New Healthcare Challenges Require New Generation of Hospital Information Systems

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Abstract.
In today's society the need for fast medical consultancy is rapidly increasing. The shortage of consultants in many medical areas is a fact today. The dispersion of the population is another important factor in medical consultations. The need for remote consultancy and effective use of the available medical resources is world-wide seen and acute.
The healthcare and all supporting industries are changing the way they support patients. The high-end medical technologies need personnel with high-end qualifications, whose availability are limited. Top-quality specialists are rare and inaccessible in general. This lead to new thinking in the healthcare development industry - the effective combination of knowledge and expertise of academia and industry.
This paper presents some authors' results and observations on the development process of new generation of Hospital Information Systems.

***Index Terms*—Hospital Information Systems (HIS), Intelligent Medical and Healthcare Information Systems (IMHIS), Advanced Analytics Medical Tools, Telemedicine.**

I. INTRODUCTION

After 2000 year, many industrial areas were directly dependent on the use of computer equipment. In 2010 more than 80% of industries in Europe are based and/or supported by computers: many studies and analyzes of the European Commission show that now quality indicators of individual industries directly dependent on the quality of used computer systems, devices and equipment.

The same can be said about our life: more and more it is oriented to computer support: we have the so-called "ubiquitous computing". Now, more and more people do not associate the term "computing" with classical desktop computers; they talk about mobile and embedded computers in cars, washing machines, phones, TV, different types of smart or intelligent devices. They talk about some new kinds of computer-based systems and devise: Internet-of-thing, cyber-physical devices and apparatus, about safety-critical applications and systems.

The medicine is not an isolated island and for the last 30-40 years many computer-based devices, apparatus, tools, and applications became a part of medical infrastructure, hospitals' equipment and clinicians' practice. At the beginning, the computers were only parts of information systems and special devices. After these first years, some hospitals started to use computer apparatus to increase sensing of clinicians and this created a new science direction - the "computer-assisted diagnosis". Today computer-supported methods and computer-assisted methods for medical purposes have a big advantage because they only increase clinicians' sensing systems and enable to do high precision tasks. In many cases of diagnosis process the physicians start to use computer systems as a second opinion (this is named as "computer-aided diagnosis"). This is a normal point of view for clinicians - everybody using stethoscope needs from time to time newer and better one. It determines the small resistance of the medical staff to the adoption and better use of computer-based apparatus and systems. We think that in the future the speed of this process is dependent on the need to keep solutions safe because they are related to human's health.

Since 2005, there is an explosion of e-Health scientific publications and funded by governments' new surveys and new strategies, as well as expand the themes within the framework of the European Union at the national and above-national level. At the same time, the number of the healthcare topics funded by European Union at national and supranational level rapidly grew.

According to the analysis of the European Commission [6] over 10% of jobs in Europe are in the healthcare sector and from this sector received over 9% of the EU gross revenue. In 2010, the gross income of the companies of e-Health sector amounted to 2.5 billion Euros and until the end of 2015, is expected to rise to 2.7 billion Euros (in surveys of the European Trade Association COCIR).

The paper presents the most important authors' result and comments of the new generation HIS – the Intelligent Medical and Healthcare Information Systems – after several collaborative research and development projects between Technical University of Sofia, Bulgaria, and Medical University of Sofia. These collaborative projects covered different aspects of research, analyzing, evaluation, and development of new IT-based medical apparatus, tools, services, and information system frameworks and architectures.

II. SOME BUSINESS, TECHNOLOGY AND POLICY TRENDS

In the period 2007-2013 year the researches in Medical Informatics and eHealth systems were focused on a wide range of topics: from new generation medical sensors via new HIS architectures to the legal aspects of the protection of the information and the safety of the technologies. The reason for this was the imbalance between the available IT infrastructure and its application: hospitals are relatively well IT equipped for administrative purposes; the infrastructure for the maintenance of the information for patients is less-developed; and the maintenance of a permanent (or regular) contact with the patients is still rudimentary condition.

