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Patient Safety: Detection and Prevention of Adverse Drug Events

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Abstract. Adverse Drug Events (ADE) represent a key problem in Public Health. The detection and prevention of ADE is a real challenge for hospitals and healthcare professionals. Healthcare Information and Communication Technologies can contribute to reduce the incidence of preventable ADE. During this workshop, we will discuss the various aspects of detection of ADE through methods like data and semantic mining in medical databases; the possibility of preventing ADE by using clinical decision support systems; the importance of Human Factors Engineering and the contextualization of knowledge. Examples and demonstrations will come from the European Project PSIP, devoted to the detection and prevention of ADE in Hospitals.

Keywords. patient safety, quality of care, data mining, decision support systems

1. Introduction

Adverse Drug Events (ADE), caused by product safety problems, medication errors, or Human Factors (HFs), are a major Public Health issue. They endanger the patients' safety and instigate considerable extra hospital costs.

Healthcare Information and Communication Technologies (ICTs) may help reducing the incidence of preventable ADE by providing the healthcare professionals and patients with real-time relevant alerts, information and knowledge (guidelines, recommendations, etc.). But their efficiency is impeded by two major drawbacks: the lack of sufficient and reliable knowledge about ADE, and the poor ability of present ICT solutions to deliver contextualized knowledge focused on the problem at hand, aggravated by a poor consideration of causative HFs.

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The objective of the workshop is to examine some points in the management of ADE through ICT:

- Is it possible to detect ADE by mining large medical databases, and particularly hospital Electronic Medical Records (EMR)?
- Is it possible to prevent ADE by using clinical decision support systems (CDSS) linked with CPOE and EMR?
- How to take into account Human Factors which are at the origin of a large number of ADE?

These different chapters will be assessed by a literature review and illustrated by some examples issued from the European Project PSIP (Patient Safety through Intelligent Procedures in Medication).

2. Identification of Adverse Drug Events

Most frequently, the identification of ADE is realized through retrospective analyses of patients' records. This is mainly done by a systematic review of the patient paper records. Many methodologies are available, but one of the most employed is the "chart review" which allows the analysis of a large number of patients' records in a limited time. This method is highly time-consuming, and requires a sufficient number of trained healthcare professionals.

Currently, the systematic review of healthcare records can be improved by filtering medical computerized databases by various querying methods [1]. Several statistical methods and advanced algorithms can be used for mining the medical data bases and identifying ADE. Semantic mining will be used to interpret the text-based information from reports and letters.

2.1. Data Mining

To explore large medical data bases, statistical and data mining methods are available, such as CART, neural networks, nearest neighbor techniques or decision trees. As the objective of data mining is to provide decision rules for computer decision support systems, "association rules", or "decision trees" algorithms seem the most capable of providing exploitable results. Other statistical techniques such as clusters, multi-component analysis, or logistic regression analysis can help to refine the mining.

These different methods will be discussed, and demonstrable examples of data mining results will be displayed. These examples come from the exploitation of more than 15,000 records extracted from four different hospitals in the framework of the PSIP Project. More than 200 decision rules are obtained from this phase for further implementation in the decision support system. This shows that ADEs can be identified from these techniques. Another interesting result resides in the differences observed between medical departments, hospitals, regions, and countries.

2.2. Semantic Mining

Semantic mining in comprises techniques to extract relevant information from discharge letters, discharge orders, procedure reports, drug approval documents and clinical guidelines.

Semantic mining is a huge challenge in the exploitation of medical documents. In the workshop, we will examine how semantic mining is able to help in the codification of medical documents and in the process of discovering ADE.

Illustration and examples will be given from the PSIP Project, where semantic mining is performed using a multi-terminology server, mostly around the MeSH.

3. Prevention of Adverse Drug Events

3.1. Decision Support Systems

CPOEs improve the quality of the prescription, the safety of the administration, and more globally the quality of care [2]. They are more reliable if they are linked with decision support systems. These CDSS provide alerts to physicians and nurses during the different phases of prescription, dispensation and administration. But one of the side-effects is the over-alerting consequences due to the high number of triggered rules after an order.

To improve the adequacy of the CDSS with the users' needs, and to avoid over-alerting, it appears necessary to contextualize the decision support system, i.e., to adapt the DSS to the clinical, professional and organizational contexts. From the results of data and semantic mining, the CDSS have to be adapted to the context where they will be used.

3.2. Information Systems

Contextualized information must also be provided during the prescription and administration phases. This additional information should be available through an 'info-button' linked to the CPOE. The principles and implementation of context-dependent decision support systems and information systems will be discussed during the workshop. The implementation principles will be presented on the basis of the PSIP decision platform designed in the EU project.

4. Human Factors Engineering

4.1. Human Factors Engineering and ADE

Many ADE (up to 90%) are not due to prescription or administration errors, drugs interactions of contraindications. They are related to human, organizational and cognitive factors. The detection of these ADE is more difficult [3] and their correction necessitates more than ICT, and requires a real Human Factors Engineering (HFE).

Moreover, the definition and the specifications of the CDSS aimed at preventing the ADE have to take into account HFE to provide the right information, in the right time, at the right place, to healthcare professionals able to handle it. One of the methodologies to manage these aspects is "Usability".

4.2. Usability Studies

Usability is the "effectiveness, efficiency and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment". Within usability engineering, specific methods have been developed to achieve the usability of a product or application. This requires the two-stage approach:

1. Analysis of the socio-technical system combined with a user-centered approach to the design of the system. The outcomes of this analysis are usability goals and specifications that support a user-centered design of the application (the contextualized DSS) and the corresponding Human Computer Interface.
2. Usability assessment of the prototype has to be performed till usability goals are completed. The outcome of this analysis of the usability problems are recommendations for the development of ICT for fixing the problem.

5. Agenda of the Workshop

The workshop will discuss these different topics, firstly in a general way, secondly by using the experience and results of the PSIP EU Project with the participation of:

- Régis Beuscart, Peter McNair: General presentation of the Workshop. Data Mining Principles and Results.
- Stefan Darmoni: Semantic Mining
- Vassilis Koutkias, Nicos Maglaveras: Decision Support Systems for preventing ADEs
- Christian Nohr, Marie-Catherine Beuscart-Zephir: Human Factors Engineering
- Conclusion

6. Conclusion

Due to the high number of ADE during hospitalizations and their impact on Public Health, it is mandatory to improve methods and systems to detect and prevent them. ICT can improve the identification of ADEs through data and semantic mining methods, and can help to prevent them through decision support systems connected to both CPOEs and EMRs. The place of these systems has to be carefully assessed by means of Human Factors Analyses.

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