Advanced ICT for patient safety and quality of care

This paper reviews benefits that ICT applications, such as decision support tools and computerised physician order entry systems can bring for increased patient safety. Emerging technologies, such as data mining, modelling, simulation and biomedical imaging, are touched upon. These are findings of an EU study analysing key issues towards a research roadmap for eHealth-supported patient safety.

Veli N. Stroetmann, Karl A. Stroetmann*, Jean Pierre Thierry†, Octavian Purcarea‡*

Introduction

Since the USA report *"To Err Is Human: Building a Safer Health System"* [1] was published in 2000, the subject of patient safety and medical errors gained wide international attention in health policy, healthcare and research environments. Several European Union Member States (MSs) estimated the size of the problem, with findings similar to those in the USA. The European Commission (EC) has co-funded a wide range of research projects developing ICT solutions supporting healthcare professionals, including innovative decision support systems (DSS), electronic health record (EHR) applications, alert systems etc., all aiming at improving the quality of care. Information technology can reduce the rate of errors in three ways: by preventing mistakes and avoiding adverse events, by facilitating a rapid response after an adverse event has occurred, and by tracking and providing feedback about such events.

However, patient safety should not only involve reducing medical errors. *Our vision is rather to optimise patient safety and improve the quality of care across the whole health value system, including clinical research, risk assessment, disease prevention, personalised care, optimising medical intervention as well as training & education.* In other words, we propose to *look in a holistic way at newly emerging opportunities* to preserve health and improve the quality of acute and longer-term care, also taking into account *biomedical and other research results*, supported by ICT-based solutions.

ICT in healthcare: current state of play

ICT applications can be useful in almost every aspect of healthcare, including facilitating information and communication within and among healthcare organisations, supporting diagnostic and therapeutic processes, allowing the delivery of care to remote locations, increasing the efficiency of delivery, and, last but most important, increasing the quality of care provided to citizens. Wachter believes that "it seems self-evident that many, perhaps most, of the solutions to medical mistakes will ultimately come through better information technology. We may finally be nearing the time when institutions and providers will not be seen as credible providers of safe, high-quality care if they lack a strong IT backbone."[2]

One of the most important developments in recent years in many MSs has been the planning and implementation of EHRs at the national, regional and local level. In England, an evaluation of the *National Care Record System* led to the conclusion that it has significant potential to improve safety as lost or poorly completed records are a major contributory factor to patient safety incidents. It is likely that these large-scale deployments of eHealth infrastructures will lead also to the broader implementation of other ICT tools, like those addressed below.

There is a wide consensus that the use of a ***Decision Support System (DSS)*** can improve patient outcomes. DSSs are broad solutions, which are often incorporated in a variety of eHealth applications. They go back as far as 1974, and evidence indicates that they can indeed enhance clinical performance for drug dosing, preventive and other aspects of care, but so far not really convincingly diagnoses. However, it is also known that they may occasionally foster errors in entering and retrieving information, and errors in the communication and coordination process, rather than reducing them. Coiera concluded that "the use of clinical decision support systems (CDSS) can improve the overall safety and quality of healthcare delivery, but may also introduce machine-related errors. Recent concerns about the potential for CDSS to harm patients have generated much debate, but there is little research available to identify the nature of such errors, or quantify their frequency or clinical impact." [3]

Computerised Physician Order Entry (CPOE) systems have received considerable attention as a key technology to reduce medical errors. CPOE systems support a process whereby instructions regarding diagnosis and treatment are entered electronically and communicated directly to responsible individuals or services. DSSs are built into almost all CPOE systems to varying degrees, providing basic computerised advice regarding drug doses, routes and frequencies, as well as more sophisticated data such as drug allergy, drug-laboratory values, drug-drug interactions, checks and guidelines.

The following case study illustrates the benefits of a CPOE system:

ePharmacy at a London hospital, UK, is a combination of ePrescribing, eDispensing using a robot system, eStockmanagement and eProcurement, used for outpatients and discharged patients. The following benefits were reported:

- Fewer prescribing errors and discrepancies
- Fewer dispensing errors: down from 30 to 21 per 100.000 packs, with a 29% gain
- Shorter response time for urgent prescriptions: from 37% within one hour to 89%
- Most dispensary staff redeployed to wards

The annual net economic benefit was estimated at approximately €1.5m.

Source: www.ehealth-impact.org

However, there is also a potential danger involved. Studies in the US, UK and Australia found that "commercial prescribing systems often fail to uniformly detect significant drug interactions, probably because of errors in their knowledge base. Electronic medication management systems may generate new types of error because of user-interface design, but also because of events in the workplace such as distraction affecting the actions of system users."[4]

Whereas CPOE systems aim to prevent errors, ***computerised adverse event systems*** monitor the occurrence of instances that could be adverse events and alert the clinician when certain indicators are present. The most common adverse events are nosocomial infections and Adverse Drug Events (ADEs), consequently IT supported reporting systems have been tested primarily in these areas. Up to now, most institutions use voluntary incident reporting to detect ADEs. However, this method is rather ineffective and identifies only about one in 20 ADEs. Conversely, most IT applications have found a significant increase in the number of ADEs reported. ***Automatic alerts*** can reduce the time until treatment is ordered for patients with critical laboratory results. These techniques seem to be well adaptable for the detection also of other adverse events, in particular as more information becomes computerised.