At the end of 2010 the studies on the expected development of healthcare services showed the expected increase in costs to reach up to 15% of the gross domestic product: the main reason is the growth of prices and the expansion of demand without substantially to increase the

Manuscript received June 20, 2016
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quality and accessibility of healthcare. This put the aim to overcome this situation. Therefore, in addition to the classical tasks, the governments and the business set new tasks for research, development and deployment of next-generation advanced analytics tools for medical systems, to assist both the processes of the administrative management of medical activities and the existing clinical practices and the activities (i.e., "e-Health Action Plan 2012-2020: Frequently Asked Questions", Brussels, Dec. 1012). The usefulness and the necessity of the research into new generation advanced analytics for in medical systems are much discussed in the last 2-3 years: very indicative are research reports and analyses of IBM Institute for Business Value [7], Deloitte [8], MarketsandMarkets [9], and Control Engineering Europe [10]. All these reviews and analyzes show extremely high relevance of research on e-Health in all its aspects: from the medical, the financial, and the engineering aspects to the legal, the legislative and the organizational aspects.

Today the progress in medical diagnostics and new thinking in the healthcare development services are achieved by the intensive introduction of ICT and providing of effective guidelines for pre-analytical procedures, medical diagnostic services, and healthcare management services. But in the last 3-5 year many times was discussed business aspect of future trends of computer-assisted and computer-aided methods and technologies. The Frost &Sullivan investigation [5] of computer-aided diagnosis market was mention: *"From the inception of the market in 1998 up to 2008, revenues from the North American Computer Aided Diagnosis market continued to grow rapidly year after year. It surpassed the $100 million mark for the first time in 2007. However, this upward trend was reversed in 2009 due to several factors affecting global healthcare."* In combination with some other studies can be extracted some interesting trends [1,3,4]:

- Standalone types of computer-aided diagnosis applications and tools are not more interesting in last 2-3 years: business interest is oriented to tools/applications that can be integrated with hospitals' information systems. This trend is well known for other computer-based business and the result is plug-in technology. But computer-assisted methods are more suitable for this than computer-aided and computer-automated methods.
- Decreasing of changing a computer-aided market is based on reimbursement a costs for this research. Now the hospitals include this to patients' cost but patients do not want to pay for this. The result is the companies; push to research groups for creating an interesting to integration functions to companies' hospitals systems. This is another well-known scheme and the result is increasing a government regulation rules: i.e., the new U.S. Food and Drug Administration (FDA) draft guidance documents for CAD technology issued in October 2009.

The Health sector has been applying information and communication technologies for quite long time but although large achievements have been attained, many challenges remain either partially explored or simply unexplored. Current generation of Hospital Information Systems changes a lot from their previous basic functions: many new functions and expectations are addressed to them. The future of HIS does not oriented only to the hospital data and information. HIS will have to cover patients out of the hospital and it will have to collect data for scientific research, and to provide data for pharmaceutical analyses, and so on.

The technology trends are closely connected to the future of the computer as a device. Today's research and development of new methods and technologies are still oriented to desktop types of computers. And this is true not only for the full list of medical devices and applications. But the future will be too different: we will have central service-based servers and many consoles/terminals (mobile and desktop) connected to them. The speed of communication and the local power of console/terminal will be dominant for the new era of medical applications. This will change the point of view to current Data Mining and AI applications in medicine because will change boundaries between thin and fat clients from computer point of view. As example this will change in many aspects the computer-aided diagnosis application oriented to chronic diseases.

Our examinations on current generation HIS concluded to the fact that hospital network overloads immediately if massive image or real-video exchange starts. This is unacceptable for this type of systems. In this context IMHIS has to address modes of failures, attacks to the network, overload of information and data and basic robustness. The performance characteristics should include among others:

- Speed of response
- Security and access control
- Accuracy of response
- Data and resource occupancy
- Network bandwidth
- Quality of service.

