancers with altered expression levels

Type of cancer	Reduced expression	Increased expression
Bladder	miR-29c, miR-26a, miR-30c, miR-30e-5p, miR-145, miR-30a-3p, miR-133a/b, miR-195,miR125b, miR-199a	miR-17, miR-23a,b, miR-26b, miR-103-1, miR-185, miR-203, miR-205, miR-221, miR-223
Lung	let-7, miR-34 family, miR-143, miR-145, miR-124a	miR-17-92 cluster, miR-21, miR-155, miR-191, miR-205, miR-210
Thyroid	miR-30d, miR-125b, miR-26a, miR-30a-5p	miR-146b, miR-221, miR-222, miR-181b, miR-155, miR- 197, miR-224, miR-346
Ovary	miR-199a, miR-140, miR-145, miR-125a,b, let7	miR-200a/b/c, miR-141, miR-18a, miR-93, miR-429

Table 1. Some micro-RNA involved in different human cancers with altered expression levels (continue)

Type of cancer	Reduced expression	Increased expression
Breast	miR-205, miR-143, miR-145, miR10b, miR-125a/b, miR-155, miR17-5p, miR-27b, miR-9-3, miR-31, miR-34 family, let-7	miR-21, miR-22, miR-23, miR-29b-2, miR-96, miR-155, miR-191, miR-181, miR-182, miR-27a, miR-210
Esophagus	miR-203, miR-205	miR-194, miR-192, miR-200c, miR-21
prostate	miR-128a, miR-101, miR-125a/b, miR-15a,miR-16-1, miR-143, miR-145, miR-23a/b, miR-200, miR-330, miR-331	let-7d, miR-195, miR-203, miR-21, miR-181, miR-106, miR-363, miR-221
Colorectal	miR-143, miR-145, let-7, miR30 -3p, miR-124a, miR-129, miR133 b, miR328	miR-18, miR-224, miR-10a, miR-17-92 cluster, miR-21, miR-24-1, miR29b-2, miR-31, miR-96, miR-135b, miR-183
Chronic lymphocytic leukemia	miR-15a, miR16-1, miR-29, miR143, miR-45,miR-30d, let-7a, miR-181a/b, miR-223, miR-92, miR-150	miR-21, miR-23b, miR-24-1, miR-146, miR-155, miR-106b, miR-195, miR-221, miR-222

The use of microRNA in cancer treatment:

Expression of microRNA disorder with specific pathological state and response to therapy in a variety of tumors associated have been shown. Recently in cancer treatment from itsself microRNA or AMO (anti-microRNAantisense oligodeoxyribonocleotide) alone or in combination with medications, chemotherapy and radiation are used (8).

In general, through inhibition of oncogenic microRNA and artificial microRNA or cut it by pairing with mRNA, microRNA artificial induction of pairing with mRNA, Induction of Tumor suppressor microRNA and reduction of microRNA expression by epigenetic factors such as promoter methylation, Can be prevent cancer progression. Of Antisense oligonucleotides which paired with microRNA, can be used to reduce microRNA expression, such as Antagomir that of this same type (4). The advantages use of miRNA as therapeutic targets in cancer is that a miRNA can targeting multiple mRNA and on the other hand, an mRNA, can target of several miRNA.

There are two methods for regulating the expression of miRNA in cancer, the first method, the inhibition of oncogenic miRNA expression by using syntetic anti-miRNAs or miRNA antagonists or Locked nucleicacids (LANs), For example the use of antisense oligonucleotides (Antisense) which their sequences supplements the mature miRNA oncogenes within the body (20). The second method about tumor suppressor miRNA are done that in various cancers decreased their expression, in this case treatment by restoring the expression of miRNA in normal mode can be performed, for the purpose of miRNA replacement therapy is used (13).

Treatment methods with micro-RNA: Here are two methods mentioned:

1. Use of microRNA mimic: In this method of microRNA that has the role tsmicroRNA, usually as double-stranded that is Dicer product, transferred into cells. Like the other methods have been used in in vitro and in vivo. In 2010, LPH nanoparticle that with a single-stranded anti-tumor antibodies were combined, could be purposefully Mir-34a transmit to melanoma cells (13).

2. Using of precursor protein the microRNA: In this method, gene related to microRNA in a expression vector imported that can be a viral or plasmid, in designing of vector, issues such as the promoter, gene fragment are considered (30). Of lentiviral and Adenoviral are used for both differentiated cells that are not dividing and also dividing cells. But since Adenoviral, do not enter within the genome, in the dividing cells gradually disappearing (25). The main problem use of expression vectors in vivo that is often the host immune system eliminates them (30). In one experiment, by raising the the expression of K-ras in mice, As conditional created lung cancer, it was found that intranasal administration of adenoviral expressing let-7a reduces tumorigenesis (23).

Methods

In order to investigate about micro RNA and their function In the cancer, focused on studies have been done on the field, and to conclude, and from articles in databases such as springer, pubmed, science direct, Google Scholar were brought , used for present study.

Results

Considering the fact that most common techniques for early cancer screening can not diagnose disease, Identification of tumor micro RNA are released in the bloodstream during the gradual progress of the disease, is a key way in early detection of cancer. Micro-RNA by binding to target mRNA, causing inhibits their translation or decomposition, and increase or decrease the expression of micro-RNA are involved in apoptosis or cancer, Due to the importance of micro RNA to detect and treat cancer, led to studying and tracing techniques have a growing trend in recent years. Specifying the target miRNA molecules and study their molecular interference effects In the signaling pathways, will help to easier and more effective understand of cancer. miRNA in cancer treatment are also considered, and to make effective changes In these molecules can be affected them the target molecules. Although obstacles and difficulties as well, including a miRNA can be Control a large number of expressed targets genes, therefore, any change in the it can cause targeting genes other than the original target genes. There is

very few information on the factors that affect the expression of microRNA, however, many studies confirming the fact microRNAs have an important role in the onset and progression of Cancer. Thus, miRNAs are useful and powerful tool in the diagnosis and prognosis of diseases, including cancer and are also effective in the treatment and control of cancer.

Discussion

In the total miRNA are a category of Noncoding small RNA which that regulated the expression of genes at the level of RNA or transcription, and given the role of miRNA in proliferation and differentiation processes, is expected to disrupt their expression related to cancer.

Conflict of Interests

Authors have no conflict of interests.

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The Role of GIS in Information System, Management and Decision Making in Hospitals and Ambulance Centers

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Mini Review Article

Abstract

The exclusive capabilities of Geographical Information System (GIS) can be distinguished in combining diverse and very different information sources, in real-time storage and retrieval of descriptive and local information, in evaluation and analysis of time trend of incidents in form of statistical and spatial modeling and in positional assessment on the effects of development. Above descriptions show that GIS has grown as the most powerful tool for management, decision makings and optimized and rapid access to the information required for the hospitals and ambulance centers. suitable readiness for effective response and rapid reaction to the conditions of the natural disasters like industrial incident and human made incidents, e.g. urban and road accidents is the objectives and responsibilities of hospitals and medical centers. Moreover more than eighty percent of the required information in ambulance centers are positional information or information that are somehow dependent to location. Hence, application of Geographical Information System technology will be very considerable and beneficial for hospitals in order to displaying the location and region coverage and to lead the teams toward the region, to make appropriate decisions in crises and disasters and for emergency management (especially in information related to HSE of industries). Also in the analysis and assessment of hospitals' information and injured that are referred to hospitals, using GIS technology will be improve applications of Information Technology in hospitals and emergency centers in the following fields: -locating new areas for the construction of hospitals in according to the maps and different layers of data, analyzing reserved equipment and facilities for high risk situations, routing in order to provide the most rapid and timely aid, capitation of population of the region in terms of equipment and hospitals' beds, appointing places in danger of crisis and for emergency aid and finally creating patterns of diseases dominance and health problems in the field of hospitals for Planning and decision making based on evidence and documents.

Keywords: Geographic Information System, Hospital, Emergency, The spatial information

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Introduction

Specifications of Geographic Information System consist of: a coherent and organized collection of hardware, software, professional

forces, and reference location data. These elements are used for gathering, saving, updating, retrieving, integration, displaying and analysis of reference location data. [1] also its application for optimum decision making and proper planning for users, managers and planners has caused national academy of science (NAS) to express in its comprehensive report that "tools and data related to Geographic Information System (GIS) and Geographic Positioning System are a fundamental parts in every stages of management of emergency centers and hospitals that includes planning, collection geographical information to feed back and betterment in reduction of future incident effect." [4]

In fact, by the use of its special tools and techniques GIS starts to evaluate proposed region or location and then prepare the necessary maps from these areas and collecting the descriptive data related to surveying topic, process them and connects local data to descriptive data. Then a topographic database (TDB) with the capability of searching and retrieving information will be created. [1]

In this paper, we try to introducing the role and applications of Geographical Information System in system of information, management and decision making in hospitals and emergency centers. Also we show how using this system will cause saving time and costs of these centers, how it will save the lives of referrers, how it will accelerate the process of successful planning for managers and decision makers and eventually how it can ensure successfulness of programs and projects.

Geographical information Technology is based on Spatial Data Infrastructure (SDI) containing basic information, accurate and updated based on desktop systems, based on Internet and Intranet, based on management Information System (MIS), based on mobile GIS and based on information catalog. All these infrastructures are applied in sections of hospitals, Rescue teams, and in Safety and emergencies centers and they be used as a part Comprehensive system of health management.

GIS and response to the question of managers and decision makers

Reference spatial information: The first question is what kind of information is "the reference spatial information"? Having answered this question it could be specified that what kind of stuff (Information) we have within a single location? A location may describe by different properties, for example name of location, address, postal code or its geographical coordination (latitude and longitude). [1]

In many of events and accidents, position of hospitals or emergency centers and the victims, plays major role in the rescuing and giving response to the victims. [4]

Positioning: One important application of spatial information system is positioning and identifying the Possibility of events with respect to a series of certain parameters. This means that the GIS can specify the places that have the same certain conditions, for example to point out the locations in which the average rainfall is higher than 300 millimeter or the locations in which we have high prevalence of malaria. In analysis and inspection of hazards and risks that hospitals may be exposed to them, one of the most important issues which must be considered is position of hospitals in terms of mode of facing with a crisis and events in the study area. And if we have such crisis or disasters, hospitals and emergency centers must have facilities, equipment and sufficient preparation for the quick response to injuries. [5]

Also one other application of the system we can cite here is, locating new places for the construction of hospitals and health centers with respect to the parameters such as, distribution of existing medical centers, region population, incident potentiality, fee of territory and ...