Research has shown how important it is to design systems with the end-user, the clinician, in mind. If systems do not respond fast and display all relevant information in a coherent, easy-to-use manner, they are rejected and can even lead to more errors, not fewer. Only a deeper understanding of the complex cognitive and socio-technical interactions, which are so characteristic of healthcare processes, will result in the design of systems that support safe outcomes in the hands of busy or poorly resourced clinicians. Furthermore, the organisational culture, including barriers to reporting errors, will play a key role in the acceptance of electronic tools such as incident reporting systems.

ICTs play also a very important role in ***improving communication***. For instance, ePaging, where a system identifies and pages the professional on call (*role* based), which leads to a more rapid treatment (e.g. in case of critical lab results). Such a system requires physician-on-call schedules, known responsibilities, traceability, etc. The following case illustrates the benefits of a practical application of this:

DISPEC – ambulance emergency service, Romania, is a sophisticated, electronic emergency ambulance telemtage and dispatch system, introduced in 1996 by the City of Bucharest Ambulance Service. The nature and severity of an incident is identified by trained personnel based on information received from the caller, and the best matching ambulance equipment and team (4 types of ambulances equipped with GPS located across the city) is sent to the emergency site. The following benefits were reported:

- The incidence of death per emergency decreased by >25%
- Handling of increasing number of emergency calls with shrinking financial and staff resources
- Dramatic drop in call to dispatch time - decrease in average time by about 30%
- Dramatic drop in time till arrival at emergency site - decrease in average time by 35%

The annual net economic benefits were estimated at €1.4 m per year.

Emerging technologies

Various developing eHealth technologies will have a significant influence on new healthcare process models, and may also impact patient safety.

Towards a culture of safety in eHealth RTD

Whereas eHealth applications are intended to have a beneficial impact on citizens' health, recent research has

shown that some may under certain circumstances also be potentially harmful. New technologies inherently pose new risks. Patient safety aspects should, therefore, be taken into account by all eHealth Research and Technological Development (RTD), from EHR integration, home monitoring and assistive living, to biomedical informatics, nano-devices, and more.

Data mining for patient safety

New data mining techniques for *identifying common patterns in safety-relevant events* will be developed using powerful language processing algorithms to analyse structured and unstructured data (e.g. the text of physician's notes). Semantic mining will enable researchers to find meaning hidden in documents, and relate it to information available in other forms, such as images. Novel tools enabling the *integration of data from existing large databases and specific applications* need to be developed.

Integration of clinical research and patient care information

Connecting healthcare and clinical (trials) research will lead to improved drug safety due to higher quality data and real-time identification of safety issues and trends. Achieving global interoperability, especially semantic, would enable the immediate reporting of any adverse event for any patient anywhere who is taking that drug. Studies on rare diseases will become easier as candidate patients will be automatically identified worldwide. The integration of data across clinical and research boundaries and the monitoring of treatment will also accelerate the discovery and development of more effective innovative medicines with fewer side effects.

Advanced biomedical imaging

The increased precision, quality and availability of biomedical images can change the delivery of healthcare, with an obligatory impact on patient safety and healthcare related risks, for example, through optimising the therapeutic approach, and guiding minimally invasive interventions. Various subspecialties in surgery are bringing image-guided interventions into clinical practice, which will make surgery safer.

Simulation and virtual reality

Modelling and simulation of concrete disease processes can help to predict the results and side effects of a particular intervention in advance or enable medicines to be tested in 'virtual clinical trials' without putting people at risk. Simulation is also being used as a training and feedback method in which learners practice tasks and processes in lifelike circumstances using models or *virtual reality* (VR), with feedback from observers, peers, actor-patients, and video cameras to assist improvement in skills. VR simulations are already revolutionising surgical training

Outlook

Overall, ICT is an enabler that will revolutionise future healthcare processes, and a key component of a safer healthcare environment. However, it is only one component, and management and cultural issues deserve the same attention. Moreover, a holistic vision and strategy taking into account also organisational factors is mandatory if safety is to be strengthened for all, be they healthy citizens or patients in need of service.

References

1. IOM Report. 2000. To err is human: Building a safer health system. Institute of Medicine, 287 p. Available at: http://books.nap.edu/books/0309068371/html/index.html.
2. Wachter R. The End Of The Beginning: Patient Safety Five Years After 'To Err Is Human'. Health Affairs Web Exclusive. 2004; W4- 539.
3. Coiera E, Westbrook J.I., Wyatt J.C. The Safety and Quality of Decision Support Systems. In Haux R, Kulikowski C, editors. IMIA Yearbook of Medical Informatics 2006. Methods Inf Med 2006; 45 Suppl 1.
4. FCG Computerized Physician Order Entry: Costs, Benefits and Challenges. 2003. A Case Study Approach.

Acknowledgements

This paper was written as part of the ***eHealth for Safety Project - Study on the impact of ICT on patient safety and risk management in healthcare*** (www.ehealth-for-safety.org) commissioned by the European Commission, Directorate General Information Society and Media, Brussels. This paper reflects solely the views of its authors. The European Community is not liable for any use that may be made of the information contained therein.

The Authors

Veli N. Stroetmann[*], MD, Ph.D.*
Karl A. Stroetmann[*], MBA, Ph.D.*
Jean Pierre Thierry[†], MD*
Octavian Purcarea[¥], MD*
[*]*empirica Communication and Technology Research, Bonn, Germany*
[†]*Symbion, Maisons-Laffitte, France;*
[¥]*European Commission, Brussels, Belgium*

Correspondence

Dr Veli N. Stroetmann,
empirica,
Oxfordstr. 2, D-53111 Bonn, Germany
[redacted]