The other computer hardware problems are visualizing devices (monitors are a part of this group). The major task of computer applications is to transfer one type data (input data) to another type (output data) because the output data is more suitable and understandable for the user. But users receive this information from the computer via computer's output devices. We think that devices like artificial skin will not be suitable for medical purposes but visual devices will be the major output subsystem for humans. The future is 3D visual systems but computer science researchers do not forget one very important fact: the human sensing system is not educated to get so many and so different information from artificial sources. This requires special technologies and a special education oriented to these new types of information exchange between users and computers.

Massive research effort targets improving clinical outcomes and increasing the access to healthcare services and information, all while creating efficiencies that can save money and generate revenue. The analyses show expectations of the society for higher service quality, better results and lower costs. This poses a number of serious challenges to the Healthcare sector, as increasing expectations contrast with the clearly expressed critical shortage of resources, considering the ongoing ageing of population, each year requiring the increasing use of these resources on a daily basis. At the same time there is an increase of the share of chronically ill people, thus additionally limiting the available resources for healthcare. Those challenges have led to the development of various approaches and solutions during recent years, the most widely spread being the e-Health and Telemedicine. With the development of hardware tools for medical needs and the emergence of new approaches for working with the patients (pHealth and mHealth systems) these advantages have reduced significantly. This brings the issue of new paradigms for work with the medical information. One of the most promising directions of research is considered to be the exploration of the possibilities for creation of tools for advanced analysis of new generation, which would allow the healthcare to function successfully, while balancing between the demands and expectations of patients and society, and the resources and changes in medical systems and practices.

In order to achieve this, it is required that the tools for advanced analytics are able to use the increasingly broadening range of information of the patient, thus allowing a much earlier action for medical and administrative intervention. Directions are mixed medical, technical and financial: eHealth, Telemedicine, mHealth, pHealth, scalable business models, emerging reimbursement and payment structures, preventive health efforts, disease surveillance methods, chronic disease management, mobile telemedicine, and behaviour change interventions. As a final result, this would help improving the quality of patient care, better results of the work of the health system and reduction of costs.

III. Problems and Limitations

It is objective reality, that clinical workflow still depends largely on manual, paper-based medical record systems that is economically inefficient and produces significant variances in medical outcomes. There are basically two types of healthcare data:

- Administrative data – relating to costs, resources, staff, scheduling, etc.
- Clinical data – relating to the patient's condition, diagnostic tests, monitored parameters, care plans, etc.

Traditionally, clinical data has been collected either:

- At the patient's bedside, for example using an electrocardiograph or a patient monitoring system.
- In a clinical laboratory from a tissue, blood, urine or other sample taken from the patient.
- Image-based examinations presented in many different variations: from film-based X-rays and U-sound results to sophisticated tomography images.

In general, the paper-based raw clinical data is presented to the physicians with minimal processing. The physician then considers each piece of information, together with other available data, and reaches a diagnosis or makes a treatment decision. Changes over time are not tracked exactly in general: tracking patients before and after hospital visit is a task distributed between GPs, hospital doctors and the patient itself. This process is inconsistent in general.

The attempt for integration of databases in widely differing medical fields, having different requirements for the examination and accompanying the patients, is also an uncommented element of such classes if systems and will represent an innovation. The existence of multiple databases, storing a variety of information, in turn leads to the solution of issues related to heterogeneity, interoperability, complex data structures, and integration:

- The data are derived from various sources: internal (electronic health records, clinical system for, decision making, etc.) and external (laboratories, pharmacies, insurance companies, etc.).
- Data are in multiple formats (flat files, relational tables, text files, etc.) and they come from various geographical locations.
- Nowadays data sources include: data from websites and dedicated servers, social networking and blogs; remote sensor and measuring devices; invoices related to health care (both in unstructured or semi-structured formats); biometric data (medical images, blood pressure, etc.), unstructured and semi-structured data such as electronic health records, annotations, medical prescription, e-mails and paper documents.
- The data have an extremely high degree of heterogeneity in respect to the type of the used data model, the scheme of a given model, as well as the incompatible formats and nomenclatures of the values.
- At the same time the data is highly decentralized, with a high degree of terminological variations, records' specifics, data presentation formats and applications.