Modeling and assigning spatial Pattern for incidents: By using data and collected information related to happened events in a particular area, we can outline a spatial pattern for a series of particular events. For example, whether the most road accidents occur in certain areas? And whether a certain disease is prevailing more in areas with specific geographical features? [4]

Aid in crisis Management: This item studies the events that may exist under certain conditions via modeling. In other words, it Predicts events and the consequence. For example, if a toxic substance gets into the surface water resources of an area what would be the volume and speed of contamination? Or in case of incidents and natural disasters such as floods and earthquakes, what would be the rate of spread of pandemic infectious diseases? [3] , [4]

In these cases we can use the Spatial information system and identify the most suitable areas for housing disaster victims and the nearest therapeutic areas and rescue centers for them. For example, to specify area of green open spaces for the settlement of disaster victims, rescuing and emergency air landing.

Non spatial questions: We have questions like "what is the average number of hospitals that we have for a certain number of the region's population?" and "with respect to population of a region and its existing medical center, how many beds should be considered for the construction of hospital in the region?". Although we do not need to know specific information such as: longitude and latitude location and address and distance of points, but these questions can be answered by the GIS as well.

Spatial questions: There are questions such as, "what is the nearest rout to providing rescue for a certain point?" or "whether the distance between the medical centers are in accordance with the existing standards?" In order to answer such questions, it is essential to know their spatial information. [4]

Applications of GIS in Hospitals and emergency centers:

The information resulted by GIS application in hospitals and emergency centers can be divided into two parts:

Information that is used in Information System of hospitals and emergency centers:

Increasing in performance of health and medical services: Research studies in hospitals are carried out to improve performance and to optimize hospital services and to fight against diseases in order to promote the level of health in the society. In this field the GIS can be considerably helpful for the researchers in order to understand the manner of distribution and spread of diseases and their relationship with environmental factors such as climatic conditions, water quality, hygienic status, industrial and agricultural activities and environment pollution factor. In this subject they will search for disease symptoms in the range of hospitals based on different criteria such as: local, descriptive and conditional. Then they predict and prepare required services for dealing with these effects. In this subject also they enter exact address of the patient to the GIS software and in the next stage they will add basic map of the region, after that the distribution map of the specific disease in the region is prepared. We can use this map for finding a general view of areas that are affected by disease or path of the progression of the disease.[3]

Evaluation of the risks of spreading infection: The risk of spreading infection due to health aid (HAI) is one of the concerns of the hospital system. These risks could be derived from natural factors such as age, severity of disease, overall health status of patient and or be resulted from external factors and hospital environment including medical care, medical equipment and even the immediacy of patients with other patients in the same room. Spatial information system can collect descriptive data and spatial data of patients that are infected with infectious diseases in hospital environment and prevent

the risk of spreading infectious diseases in Hospitals which is one of the major factors in giving services to patients.

Evaluation of Beds Occupied Ratio: Appointing Bed Occupied Ratio (BOR) in crisis situations in which we need statistical information about hospital status for providing the services to the injured people of accidents and natural disasters is one of spatial information systems services. For complting information SIS can be effective in health information systems (HIS) of hospitals by following admission status, patients discharge status and the occupied beds in hospital. [4]

Integration of various satellites positioning system: Because life and death of injured people in accident depends on seconds, existence of a spatial information system is a necessity for emergency centers. Regarding this filed spatial information systems is facilitate the following applications:

To assign critical areas and disasters probable areas in order to provide timely and rapid aid In cases of emergency and crisis, using satellite locating system (GPS) in ambulances, evaluation of services of lifeguard centers in terms of limitations and conditions with using data from the reference spatial data, rapid positioning of lifeguard centers and hospitals near disaster probable area, appointing possible points for transmitting rescue and urgency group to search for victims of disastrous events in which we buildings is destroyed.

Finding the best place to build an emergency medical center with respect to the GIS data in locations in which we have highest rate of road accidents is among applications of GIS in the information system of emergency centers.

Information which are used in management and decisions making system of hospitals and emergency centers:

Assist in special disease and incidents: In the early 21st century, the prevalence of different diseases such as H1N1 virus or incidence of natural disasters such as earthquakes and floods in some areas showed that hospitals and lifeguard centers with respect to their existing facilities was not able to meet the demands arising from these events. In order to achieve correct and rational decision making and planning in these Conditions, using some of public centers and buildings or constructing prefabricated hospital as secondary care centers are the best options for accelerating the improvement of capacities of nursing and medical care. In this issue GIS maps gives spatial information regarding locations of the proper buildings and places for this conditions and plays a major role in planning and management of hospitals and medical centers

Assist in the management of trauma centers: In hospitals or trauma centers, planning and management are very important for rapid audit and treatment of trauma patients to reduce mortality caused by accidents and unexpected events. A hospital or comprehensive trauma center, must prepare the possibility of offering services to a large number of trauma patients with provision of rapid and high quality nursing facilities. In fact, a trauma hospital usually includes a network of emergency medical services and ground and air ambulance with possibility of establishing contact with one or more trauma centers. In this field, to determine optimum locations for the establishment of trauma centers so that the maximum numbers of people that are exposed to severe injuries and accidents have been treated in the shortest time, is considered a major challenge for planners and managers of hospital emergency. In this regard, spatial information system with the use of spatial data and overlapping functions (Overlay) in according to the reference spatial data and the people who have uppermost need to the services assists planners and managers in hospitals to determine the most optimal location for construction of these centers. Because of Special training in these centers and special equipment and resources needed for these centers, large expenditures are imposed to the managers and decision

makers of these centers. So the logical and true decision making before the construction of these centers, In addition to reducing mortality from injuries and accidents in their covered region, will cause optimization of costs and more profitability for these centers as well. Also, using web-based software of the Spatial Information System like Arc-IMS and Arc-SDE, we can provide accessibility for users to locate hospitals and trauma centers as well as ambulances and helicopters of these Centers [4]

Crisis Management: One of the complications and problems in emergency centers is management of crisis and accidents and in this respect the GIS maps can play basic role in decision making and timely shipment of rescue ambulances to disaster area. In procedure of crisis management, in urgency centers we would have need to build some prerequisites with the use of spatial information system. These steps include providing maps of roads and lanes and specifying rescue bases on it with the use of GIS software. Moreover, all rescue vehicles like ambulance, fire extinguisher, police, etc must be equipped with required devices to send their positions to the control center online. As soon as coordinates of the location of the incident received by control center, software box linked to the AVL software determine the closest rescuer vehicle. Also GIS contribute to the urban rescuing in metropolises, determining the best way for ambulance to reach the scene by the use of NETWROK ANALYSE process, routing Data, urban traffic data transmission in management of crises and accidents in emergency centers.[2], [3]

Positioning and constructing health centers: Construction of hospitals and for providing health and medical security needs of a region depends on numerous factors and conditions including following:

Population distribution of that region, prevalence disease in that region, number and manner of activities of other hospitals in that region and their geographical distribution, geological assessment and regional survey for the location of construction site, to specify geographical features and phenomena of every specific region close to disaster areas

In this regard, by evaluation of spatial data and drawing required maps for each case, spatial information system helps managers and planners of hospitals in the decision making to determine the optimum location for the construction of hospitals.

Currently one of the most important rings in the medical network of referral system in the country is its association to the hospitals. In recent years some efforts had been carried out In this regard, but many of them have not been successful, because some parts of the country implementation of referral system, is practically faces difficulties. One of these difficulties returns to improper determination of hospital construction location, For example, there are hospitals that are constructed in areas with lack of referral, or specialized hospital has been built in a city that has not a general hospital. These Problems illustrates the importance of spatial information system to be implemented and used in the decisions making of planners and managers of these centers.

3-2-5- displaying information: Regarding application of maps and reference location data generated by Spatial information system in hospitals, this system as a support of decision making system will help hospital managers with directions, planning and fulfilling hospital responsibilities by the following applications:

Analyzing and monitoring of information in displaying positions of hospitals and emergencies centers, displaying different densities for occurrence of diseases in the geographical area, appointing limits of diseases for prevention and management planning on the prevalence of diseases and appointing possibility of their spreading to neighboring areas [3]

Execution suggestion in the field of GIS application in hospitals and emergency centers

1- a proper and unique database, should be prepared by using spatial information system for all hospitals and emergency centers in the country. In this database we should provide and analyze all spatial data and descriptive data required for hospitals and emergency centers with respect to the location of each hospital.

2- By providing dynamic web based maps; we should provide access for managers and users to these maps and help them to find the nearest and most appropriate hospital. And as a consequence, the problems that existing crisis management of accidents and disasters has faced them will be reduced.

3- By using data derived for spatial information system, in all over the country, we recommend locations for construction of new hospitals as the optimal locations.

4- Better utilization and more application of various capabilities of the technique and tools of GIS and network analysis in planning of hospital and emergency centers' managers and acquainting them with the application and the role of GIS in decision making.

5- Using the GIS in the system of emergency medical service (EMS) in order to optimize their services and accelerate and appropriate their response to victims should be considered as an integral part of these centers. Also, using this Information should be considered as a principle in the programs and managers' decisions in hospitals and emergency centers.

Discussion

One of the most important benefits of using GIS In hospitals is collecting and classification of dispersed data in form of digital information which accelerates searching and retrieving endeavor. Also with the unique features of the GIS, we can easily integrate descriptive information of hospitals and emergency centers with spatial and geographical data. Moreover, we can draw all types of querying, reporting, investigating the trend of distribution of diseases and their affecting factors on digital maps.

Important and emphasized point regarding the GIS application in hospitals and emergency centers is that we can organize information and manage planning in critical condition and improve reports and analyzes gathering. Besides, we can follow standardization of unique codes for all features including both descriptive and spatial and we can help planners and managers in decision making and critical planning by timely information.

Conflict of Interests

Authors have no conflict of interests.

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The Necessity of Formation of Health Information Technology: Goals and Strategies for the Future of the Healthcare with the Approach of Maturity Assessment and Risk Analysis

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Abstract

In this paper, the goal of the effort is to determine the future of healthcare and to explain the importance of establishing strategic roadmap in this area. Identification of strategies for future of healthcare includes adaptive and dynamic learning through the industry, governments, and universities. The most important part in generating strategies is to determine the goals with high levels expectations and exclusive path. Healthcare technology goals which are presented in this paper could be inspiring to make a better future. Future developments of medical and health care depend on investing in research, development, and education today. So that health managers achieve goals of the health care system by making appropriate decisions and allocate resources. With appropriate goals and strategies, risk, maturity and reliability level of HIT system could be calculated by using COBIT and best scorecard (BSC) method.

Keywords: Healthcare Information Technology, COBIT, Best scorecard, Maturity approximation, Risk approximation, Reliability, Strategic plan

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Introduction

Health Information Technology (HIT) is a perfect combination of information technology and medical science known. HIT is one of the most important elements to improve the quality of medical care, reduce the cost of the healthcare and improve its incomes. HIT is proposed as a comprehensive tool for effectively, efficiently and securely sharing medical data in time and space.

According to the progress of HIT during the past two and half decades it can be seen

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that although HIT at first glance was meant as a use of computer in healthcare systems and was used to obtain the online records of patient's conditions, but HIT takes much broader and more comprehensive concept with the advancement of technology. With the HIT, community and health care providers will be moved in the direction that health services and medical care will be provided with the individual pattern at home and outside of health centers. Therefore, the treatment will be less expensive and better for patients. HIT greatly improve the health of society by continues monitoring of individuals outside the hospitals and treatment centers. HIT will provide the condition to achieve the slogan of prevention better than cure by recognizing the warning signs and adopting appropriate strategies. HIT can help health care providers to recommend treatments that are more suitable conditions for individual use. HIT also helps to patients have a faster diagnosis and are treated better by doctors outside the medical centers. So the impact of treatment decisions will be increased for patients and the quality of the services will be improved simultaneously with reduction in the cost of health care. HIT caused the development of society in the long term.

According to what was said in today's world, all societies require to moving from traditional medical systems towards personalized health information technology. Such a change in the system of health system services requires the movement of large volumes of information between individuals, providers, and organizations which lead to a high degree of partnership between diverse systems. This information should be shared with qualified persons at a correct time with the high-security factor, which requires vast infrastructure in the IT sector. On the other hand, the sensitivity of the information is also very high because misinformation can lead to death or deterioration of the patient's disease. So HIT system is a broad participatory system with large volumes of data with very low error threshold. Future advances in medical information technology depend on today investment in research, development, and education. So decision makers of healthcare strategies achieve the goals of the health system by making appropriate decisions and resource allocation.

Like all other organizations and businesses, a strategic plan should be developed for future of the HIT based on its prospects, goals, missions, and etc. The Office of the National Coordinator for Health Information Technology (ONC) is among the most important organizations that develop strategic plans for HIT. HIT strategic plan was presented for the first time in 2011 [1]-[5]. This strategic plan was released when adoption of HIT was in its early stages, implementation of the Affordable Care Act was at the beginning, and the mobile health applications was unfamiliar for consumers. Implementation of this plan caused to creation a strong foundation for achieving next Plan's goals and objectives. Over 450,000 professionals and 4,800 hospitals investigated capital, time, and hard work to convert the documents of their patient from paper system to the Electronic Health Record system (EHR). Also, they reconstruct and adapt their workflows based on the electronic healthcare delivery system. So the new healthcare system needs to infrastructure that shares information with the high-security level across multiple platforms, providers, payers and consumers. The second strategic plan was developed and released in 2015 for years between 2015 and 2020 [6]. By implementation of this plan, high-quality care with lower costs must be obtained and caused to a healthy population and engaged individuals.

In this paper, the goal of the effort is to discuss about the importance of developing a strategic plan for future of health care and consider desired visions, missions and goals of HIT strategic plans. After that HIT, like any other IT based system, will be analyzed from three aspects of risk, reliability, and

maturity. In the field of information technology investment some engineering tools are existence that are used to evaluating the reliability and risk level. In this paper first HIT system will be analyzed based on connecting network topology with emphasis on best practice card models (BSC) and IT Architecture Framework (Cobit). Then results will be provided in terms of maturity, reliability, and risk.

The organization of this paper is as follows: The necessity of developing a roadmap of HIT is explained in section 2. Then fundamentals of a roadmap and strategic plan of the healthcare systems will be examined. Also, strategic visions, missions and objectives for the future of HIT will be discussed in this section. Section 3 will be devoted to the estimation of the risk, maturity and reliability of HIT services by using COBIT and Best Scorecards (BSC) theories.

Principles of strategic plan for HIT

In past decade HIT is among the most important factors in the strategic planning of health care future. Create a clear vision of the future of health technology and smart investments in technology are crucial factors for success. It should be noted that economic and social issues related to health and health care are inextricably linked to aspects of medical technology. ICT4D is a conceptual framework for analyzing the parameters such as, technology, economic, political, social, that are constantly changing at three levels: local, national, international, for the identification, prioritization, policy and coordination of human resources, stakeholders, and contractors [7]-[11]. This framework is shown in figure 1.

Based on this framework, the conceptual model of quality health information technology is provided as shown in figure 2.

By personalization of health system simultaneously competitiveness cost will be reduced and quality and accessibility of health services will be improved. In Fig 2, The top corners represent the kind of quality and bottom edges represent high-quality standards [12].

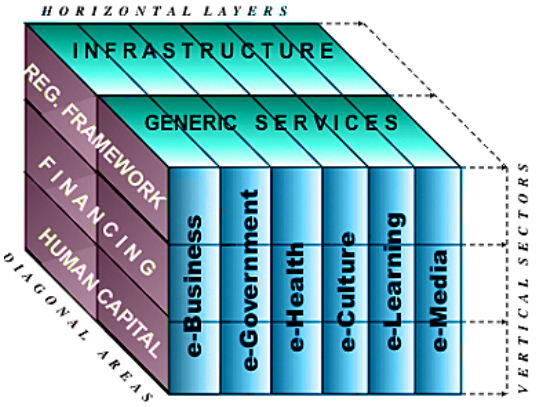

Figure 1. Conceptual framework of ICD4D

Levels of HIT strategic plan: HIT Strategic Development Plans can be presented in three levels. Each of these levels has its own specific strategic framework and scope.

Figure 2. Quality cube in the context of health technology

These levels include future of health and health technology, the future of the smart environment and foreign intelligence in health, and strategy for the future of health. In the framework of the "The Future of Health Technology", four strategic areas are available; Attitude to the future, speed-up to health technology, speed-up to intellectual leadership, improve the global health information

infrastructure. In this area, health technology has become a key issue in the field of smart health care by wide effort to continuously collect medical data, immediately analysis of medical information, accurate analysis results, emotional calculations with emotional intelligence, surgical robotics, nano-surgery, gene therapy, medical remote online training patients, and bioinformatics.

The next framework is "Future of smart environment and foreign intelligence". This framework reflects the need to link the traditional information technology and natural sciences with nanotechnology. It expresses that the human body and the world in which it operates is a complex adaptive system that constantly changing and the real challenge is in understanding the dynamics of that data. Smart biomechatronic systems and health care equipment and mathematicians, understand, record and analyze this system.

In this framework strategic areas are consisted of goals and unsolved problems, consumer/Social IT environment, dietary and nutritional supplements, implanted bots, implanted antennas and sensors, embedded sensors in clothes and textiles, human-machine integration, long life/range of life expectancy, future development of care for older people, intelligent care devices, treatment and care through advanced technology (Hi-Tech Cure), global health care, healthcare compliance management process.

In the framework of the "Strategy for Future Health," five strategic areas are available such as healthcare strategy, E-health strategy, strategy of longer life and extend life, nanomedicine strategy, development of human capabilities, public health strategies. The main items that are used to slow aging is discussed in this area such as reconstruction of organs, neurological signal transduction mechanisms to control physical robots, quantum mechanics and molecular imaging for detection of human thought patterns, "immortality" lack of cellular and molecular decay. Better prevention of disease, reduce medical errors and "the continued integrity" in modern life is created by issues of access, availability, quality and cost of care services, access to definitive and unambiguous tests, computerized patient records and use of artificial intelligence to monitor and control hospital infections, access global data, within the framework of biological and memory map, physiological and molecular data analysis and argument by consumers, data preparation, reality extraction of the raw data.

According to what was said, HIT has become a key issue in smart health. Strategic planning process and development of a strategic roadmap is a long process that will summarize in the following steps:

1.Determine missions

2. Determine the long-term and short-term visions:

By determining the long-term and short-term prospects, the desired image of the future will be traced.

3. Determine the strategic goals and objectives:

The strategic goals should be set in such a way that lead the healthcare system from missions to short-term and long-term prospects.

The strategic goals should have the following characteristics:

a) be accurate and measurable.

b) be challenging and realistic.

c) have a key role in the development and decisively follow-up.

d) have a clear and accurate schedule to achieve them.

4. Determine the strengths and weaknesses/opportunities and threats

5. Determine the strategic actions required to achieve desired strategic objectives

6. The allocation of required resources

Missions, Visions, and prospects in HIT strategic plan: HIT provides a collaborative ecosystem that enables the right information at the right time to the qualified people in the organization. So these people can use the data with high reliability for the diagnosis

and treatment of patients. HIT echo system should be such that support the overall health of the community in sensitive situations such as epidemics of diseases such as nebula or events such as earthquakes, accidents with high casualties, flood and etc. So the mission of HIT system, in general, is to improve the health, healthcare of individuals and communities by using the information technology. Also, data obtained in the health system could be used to conduct research priorities and allocating funds in the health system. So HIT is caused to improve the quality of health care services without the need to raise the frequency of services to patients.

The aforementioned visions are summarized as follows:

- Improve the quality of healthcare
- Reduce the costs of health care and treatment
- Expedite detection using continuous monitoring of the physical condition
- On time treatment before serious symptoms of the disease.
- Increase the performance of older people and reduce the speed of aging process
- Reduce the level of medical errors

All of these visions require their own infrastructure and technological devices. Technological innovations that should be developed until 2050 in order to achieve these visions are shown in Tables 1-7 [13]. Proposed technologies are arranged in six broad areas of research and cover the most likely cause of future developments and innovations in health care.

Specialized Alternatives for parts of the human body not only can make sense to people without feeling back but can also strengthen the common features and convert them to stand out features. Details of Augmentation schedule are shown in Table2.

Development and distribution of advanced detection sensors will turn guess like diagnosis with incomplete information to the individualization diagnosis based on data-driven instructions. Details of Augmentation schedule are shown in table 3.

Table 1. HIT technological areas until 2050

Number	Schedule
12	Augmentation
15	Diagnostics
12	Telemedicine
7	Bio gerontology
10	Treatments
9	Regeneration
65	Summation

Global networks and mobile technologies will fix the problem of necessity of being doctors close to patients for the diagnosis or treatment. Details of telemedicine schedule are shown in Table 4.