This in turn is associated with problems when conducting manual search for specific data or information. The purpose of work in this direction is to examine the sources of medical and biological data, the standards for descriptions of medical and biological data and the possibility of using text annotations as a source of medical information.

Organization, storage and maintenance of a huge range of medical and biological data remains a challenge due to the following factors:

- The volume of the data is increasing almost exponentially in the last decade.
- New data types are emerging and new medical and biological concepts are being developed.
- There are so many standards that it is easy to say there is no world-wide standardization in the nomenclature of the data.
- The data is most often stored in flat files and relational databases: about 70% of the data is stored in text format or as static images; the remaining 30% of data is stored in different types of databases, organized in indexed files or in specialized relational databases.

The strong decentralization of the medical and the biological data, the high differences in terminology and in the peculiarities of the entries presentation, and the difference in formats of data search queries requires exploration of the possibilities of creating automated procedures for databases integration. The aim is to achieve more than just retrieving and modifying data because nowadays the professional performance in any field of activity is increasingly dependent on accessing proper data and information. This requires comprehensive, easy to use and linked to the other databases surveys to provide the necessary data resources. The heterogeneity and decentralization require suitable methods to provide access to the actual data associated with a specific disease or a specific medical problem. This involves the integration of large and diverse databases / information / knowledge associated with different levels of performance and reading the problem.

Very significant group are issues related to medical imaging: modern non-invasive medical imaging techniques allow the generation of highly detailed anatomical and physiological information about the human body. This information is usually represented by a sequence of high-quality medical images (slices) stored in specialized or standardized formats (i.e., DICOM). In general, this information is:

- two-dimensional: static images, such as chest X-rays,
- three-dimensional: 3D reconstruction of the bodies from a set of slices, and
- four-dimensional: information about changing the 3D structures in time, i.e., real-time information for the fetus.

In addition, there may also be used a pseudo-colour as an additional procedure in order to extract specific information about the patient. All these data are unstructured by nature.

The main problems in the medical image processing, essential to the information or knowledge retrieval, are connected with:

- The segmentation, recognition and classification of anatomical structures or abnormalities.
- The retrieval of specific morphometric features from 3D models of anatomical structures.
- The comparison of the images, etc.

An additional problem in the use of medical images as a source of information is the fact that often the images are

subject of disturbing influences as linear or non-linear distortions, shifts, rotations, scaling, etc. This determines the ineffectiveness of many of the algorithms: very slow processing and extracting the necessary information from a single image.

One of the biggest problems for healthcare system and the quality of medical services is patient mobility. Today the answer is the Telemedicine tools and services because they have the potential to reduce differences in the lives of people: to provide permanent and rapid access to physicians at a distance using telecommunications, computer and information technologies, regardless of the patient's and the physician's locations:

- Telemedicine centres offer easy and almost immediate and/or simple access.
- Telemedicine enables and/or increases the access to an expert physician. It is quite common for serious medical conditions to be diagnosed at a later stage because it is often difficult for patients in rural areas to travel to large cities to get medical consultations in a tertiary hospital.
- Telemedicine is become a reasonable alternative to hospital physician visits and helps monitor chronic conditions: many patients require further monitoring and consulting after the treatment given to them in hospital.

All these define a set of problems to supplement current HIS with needed communication technologies for telemedicine purposes: from simple phones and emails, via satellite communications and reach to the video-monitoring and the video-conference systems. As a result the quality of Telemedicine applications is unambiguous depending from the quality of live images & video, live sounds & audio, real-time stream of additional data and information for patients.