Table 1. Augmentation schedule

No	Areas	Plan	Technology	Year
1	Augmentation	Neuroprosthetics	Exoskeletons	2028
2	Augmentation	Neuroprosthetics	Neuroprosthetics	2030
3	Augmentation	Neuroprosthetics	Enhanced metabolism	2034
4	Augmentation	Neuroprosthetics	Optogenetics	2038
5	Augmentation	Neuroprosthetics	Neuroprosthetics	2044
6	Augmentation	Sensory augmentation	Hybrid assisted limbs	2020
7	Augmentation	Sensory augmentation	Auditory vision substitution	2024
8	Augmentation	Sensory augmentation	Myoelectric prosthesis	2024
9	Augmentation	Sensory augmentation	Augmented olfaction	2028
10	Augmentation	Sensory augmentation	Augmented hearing	2034
11	Augmentation	Sensory augmentation	Telescopic & microscopic vision	2038
12	Augmentation	Sensory augmentation	Sensory augmentation	2048

Table 2. Diagnostics schedule

No	Areas	Plan	Technology	Year
1	Diagnostics	Sensors	Sensors : internal-external	2044
2	Diagnostics	Sensors externa	Non-invasive glucose sensors	2024
3	Diagnostics	Sensors externa	Rapid gene sequencing	2028
4	Diagnostics	Sensors externa	In-clothes	2038
5	Diagnostics	Sensors externa	Ingestible sensors	2038
6	Diagnostics	Sensors externa	Medical tricorder	2038
7	Diagnostics	Sensors externa	At-home	2044
8	Diagnostics	Sensors interna	Epidermal sensors	2024
9	Diagnostics	Sensors interna	Tissue-embedded sensors	2030
10	Diagnostics	Sensors interna	Blood stream sensors	2038
11	Diagnostics	Big data	Open health records	2020
12	Diagnostics	Big data	Question answering computing systems	2028
13	Diagnostics	Big data	Data-driven patient communities	2030
14	Diagnostics	Big data	Data-driven diagnostics	2038
15	Diagnostics	Big data	Big data	2044

In the decades ahead, the development of knowledge will enhance our understanding of aging and to slow the aging of the action. Details of biogerontology schedule are shown in table 5.

The manufacture and distribution of a miracle drug binding are not enough for the entire population. Treatment can be precisely targeted to everyone's unique characteristics. Details of treatment schedule are shown in table 6.

The problem of desperately searches to match donors and non-replacement of major organs and extremities will be fixed through the further development of organic growth for the order. Details of regeneration schedule are shown in table 7.

Based on the prospects, goals and objectives of HIT strategic plan can be determined as follows [1], [6], [12]:

1. Self-Managed Health system with individual pattern
2. Transform traditional health care Delivery system to smart It-based system
3. Improve quality, accessibility, safety, effectiveness, and efficiency of health care system
4. Reduce the cost of healthcare services
5. Support the delivery of high-value health care
6. Follow up research and development activities around the smart HIT
7. Enhance national Infrastructure of HIT

Strategic actions to achieve strategic goals: The objectives mentioned in the previous section at the operational level means the following:

• Start thinking seriously about long-term solutions and invest in them.

Table 3. Telemedicine schedule

No	Areas	Plan	Technology	Year
1	Telemedicine	Remote virtual presence	Robotic healthcare assistants	2038
2	Telemedicine		Ai therapists	2038
3	Telemedicine		Virtual triage	2028
4	Telemedicine	Remote virtual presence	surgery assistance	2024
5	Telemedicine	Remote virtual presence	Full body simulation	2040
6	Telemedicine	Remote virtual presence	Full brain simulation	2048
7	Telemedicine	mhealth	Telemetrics	2030
8	Telemedicine	Remote virtual presence	Robotic surgery	2024
9	Telemedicine	Mhealth	App-driven diagnostics	2024
10	Telemedicine	Mhealth	Natural language processing	2028
11	Telemedicine	Mhealth	Mhealth	2042
12	Telemedicine	Remote virtual presence	Remote virtual presence	2044

Table 4. Bio gerontology schedule

No	Areas	Plan	Technology	Year
1	Biogerontology	Cryonics	Suspended animation	2030
2	Biogerontology	Cryonics	Full-body cryopreservation	2034
3	Biogerontology	Cryonics	Reverse cryonics	2040
4	Biogerontology	Cryonics	Cryonics	2044
5	Biogerontology	Life extension	Anti-aging drugs	2034
6	Biogerontology	Life extension	Genetic engineering	2038
7	Biogerontology	Life extension	Life extension	2044

• Start unpredictable manage and organize the process of creating and applying technology.

• Start addressing critical condition Health Emergency as national and international issues.

It also means that we must:

• Health technology supports current and future outlook of the future of our health care.

• Distinct and promising areas to define health technology research.

• Show that the rising costs of health care and health-oriented technology can be stop or reduced by a new allocation of R & D resources.

• Define Fruitful areas for research and development that have the impact on health and health care.

• Identify new technologies and applications that are essential to health and wellness.

Reliability

Over the years, IT has become the backbone of business to the extent that in many cases work is impossible without it. As a result of its increased role of merchandising, IT function is changing and it is transforming from technology provider into strategic partner.

IT Governance Institute suggests that "fundamentally, two things are related IT Governance: IT adds business value and reduce risks." This IT governance leads to four main focus areas, all of which are determined by the value of the beneficiary. Two of them are add value and reduction of risk that are results and two other are strategic alignment and measurements of performance that are stimulant. As noted Van Grembergen [14], while the increase of value is focused on creating business value, risk management focuses on the market value.

In this section first the control objectives for information and related technologies (COBIT) are explained. Then IT BSC with a particular focus on strategic alignment and performance measurement is demonstrated as a supportive mechanism for the development of IT governance within an organization.

Control objectives for information and related technologies (COBIT): COBIT designed to help IT governance with understand and manage the risks and benefits related to information management and related technologies.

Table 5. Treatment schedule

No	Areas	Plan	Technology	Year
1	Treatments	3d printers	3d-printed drugs	2020
2	Treatments	3d printers	Personalized medicine	2028
3	Treatments	3d printers	3d printers	2038
4	Treatments	Anti-aging stem-cell treatments	Stem-cell treatments	2020
5	Treatments	Anti-aging stem-cell treatments	Prenatal gene manipulation	2024
6	Treatments	Anti-aging stem-cell treatments	Gene therapy	2034
7	Treatments	Anti-aging stem-cell treatments	Anti-aging stem-cell treatments	2044
8	Treatments		Bioelectronic drugs	2034
9	Treatments		Enterotype treatments	2040
10	Treatments		Nanocomposite drug carriers	2040

Table 6. Regeneration schedule

No	Areas	Plan	Technology	Year
1	Regeneration	Synthetic & artificial organs	Synthetic blood	2020
2	Regeneration	Synthetic & artificial organs	Tissue regeneration	2024
3	Regeneration	Synthetic & artificial organs	Artificial vascular system	2028
4	Regeneration	Synthetic & artificial organs	Artificial muscles	2034
5	Regeneration	Synthetic & artificial organs	3d printed organs	2038
6	Regeneration	Synthetic & artificial organs	Artificial general-purpose cells	2038
7	Regeneration	Synthetic & artificial organs	Artificial limbs	2040
8	Regeneration	Synthetic & artificial organs	Artificial retinas	2044
9	Regeneration	Synthetic & artificial organs	Synthetic & artificial organs	2044

COBIT is independent from platforms adopted in an organization, and it is standard for control over information technology developed and upgraded by the IT Governance Institute. COBIT is designed to help three distinct audiences:

1. Managers, who must often unpredictably adjust their risks in IT environment and control the investment.

2. Users, who need to ensure about security of IT services used to deliver their products and services to internal and external customers.

3. Auditors, who can use COBIT to prove their opinions and / or provide recommendations on internal controls management.

COBIT framework: Conceptual framework of COBIT can be considered from three points of view can be considered: (1) IT processes, (2) information standards and (3) IT Resources. These three aspects are presented in COBIT cube and are shown in figure 3.

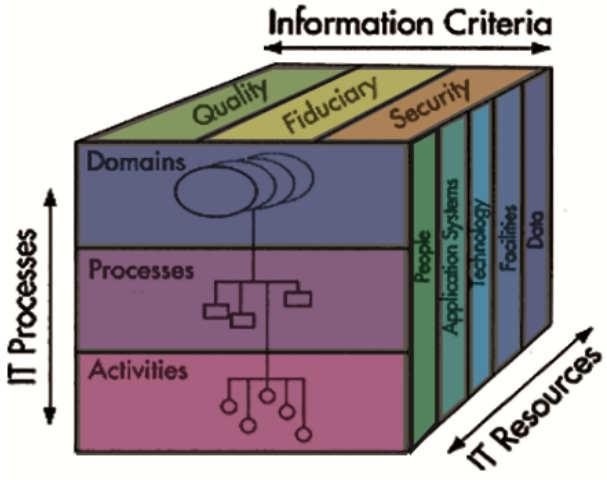

Figure 3. COBIT cube

IT processes: This framework recognized 34 processes divided into 4 domains. The relation between these domains are shown in figure 4. Also, this framework presents high-level approach to control these processes with 318 detailed control objectives and audit guide to assess the IT processes.

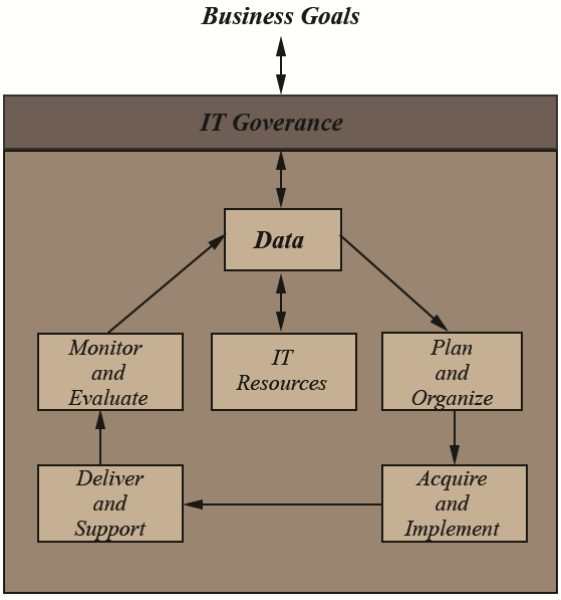

Figure 4. COBIT domains

Four main domains of IT processes are:

1. Plan and Organize, this domain covers strategies and tactics and is associated with the identification of the way IT can best contribute to achieving business goals. In addition, the realization of the strategic vision should be programmed, communicated and managed for different views. Finally, the appropriate organization and technical infrastructure should be placed in their own places.

2. Acquire and Implement, for the realization of the strategy of IT, IT solutions need to be identified, developed, implemented, Acquired and be integrated in business processes. In addition, this domain should cover changes in the systems and maintaining existing systems to ensure that the life cycle of these systems is continuous.

3. Deliver and Support, this domain is associated with the actual delivery of required services, which its range is extensive from traditional operations over security and continuity aspects to training. Also, the necessary support processes must be established to deliver services. This domain encompasses the actual data processing by software system which are often classified as the controls of software.

4. Monitor and Evaluate, all IT processes should be evaluated on a regular basis over time in terms of quality and compliance with control requirements. So this domain to neglect the management of the organization control process and independent assurance provided by internal and external auditors or obtained from alternative sources handle.

Information criteria: COBIT considers quality requirements and safety control of commercial companies and suggests 7 information criteria that will be used for general definition of IT in the field of business.

- Effectiveness: information is related to trade and should be delivered in suitable, correct, consistent and usable manner.
- Efficiency: the provision of information through the optimal use of resources
- Confidentiality: Protecting sensitive data against unauthorized disclosure
- Integrity: The accuracy and completeness of the information.
- Accessibility: information exists now and in the future, whenever it is needed.
- Compliance: Compliance with laws, regulations and contractual arrangements.
- Reliability: Provide appropriate information for managers to fulfill their responsibility of financial reporting and adapting.

The privious information metrics provide a general method for identifying business requirements. In Fig 5, the rate of maturity and risk caused by the organization's deviation from business goals is shown for each criterion.

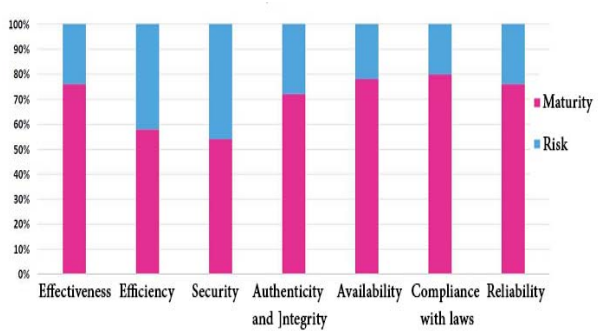

Figure 5. Risk and Maturity evaluation based on COBIT and BSC

IT Resources: COBIT framework defines 5 class for IT resources:

- Data objects in the broadest sense (text, shape, sound).
- Software systems: manual and programmed procedures.
- Technologies: hardware, operating systems, middleware, networks, databases, multimedia.
- Features: environmental resources, including electricity, buildings and water.
- people: employees, skills and productivity apps

IT Balanced Scorecard (BSC): Kaplan-Norton [15] have introduced Balanced Scorecard (BSC) at an enterprise level. The idea is that the assessment should not be limited to traditional financial evaluation and should be completed with the usual measures of customer satisfaction, internal processes and ability to innovate. BSC have been mainly used in evaluation of the performance of IT and its processes [16]- [19]. Accepting the fact that IT is internal service provider, the present work confirms that the balanced scorecard approach should be changed based on the following perspectives: the role, orientation client, operational

excellence and future orientation. These perspectives are shown in figure 6.

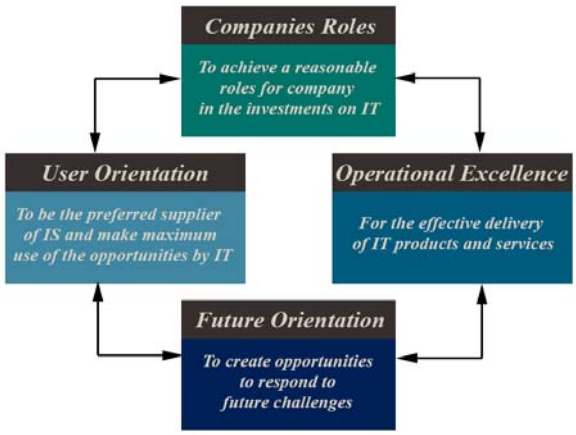

Figure 6. Perspective of IT BSC

In the Fig7, the aggregation of the status of business goals is presented in four areas of the BSC. From the COBIT perspective, the goals of a business organization can be categorized under BSC framework. Accordingly, each BSC criteria includes a number of business goals and can fulfill through them. In this Figure, the maturity and risk indicators for each domain are calculated and presented. Also, the maturity and risk of the organization from the BSC methodology perspective calculated and listed.

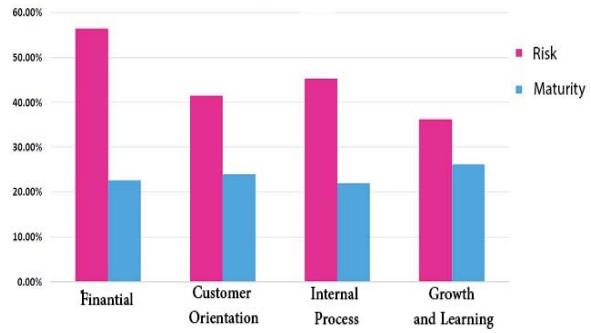

Figure 7. Risk and Maturity evaluation based on COBIT and BSC

Risk Model: Risk model helps organizations manage risk while managing their business. This model has been formed from a set of guiding principles and risk management process.

Risk model will support the following principles:

- Continuous assessment of risks
- Integrate risk management in every role and every function
- Positive approach to risk identification
- Use risk-based schedule
- Create an acceptable level of formality

The risk management process is provided in figure 8.

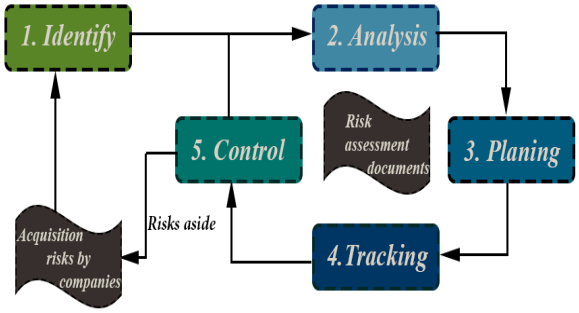

Figure 8. Process of risk management

Risk management steps are as follows:

1) Identify: Determine the source of risk, failure modes, conditions, consequences, business results and operating results.

2) Analysis: Determine the risk and its impact and use this information to calculate exposure levels to help rank risks relative to each other.

3) Planning: Determination of styles that entirely prevent from the risk, it will transform risks to other parts or reduce the effect of risk.

4) Tracking: collect information on how to modify risk factors over time.

5) Control: implementation of the planned response against specific changes.

To achieve a reasonable role in the investments on IT in company.

Discussion

IT organizations are increasingly using IT and ITSM and no doubt that this trend will continue. In our opinion, in HIT road map maturity, risk, and reliability of HIT system can be achieved by expanding the concept of a public BSC assigned to business goals (BG), IT goals (ITG) and the architectural

framework of the COBIT. Such an analysis of the objectives of the strategic alignment and provide powerful auditing capabilities for IT managers. The use of COBIT with BSC method simultaneously was demonstrated as novel tool for analysis and evaluating the maturity, risk, and reliability in order to align with business goals during the service-oriented approach and it will be key to success in IT management.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

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International Journal of Body, Mind & Culture
Cross-Cultural, Interdisciplinary Health Studies

Effect of Amount of 3-Methacryloxy Propyl Thrimethoxysilane Coupling Agent and Nano Filling Structure on Physic-Mechanical Properties of Dental Resin Composite

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Quantitative Study

Abstract

Many researchers in the field of dental polymeric base nano composite investigated the effect filling morphology and filling material content on mechanical and physical properties of construction after setting reaction. Our present study concentrated on the effect of Ϋ metacryloxy propyloxt tri metoxy silane (Ϋ MPS) content as coupling agent (orgnic material) on physical and mechanical performance of nano composite material. It was shown that despite of contraction after setting reaction, all this properties improved and efficient silanization can efficiently affect structural integrity of dental filling nano composite.

Keywords: Dental composite, Nano particle, Ϋ MPS, Physical properties, Mechanical properties

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Introduction

In today's society, people are very concerned about their aesthetic appearance. As part of that appearance, their teeth play an integral role. Therefore the color of restoration which used to fill dental cavity play important role to maintenance it's beauty. As a result there has been an abundance of research in resin composite technology and adhesive dentistry.[1-3]

In spite of recent advances in modern dental resin composites: The adhesion between fillers and the organic polymeric matrix in dental resin provided by coupling agents through a filler-matrix interaction

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(FMI). Comparatively, the FMI has the smallest volume in the composite body, but it is a fundamental phase to provide composite resins with sufficient properties.

Nature and amount of the coupling agent and the composition, size and distribution of the fillers affects The effectiveness of treatment with fillers γ-methacryl oxypropyltrimethoxysilane (γ-MPS),. as an Organosilanes, are those most commonly used. In resin composite Systems. The organo-functional polymerizable group forms a covalent-bond with the Polymerizable monomer groups (vinyl groups or –C=C–) during composite polymerization in samples.

Henrique et all evaluate the effect of different percentages of an organofunctionalized

Silane monomer as adhesion promoter between barium borosilicate glass fillers and (co)monomer blend in experimental dental composite resin. Flexural strength and elastic modulus can sometimes be improved with lower concentrations of organo silane coupling agent rather than higher concentrations of the silane (γ-MPS) used as coupling agent on barium borosilicate glassfiller microparticles of the dental composite resin.

Irini et al investigated the effect of Y metacryloxypropyl tri methoxy silane on the structural performance of dental resin composite.relative to the silica surface in low percentage of coupling agent orientation formed. At higher silane amounts silane molecules form a layer around the filler particles which now have to occupy a random, parallel and perpendicularly orientation relative to the silica surface. This parameter affect dynamic properties of dental resin composite.

In the some different study it was shown that effect of filer content on mechanical properties and physical resulted properties is strong. And it affect to the band between tooth and filling material. Increasing resistance against crack propagation and decrease in polymerization shrinkage but our study devoted on effect of different coupling agent content as an organic part on the physico mechanical properties of dental resin restoration composite.

Methods

In this research different dental resin composite with 3, 5,7,10 weight percent of γ-methacryl oxypropyltrimethoxysilane solution was prepared and named 1, 2, 3, 4. Samples consist of 25% silica (SiO_2) as filling material. Bis-GMA, TEGDMA monomer as matrix for structure construction had been used. Camphorquinone as light sensitive initiator of polymerization had been used.(as one percent). All the chemical are analytical grade and prepared of Sigma-Aldrich.