IV. NEW SYSTEM'S REQUIREMENTS

The two main goals of the intelligent medical/healthcare information system development is the reduction of medical errors and improved communications between medical personnel, patients, government institutions, pharmacy companies and insurance companies:

- It will increase the quality of the healthcare and medical services.
- It will offer structured data / information / knowledges for increasing diagnosis quality.
- It will increase the quality of the in-hospital and out-of-hospital life-long patients' tracking.

Unfortunately, the vast amount of existing academic studies preliminary focus on narrow aspects of the problem and most often they only cover a small set of application's functionality. Corporate developments are oriented towards the possibility of renewal and development of the old company systems, through integrating new approaches to collection, unification, search and processing of data, information retrieval and generation of knowledge. The most frequently reported result is the identified impossibility to introduce substantially new modules and tools due to outdated design of systems of older generations.

A good practice for the in deep detail analysis of current generation HIS development/use/maintenance is the use a following smart methods:

- The stakeholder-centered analysis methods: it is a base of the "learning-by-doing" approach to form business modelling activity (i.e., case study with a strong focus on discovering how stakeholders can be best involved in business modelling).
- The business modelling and analysis: the "Business modelling" approach is very effective approach for evaluation and/or validation of healthcare processes and activities; it is used as a narrative to explain new ideas/procedures/and etc. because the resulting business model depicts how an organization creates, delivers, and captures value.
- The feedback analysis methods: the estimation of the used and/or proposed structure, processes, technologies, and functionalities.
- The prospective risk analysis in hospital environments (risk analysis of entity 'Hospital'): based on business models, the methods should be used for a detailed analysis of each process and within of a process of each task; by vulnerability analysis the most critical parts and elements in tasks and processes can be identified and described to plan medical and management activities.
- The crowdsourcing: it as a participative online activity in which a group of individuals of varying knowledge, heterogeneity, and number comes together to solve a problem; it is an effective approach and it is using to study knowledge based tasks, training activities, knowledge/information dissemination, and the in-community networking.

Main outcome of all our projects is an IT-oriented technology-based set of requirements, limitations, and guidelines:

- limitations of existing quality procedures and metrics
- new approaches to the use of computer systems in medical activities
- practical recommendations for new generation HIS infrastructure and functionality
- guidelines for improving the sustainability of health systems through the analysis of risk and the reduction in the number of medical errors
- guidelines of the set of standard operation (medical laboratories, hospitals) procedures
- guidelines for the standardization and harmonization of the quality assurance efforts in digital services of medical applications focused on patient safety tasks.

Using result of our collaborative projects and analyzing correlations between results and expectation we understand that medical and healthcare staff expects new generation HIS has to be:

- Comprehensive and effective platform, which will be effectively used for purposes like hospital medical activities, remote diagnosis and patient tracking, out-of-hospital medical activities (i.e., emergency tasks), administrative activities, hospital management, healthcare insurance, pharmaceutical, and other.
- To support enhanced Electronic Medical Record and remote reporting and advising system for health promotion, disease prevention and screening, vaccination, etc.
- To support on equal manner operations of concentrated and geographically distributed hospitals, healthcare organizations and professionals.
- To provide patients' entry point to the healthcare organization.
- To start to provide automation of healthcare functions to increase patients' safety and to reduce medical errors.
- To provide strong static and dynamic data security.
- To be easy to use by the no-computer-science users.
- To be accessible on various platforms (hardware + software).

- To be adaptable: hospitals have both common structure elements/processes/activities and many specific ones.
- To be relatively small but to have a great impact for reduce the most often causes in patient safety problems: i.e., communication errors, errors in pre-analytical processes, diagnostic problems related to the hospital labs' processes and activities.
- To have smart service platform with online quality assurance activities, communication support and effective, personalized design of medical and hospital processes for patient safety for will effectively answering the healthcare objectives and priorities.