To characterized physic-chemical properties of construction some of analysis performed

Measurement of contraction after setting reaction is operated by grinder retch set up that characterized diameter and volume changes.

To investigated the degree of conversion of composite as function of silanization process Fourier transform infra-red experiment using Perkin Elmer machine operated and surface area under Picks for adsorption diagram for the samples in C=C and C-C bands estimated. That is related to the degree of conversion. Measurements were in deferent time interval

Mechanical characterization of samples operated in compression test using INSTUN device in 10mm/min strain rate. And elastic modulus of them after light polymerization characterized.

Vickers hardness characterization done by loading 200G bar on the samples in 10 second and recording applying force.

Results

Contraction after setting reaction: According to the figure one we can see contraction after setting of dental resin composites.

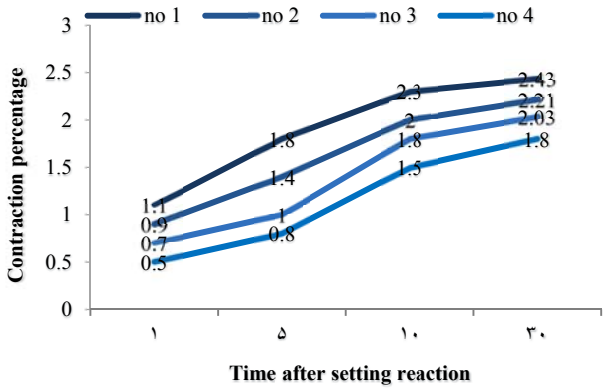

Figure 1. Contraction after setting versus time of reaction

As much as amount of silanized nano silca increases, the amount contraction after setting reaction decreases. It means complete coupling of filling material by matrix would lower the contraction. As time increases the contraction percentage increases by the slope of the curve in lower contain coupling agent which is more than higher content.

Mechanical properties of structure: In figure 2 the mechanical properties of samples as young modulus versus coupling agent was shown.

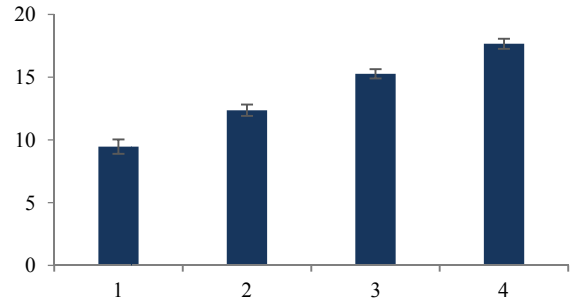

Figure 2. Young modulus of sample function of coupling agent percentage

As it was shown higher level of coupling agent of structure interact by Nano particle may enhances structure strenght. Because higher level of Nano particle-matrix integration would affect strongly load bearing of samples.

Conversion degree of structure: Figure 3 show the degree of conversion of samples as the amount of silanized Nano particles increases.

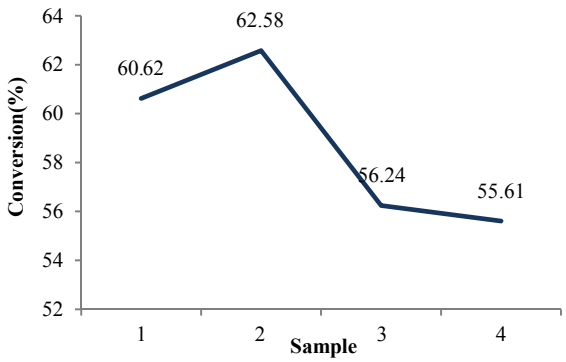

Figure 3. Degree of conversion of sample with different ϒ MPS

As observed above amount of silanization can different conversion behavior of samples. For example increasing from 3 to 5 percent in silanized particles would increase conversion ratio of samples but more than this specific amount reduces polymerization reaction. First mechanism may related to the more homogenous distribution of filed silanized particles and second one may related to the decreasing degree of chain propagation through Nano particles reaction.

Hardness evaluation: Figure 4 showed hardness profile of samples in 2 cm depth of their structure.

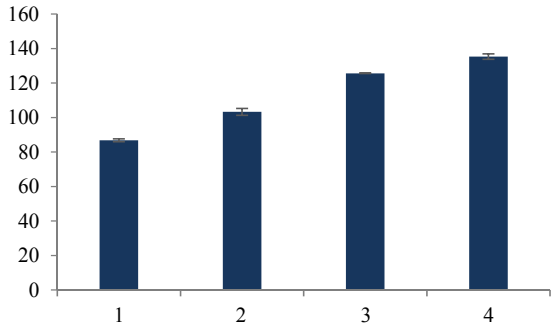

Figure 4. Vickers Hardness of different samples

Silanization by influencing the Nano particle-matrix reaction lead to the more increasing the hardness. Low level of matrix-nano particle reaction couldn't strength against indenter coin compared with integrated structure and more silanized sample boost this properties according to the figure.

As was shown despite of contraction after setting reaction samples show better physic mechanical properties as silanization reaction increases but more silanization reaction may limited flexural strength and provide brittleness of them.

Microstructure of Nano composites: In figure 5 scanning electron microscopy of silanized nano particle which interact to the matrix was shown.

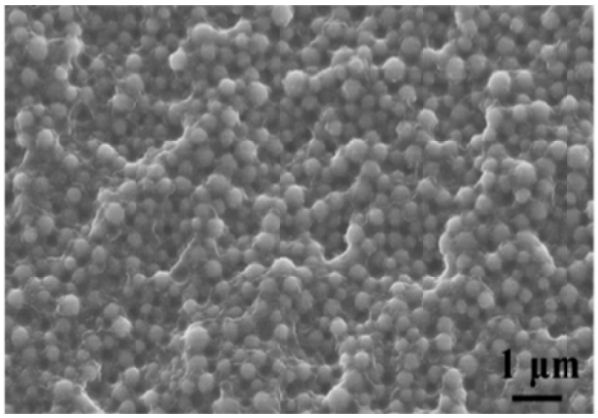

Figure 5. SEM image of silanized sample

Discussion

Our research is devoted on characterization of effect of silanized nano particle in dental polymeric nano composite filling material in the performance of physical and mechanical properties. Our reasrch shown that despite of setting contraction improvement of mechanical and pyysical properties of samples achieved by efficient silanization process.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

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International Journal of Body, Mind & Culture
Cross-Cultural, Interdisciplinary Health Studies

Towards Realization of Intelligent Medical Treatment at Nanoscale by Artificial Microscopic Swarm Control Systems

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Quantitative Study

Abstract

Background: In this paper, the novel concept of artificial microscopic swarm control systems is proposed as a promising approach towards realization of intelligent medical treatment at nanoscale. In this new paradigm, treatment is done autonomously at nanoscale within the patient's body by the proposed swarm control systems.

Methods: From control engineering perspective, medical treatment can be considered as a control problem, in which the ultimate goal is to find the best feasible way to change the state of diseased tissue from unhealthy to healthy in presence of uncertainty. Although a living tissue is a huge swarm of microscopic cells, nearly all of the common treatment methods are based on macroscopic centralized control paradigm. Inspired by natural microscopic swarm control systems such as nervous, endocrine and immune systems that work based on swarm control paradigm, medical treatment needs a paradigm shift from macroscopic centralized control to microscopic swarm control. An artificial microscopic swarm control system consists of a huge number of very simple autonomous microscopic agents that exploit swarm intelligence to realize sense, control (computing) and actuation at nanoscale in local, distributed and decentralized manner. This control system can be designed based on mathematical analysis and computer simulation.

Results: The proposed approach is used for treatment of atherosclerosis and cancer based on mathematical analysis and in-silico study.

Conclusion: The notion of artificial microscopic swarm control systems opens new doors towards realization of autonomous and intelligent medical treatment at nanoscale within the patient's body.

Keywords: Intelligent medical treatment, Microscopic swarm control, Medical nanorobotics, Mathematical analysis, Computer simulation

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Introduction

Is it possible to manufacture and send nanoscale agents within the human body to autonomously sense and control the life conditions? In 1966, when the science fiction film of 'Fantastic Voyage' was produced, realization of such scenario was a dream. But in recent years, remarkable advances in

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nanotechnology have made it possible to manufacture and send nanoscale agents inside the human body to move today's medicine towards diagnosis and treatment of complex diseases such as cancer, different types of disability, atherosclerosis, stroke, and dementia. This new interdisciplinary research area is called nanomedicine.

Each nanoscale agent has very limited capabilities. Sense, actuation, and control (computing) are local, distributed and decentralized. The internal environment of human body is very uncertain, dynamic and noisy. Brownian and viscous forces usually dominate the propulsion force and thus the motion of a nano-agent is pseudo-random. Only short-range and local communication is often possible among agents. Generally, many assumptions that are used for simplification in macroscopic and lumped models could not be employed in the nanoscale and thus the models are microscopic and distributed. Fortunately, most applications in nanomedicine have access to large swarms of nanoscale agents in even small volumes of the environment. The central question is: How can a swarm of very simple nano-agents perform complex tasks intelligently in such an uncertain environment? As a practical approach, this paper introduces the novel concept of artificial microscopic swarm control systems to realize artificial swarm intelligence at nanoscale inside human body.

There exist few works in the literature that have directly used swarm intelligence in nanomedicine. Chandrasekaran et al. discussed the application of quorum sensing (the ability of some types of bacteria, immune cells and other biological cells to communicate and coordinate behavior via signaling molecules) to the realization of swarm intelligence in a swarm of bio-nano robots (Chandrasekaran & Hougen, 2006). Martel et al. discussed a micro-assembly process and considered it on several thousand flagellated bacteria acting as micro-workers (Martel & Mohammadi, 2009). He also described the problems of communication and cooperation in the swarms of sensotaxis-based bacterial microrobots (Martel, André, Mohammadi, Lu, & Felfoul, 2009). Martel et al. compared the aggregates of synthetic microscale nanorobots with the swarms of computer-controlled flagellated bacterial robots for target therapies through the human vascular network (Martel, 2010). Wang et al. demonstrated that like swarming insects drawing crowds to a food source, a system of nanoparticles and engineered proteins can communicate with one another to raise the concentration of systemically administered drugs at the site of a tumor (Wang, Brown, & Xia, 2011). The system harnesses one of the body's own communication pathways, one that coagulates blood, to accumulate drugs where they are needed. The researchers engineered a set of nanoparticles that trigger the body to grow blood clots around tumors. A second set of nanoparticles that recognizes the blood clots then delivers a dose of anti-cancer drug to the tumor.