This allowed us to promote the following key requirements for the functionality of the architecture of new HIS:

- Unified environment for data exchange between installed apparatus and systems in healthcare organization.
- Tracking the full process of hospitalization of every single patient.
- Management of all procedures and medications.
- Administrative tracking of all patients.
- To offer a background for expert medical systems for analysis and control of health status for every single patient.
- Remote messaging to medical personnel about health status of selected patients based on remote vital data acquisition and control.
- Telemedicine services: remote diagnoses, out-of-hospital health tracking and care, etc.
- Collaborative infrastructure for Hospital-to-hospital and GP-to-hospital teleconsulting.
- Data collection, storage, and analyses for every medication and procedures.
- Information extraction from heterogeneous data (medical, biological, management, etc.), information analyses and knowledge extraction.
- Personalized access to the data and information resources via heterogeneous communication environment: for healthcare organization of any size, by government and insurance, professional associations and singleton clinicians.
- Extended security policy: It has to be based on both static and dynamic security models for data collection, exchange and access and thus to provide manageable assurance of security levels, trust levels and regulatory compliance of the new highly dynamic SOA in multi-domain (distributed) infrastructures.

In general to design and implement single system of that type is impossible but IT technologies offer solutions for such complex integrated multi-purpose systems. The architecture has to be created on the basis of the most platform-independent architecture with and a new generation access technologies (including those for mobile devices, i.e., smartphones and tablets): components + Internet-of-things. It will support multi-user (Web) approach, local (intranet) and remote (internet) access to systems modules, services as well as management of databases. This will guarantee patients' follow up even in the case of changes as well as access to medical data by patient. Such an approach is of decisive importance for emergency too. The remote access will enable transmission of medical data (electrocardiograms, primary investigations at home done by paramedics) in urgent cases and during follow up of elderly patients and / or patients with chronic diseases. The remote access will enable control of medical service of each healthcare organization by government, insurance, professional associations, etc. Database architecture will ensure the collection of medical data accordingly with concrete electronic health record in one database.

V. AN EXAMPLE OF PRELIMINARY IMPLEMENTATION

The Emergency Department (ED) is one of the principal elements of modern healthcare systems. The aim of emergency care medicine is to provide patients with the healthcare that they need, ensuring the quality and safety of care [11]. There is an increasing demand for this resource, which involves high resources (staff, costs, equipment, environment, etc.).

Quality healthcare guarantees safe, appropriate, effective, efficient, accessible, and fair patient-centered care [4]. In last two decades, the care quality has the central healthcare focus, and patient safety has come to represent one of the key quality aspects. In the case of emergency care, this interest in quality is even more evident, not only because of its social and economic impact. Today, two factors are cited as key ones to the continuing push for improving quality of emergency care:

- for many humans the Emergency Department is the only public portal to access medical services;
- another key factor is the 'life-and-death' nature of emergency care.

Although emergency medicine is relatively new discipline of medicine (it is separated as an independent discipline towards the middle of the 20th century), but nevertheless, throughout this period the quality enhancement of emergency care has been a major concern and task for healthcare. That's why we start evaluation of our approach by design project for a new generation framework to the Emergency Departments in Bulgaria. The core stage of our activities is the analysis of the existing quality of emergency care (activities, devices, environment, staff, etc.) and generation of new quality metrics.

We started project activities based on well-known key axiom of engineering: "The evaluation of quality is a process of measuring of the difference between the results that should be achieved and those that are achieved." In order to accelerate the initial project activities stage we used a hybrid approach between the two classical basic approaches to the evaluation and improvement of the quality of care [3]:

1. The so-called "Room for Improvement" model:
   - It begins with the identification of problems, followed by their analysis and proposals for improvement.
   - The main question: What could we or should we improve?
2. The so-called "Monitoring systems" model:
   - This model is used to detect problems and periodically evaluate performance, the fundamental element of which is the indicators.
   - The main question: Of everything that we do, what is most important and how can we assure that we are doing it well enough?