Rowhanimanesh et al. proposed the concept of swarm control systems for nanomedicine and considered its application to the prevention and treatment of atherosclerosis (Rowhanimanesh & Akbarzadeh-T., 2012; Rowhanimanesh & Akbarzadeh-T., 2013; Rowhanimanesh, 2013; Rowhanimanesh & Akbarzadeh-T., 2015). Loscrí at al. desgined an acoustic communication technique of nanorobot swarms for nanomedicine applications (Loscrí & Vegni, 2015). Hajizadeh et al. introduced the concept of swarm learning for autonomous nanoparticles to control drug release rate in treatment of atherosclerosis (Hajizadeh-S., Akbarzadeh-T., & Rowhanimanesh, 2015a & 2015b). Razmi et al. used swarm of autonomous fuzzy nanoparticles for control of tumor growth in cancer (Razmi, Moghaddam, & Rowhanimanesh, 2015).

Methods

An artificial micrsocopic swarm control

system consists of a huge number of very simple autonomous microscopic agents that are able to cooperate and communicate with each other to realize artificial swarm intelligence at nanoscale inside a living tissue. An autonomous microscopic agent utilizes three fundamental units including sensor, controller and actuator units as schematically shown in figure 1. Some sensors and actuators can be used as transceivers for communication. This structure enables the agent to continuously sense its environment, communicate with other agents, and autonomously apply the required actions if any abnormality is occurred. The hardware complexity of these units should be low for more reasonable manufacturing within the existing bounds of technologies.

Although different nanoscale sensors and actuators can be used in an autonomous microscopic agent, chemical concentration is the most common signal for both input and output. Hence, the sensor unit usually includes nanoscale molecular concentration sensors to sense concentration signals from the interior environment of the tissue and the actuator unit is usually composed of controllable drug pumps/valves that are connected to drug payload to release the drug molecules in the aqueous environment of the tissue with a flow rate determined by the controller unit.

The most important part of an autonomous microscopic agent is controller unit (decision making unit) that determines which concentration signals are sensed by the agent (input) and how drug release rate (output) is changed according to the sensed values. Controller unit should be analytically designed based on the mathematical model of disease dynamics at nanoscale and its performance must be verified through computer simulation before any implementation. In this paper, our insight to the notion of autonomous microscopic agent is abstract and mathematical. For real-world implementation of such agents, the critical assumptions of biocompatibility and biodegradability should be considered carefully.

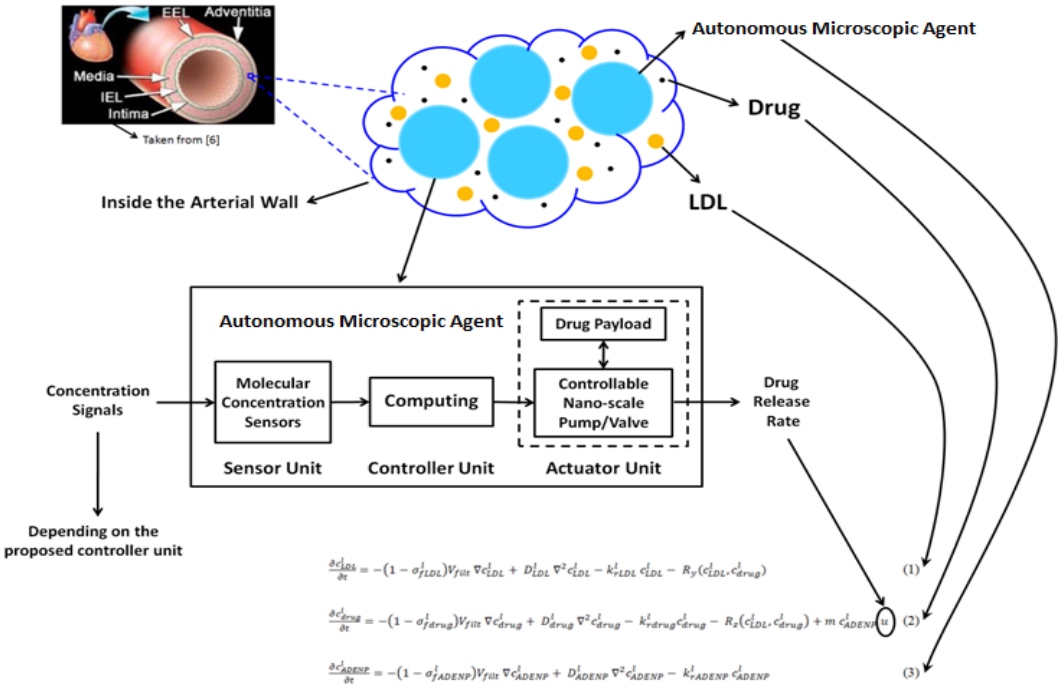

Figure 1. The general structure of an autonomous microscopic agent (used for the treatment of atherosclerosis (Rowhanimanesh & Akbarzadeh-T., 2013))

Results

In this section, it is demonstrated that how the proposed concept of artificial microscopic swarm control system can be used as a non-invasive targeted treatment method for atherosclerosis and cancer as two of the most complex diseases. The system is analytically designed based on the mathematical model of the dynamics of disease at nanoscale. The performance of the designed control system is evaluated through computer simulation in ADENP Tool, a MATLAB toolbox developed by author in (Rowhanimanesh, 2013) for simulating microscopic swarm control systems in nanomedical applications. These two cases are briefly considered here. Without loss of generality, in both cases the controller unit is designed according to fuzzy control approach.

Case I: Atherosclerosis (Rowhanimanesh & Akbarzadeh-T., 2015): The anatomical structure of arterial wall is schematically illustrated in figure 2. The following equations describe the governing dynamics on LDL, FNP, pheromone, ANP, and drug transport within the arterial wall. The details of model description and physiological parameters are presented in (Rowhanimanesh & Akbarzadeh-T., 2015).

$$\frac{\partial c^{l}_{LDL}}{\partial t} = -(1-\sigma^{l}_{fLDL})V_{filt}\nabla c^{l}_{LDL} + D^{l}_{LDL}\nabla^2 c^{l}_{LDL} - k^{l}_{rLDL}c^{l}_{LDL} - R_y(c^{l}_{LDL}, c^{l}_{drug}) \quad (1)$$

$$\frac{\partial c^{lj}_{FNP}}{\partial t} = -(1-\sigma^{l}_{fFNP})V_{filt}\nabla c^{lj}_{FNP} + D^{l}_{FNP}\nabla^2 c^{lj}_{FNP} - k^{l}_{rFNP}c^{lj}_{FNP} \quad (\text{for } j = 1{:}q) \quad (2)$$

$$\frac{\partial c^{l}_{ph}}{\partial t} = -(1-\sigma^{l}_{fph})V_{filt}\nabla c^{l}_{ph} + D^{l}_{ph}\nabla^2 c^{l}_{ph} - k^{l}_{rph}c^{l}_{ph} + m_{ph}\sum_{j=1}^{q} c^{lj}_{FNP}\, u^{lj}_{FNP} \quad (3)$$

$$\frac{\partial c^{l}_{ANP}}{\partial t} = -(1-\sigma^{l}_{fANP})V_{filt}\nabla c^{l}_{ANP} + D^{l}_{ANP}\nabla^2 c^{l}_{ANP} - k^{l}_{rANP}\, c^{l}_{ANP} \quad (4)$$

$$\frac{\partial c^{l}_{drug}}{\partial t} = -(1-\sigma^{l}_{fdrug})V_{filt}\nabla c^{l}_{drug} + D^{l}_{drug}\nabla^2 c^{l}_{drug} - k^{l}_{rdrug}c^{l}_{drug} - R_z(c^{l}_{LDL}, c^{l}_{drug}) + m_{drug}\, c^{l}_{ANP}\, u^{l}_{ANP} \quad (5)$$

As depicted in figure 3, a swarm fuzzy control approach is applied for intelligent control of Low-Density Lipoprotein (LDL) concentration in the arterial wall by stigmergic cooperation between two distinctive swarms of autonomous microscopic agents called Fuzzy Nanoparticles (FNPs) and Auxiliary Nanoparticles (ANPs).

The effect of the proposed control system on the LDL level in the interior of the arterial wall is considered over 48 hours (two days) in two distinguishing situations: unhealthy (abnormal) arterial wall where the peak of LDL concentration is 200 mg dL^{-1}, and healthy arterial wall where the peak of LDL concentration is 60 mg dL^{-1}.

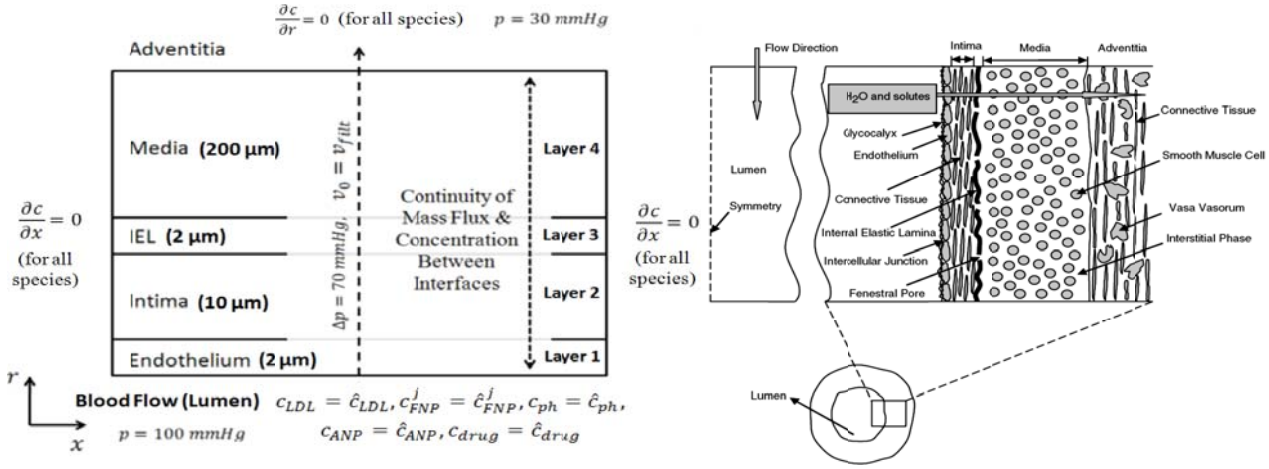

Figure 2. Transverse section of arterial wall (Rowhanimanesh & Akbarzadeh-T., 2015)