We choose this hybrid approach, because such a type of studies has been carried out in Bulgaria, but they were not permanent and do not span all aspects of emergency care. We prepare two preliminary lists of activities aimed at quality improvement: a list of mandatory ED activities needed to be improved (the "Room for Improvement" model point-of-view), and a list of activities that necessarily need to be part of the emergency care (the "Monitoring systems" model point-of-view).

One of the mandatory rules of successful development of a new framework is that the set of requirements to be a complete and a consistent. In our hybrid approach that rule is converted to the need to prove that there is full connectivity

and traceability between the activities of the two lists, i.e. for each element from one list to have at least one directly connected element of the second list (an activity giving rise this action or an activity that is a direct consequence of this action). This led to rapid extensions of the both lists with many new activities.

The next step is the restructuring and merging two lists because we need more general categories of activities (i.e., a smaller number of specific quality indicators). Here are some of these aggregated categories:

- The emergency care is a patient-centered care and this includes good communication, an emphasis on relieving suffering, and the overall experience of patients.
- Patients with emergency care needs should have as early as possible access to specialist to assure appropriate on-going treatment. Additionally, after timely and appropriate care patients need additional care which continues to support them after they have left the ED.
- The ED staff should as early as possible recognize those patients requiring immediate attention and prompt time critical interventions. This improves assessment, investigation and management of patients with emergency conditions.
- The hallways or non-equipped overflow spaces are no place for routinely caring injured or acutely-ill patients.
- The duration of patients' stay in the ED is a compromise between requirement to maximize care and comfort of patients and requirement to optimize hospital outcomes.
- The ED should have adequate space to provide the necessary patient care: the environment should be promoted patient dignity and privacy.
- The ED staff should be specially qualified and trained to deliver emergency care. In cases of injury, life-threatening illness, mental or physical changing illness as early as possible to involve senior physician/-s with specific expertise (It is recommended that these professionals have experience in emergency care). Example: in many cases diagnoses and treatments need collaboration with physician from intensive care and/or anaesthesia departments.
- The ED environment should be provided for appropriate access to diagnostic support services (labs, radiology, ultrasound, etc.) when needed for the immediate diagnosis of life threatening conditions
- The ED environment should not be a source of new hospital infection. This requires appropriate set of rules, tools, and compliance with infection and hygiene control.
- The ED management should establish mechanisms to monitor compliance and standards, with action taken if a staff short.

Designated categories allow easier to define quality indicators because the indicator's influence is localized only within a specific group. This allows binding the created indicators with the basic three structural units of Emergency Medical Systems [6]:

- 1st emergency medical care: provide treatment for emergency patients with relatively mild illness or injury
- 2nd emergency medical care: provide treatment for emergency patients with more severe conditions, requiring surgery and/or hospital admissions, in general referred from initial emergency medical facility
- 3rd emergency medical care: provide 24 hour treatment for emergency patient with serious conditions requiring high level medical care (e.g., head injuries, stroke, myocardial infraction)

The main outcome from the analysis of these indicators can be defined so "*An important element of good emergency care is the constant development of enhanced and innovative services to support the delivery of safety and quality.*"

On the base of generated quality indicators we defined following set of mandatory computer and communications technologies:

- Wireless registration, monitoring, and communication.
- Digital audio/video communication: at least host-to-host, but better teleconference.
- Handheld devices and mobile computing
- Telemedicine devices support
- Electronic dashboard: centralized with remote connections
- New generation decision support systems
- Digital image creating and archiving: supporting different standards and devices of digital radiography
- Hi-speed secure and safety pre-hospital data and information transfer
- RFID tracking: at least passive, but better active.

Now our activities continue to determine the mandatory basic functions groups that should have each new generation Emergency Department HIS.

VI. Conclusion

Today our world is computer-based. We need understand computer limitation and we need understand the future of computer technologies. Doctors want to be only doctors (no technicians) but computer technologies can increase doctors' sensing. We need create and use new computer technologies in medical application that can increase the quality of the diagnoses and the treatment. We are not only doctors or engineers, we are patients too.

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