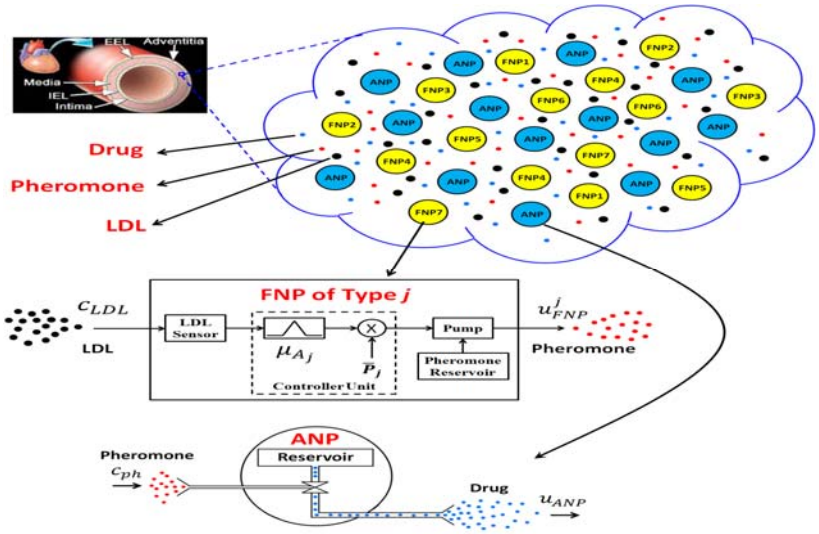

Figure 3. The architecture of the proposed artificial microscopic swarm control system for treatment of atherosclerosis (Rowhanimanesh & Akbarzadeh-T., 2015)

Figures 4 and 5 represent the final (controlled) profile of LDL concentration in the arterial wall at the end of 48 hours and compares this profile with the desired (normal) and uncontrolled (without drug) LDL levels for both healthy and unhealthy cases. Simulation results demonstrate that although the LDL concentration in lumen is very high ($200\,\mathrm{mg\,dL^{-1}}$), the proposed approach could successfully reduce the LDL level in all layers of an unhealthy arterial wall with reduction rate of 37.33%, 75.31%, 75.35%, and 73.67% in Endothelium, Intima, IEL and Media, respectively. In figure 5.(b), the proposed method could successfully understand that the arterial wall is healthy, where the LDL reduction rate is trivial and 3.16%, 7.27%, 7.41%, and 7.68% in Endothelium, Intima, IEL and Media, respectively. The mass of the released drug by the proposed technique in a healthy wall is 16 times less than its corresponding value in the unhealthy wall which demonstrates the efficiency of the new method in distinguishing between unhealthy and healthy tissues which could significantly reduce the unwanted side effects of drug.

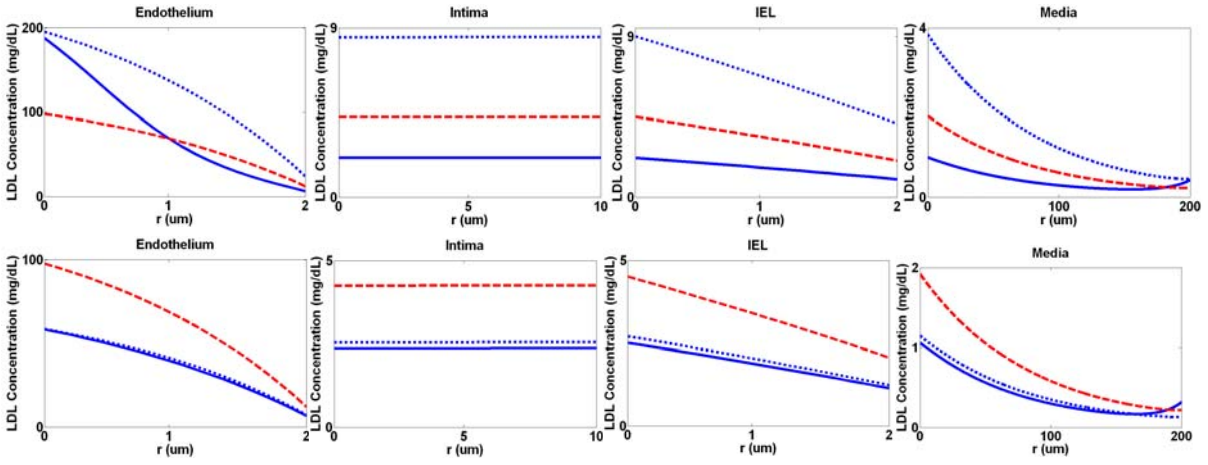

Figure 4. Final LDL concentration profiles (solid) after two days in contrast to desired LDL level (dash) and uncontrolled LDL level (dot). a) Unhealthy arterial wall, b) Healthy arterial wall.

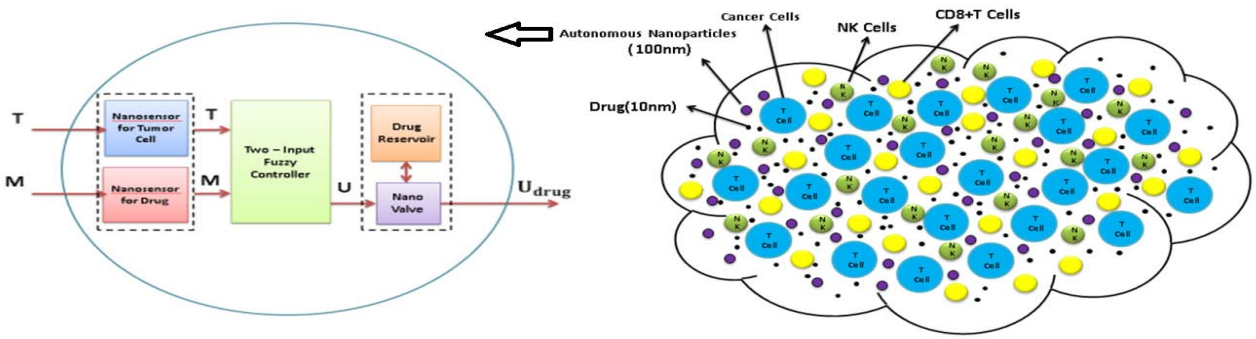

Figure 5. The architecture of the proposed artificial microscopic swarm control system for treatment of cancer (Razmi, Moghaddam, & Rowhanimanesh, 2015).

Case II: Cancer (Razmi, Moghaddam, & Rowhanimanesh, 2015): The following equations describe the governing dynamics among tumor cells (T), different families of immune cells (N, L, C), and biochemical molecules (M, I) including drug. The details of model description and physiological parameters are presented in (Razmi, Moghaddam, & Rowhanimanesh, 2015).

$$\frac{dT}{dt} = aT(1-bT) - cNT - DT - K_T(1-e^{-\delta_T M})T \tag{1}$$

$$\frac{dN}{dt} = f(\frac{e}{f}C - N) - pNT + \frac{p_N NI}{g_N + I} - K_N(1-e^{-\delta_N M})N \tag{2}$$

$$\frac{dL}{dt} = \frac{\theta mL}{\theta + I} + j\frac{T}{k+T}L - qLT + (r_1 N + r_2 C)T - \frac{u_L^1 CI}{k+I} - K_L(1-e^{-\delta_L M})L + \frac{p_l LI}{g_l + I} + \nu_L(t) \tag{3}$$

$$\frac{dC}{dt} = \beta(\frac{\alpha}{\beta} - C) - K_C(1-e^{-\delta_C M})C \tag{4}$$

$$\frac{dM}{dt} = -\gamma M + C_{denp}U_{denp}(t) \tag{5}$$

$$\frac{dI}{dt} = -\mu_I + \phi C + \frac{\omega LI}{\xi + I} + \nu_I(t) \tag{6}$$

$$D = d\frac{(L/\tau)^l}{s + (L/\tau)^l} \tag{7}$$

Figure 5 shows the architecture of the proposed artificial microscopic swarm control system. As depicted in this figure, autonomous microscopic agents continuously take feedback from both tumor cells population and local concentration of drug in the interior of the cancerous tissue. The goal of this system is damping of the tumor growth and optimal release of drug to minimize the drug side effects. Simulation results in figure 6 demonstrate that the designed control system could reach these goals successfully.

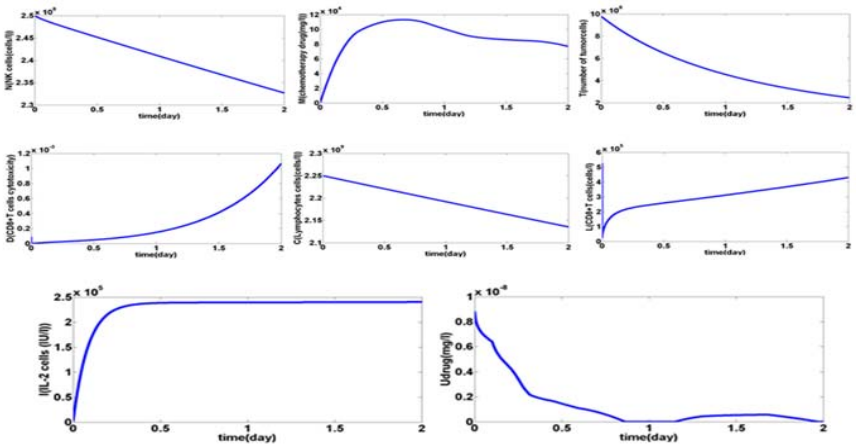

Figure 6. Temporal profile of concentration signals during two days (Razmi, Moghaddam, & Rowhanimanesh, 2015).

Discussion

Recent advances in medical high technologies show that treatment of complex diseases is highly dependent to the ability of control at cellular and molecular scales. As a promising approach towards realization of this crucial need, this paper proposes the novel concept of artificial microscopic swarm control systems. Using this paradigm, intelligent medical treatment can be done autonomously at nanoscale within the patient's body. An artificial microscopic swarm control systems consists of a huge number of autonomous microscopic agents that exploit swarm intelligence to realize sense, control (computing) and actuation at nanoscale in local, distributed and decentralized manner. In this paper, it is demonstrated that how the proposed swarm control system can be used for treatment of atherosclerosis and cancer based on mathematical analysis and in-silico study.

In general, the proposed notion of artificial microscopic swarm control systems can revolutionize medicine especially for intelligent prevention, early and accurate diagnosis, and efficient treatment with least invasion, pain, side effects, recovery time, hospital-acquired infection and cost especially in complex diseases. Also, it can greatly help upcoming medical high technologies such as medical nanorobotics, molecular and cellular medicine, tissue engineering, nanomedicine, engineered microorganisms, targeted therapy, immunotherapy, DNA robotics, and Internet of nano things.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

None.

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