

A Medical Informatics Perspective on Decision Support Systems

Findings from the Yearbook 2012 Section on Decision Support

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Summary

Objectives: To summarize current excellent research in the field of computer-based decision support systems in health and healthcare.

Methods: We provide a synopsis of the articles selected for the IMIA Yearbook 2012, from which we attempt to draft a synthetic overview of the activity and new trends in the field.

Results: While the state of the research in the field of medical decision support systems is illustrated by a set of fairly heterogeneous studies, it is possible to identify fundamental aspects of the fields, e.g. Decision Support Systems for Computerized Provider Order Entry, both for physicians and pharmacists, as well as more specific developments such as instruments to improve processing of data related to Clinical Trials and applications to capture family health history.

Conclusion: The best paper selection of articles on decision support shows examples of excellent research on methods concerning original development as well as quality assurance of previously reported studies. This selected set of scientific investigations clearly question the way decision support systems are deployed in clinical environments as these systems seem to have little impact on patient safety and even could harm the patient. Furthermore, while significant research efforts are invested into translational & "omics" medicine, it is interesting to observe that simple data capture applications can reasonably lead to positive changes in healthcare.

Keywords

Medical informatics, International Medical Informatics Association, yearbook, Decision-support systems;

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Introduction

Out of the five selected papers this year, it is worth observing that two are concerned with CPOEs (Computerized Provider Order Entry), two are discussing issues related to clinical trials and the fifth paper presents an original system to capture family health history in two primary care units. The first paper we selected this year, addresses the central problem of drug prescription. While Decision Support for drug prescription is a central challenge in medical informatics, this paper is relatively innovative in the sense that it adopts the point of the view of the pharmacist rather than the one of the physician. The conclusion is sadly consistent with those already reported for CPOE. Basically, many pharmacy clinical decision-support systems perform less than optimally with respect to identifying well-known interactions.

The second paper evaluates the incidence of duplicate medication orders before and after the implementation of a computerized provider order entry (CPOE) with Clinical Decision Support (CDS) in a 400-bed Northeastern US community tertiary care teaching hospital. The authors show that duplicate medication order errors increased with CPOE implementation, pointing out the work system factors, and medication database design. The third paper reviews the state of the art in the field of Clinical Trial Recruitment Support System (CTRSS). Although published studies are difficult to com-

pare, the authors recall that the acceptance by clinicians is a key success factor while there is little evidence of use of interoperability standards. In parallel, it is concluded that the pre-screening phase of trial recruitment is the most effective part of the process to address with CTRSS. The author of the systematic review also observe that none of the reviewed studies attempted to mine unstructured textual data contents such as follow up notes; although automatic medical encoding seems ready to deliver [1] good quality data for specific application such as billing [2][3] or for general-purpose encoding tasks [4]. In a different context, the fourth paper underlines the lack of standards to uniformly report Clinical Trials, whose reporting quality is generally regarded as low by the authors. The fifth, and last paper of the selection, propose to study the impact of a system to capture family history for both risk analysis and clinical care, in order to anticipate future developments in personalized medicine.

Best Paper Selection

The best paper selection of articles for the guest section on decision support in the IMIA Yearbook 2012 follows the tradition of previous Yearbooks in presenting excellent research on methods used for the implementation of computer tools to help medical professionals to better access and process infor-

mation to make better decision. A brief content summary of the selected best papers can be found in the appendix of this report.

Conclusions and Outlook

The best paper selection of articles on decision support shows examples of excellent research on methods concerning original development as well as quality assurance of previously reported studies. This selected set of scientific investigations clearly question the way decision support systems are deployed in clinical environments as these systems seem to have little impact on patient safety and even could harm the patient. Symmetrically, it is suggested that more demanding standardization efforts to describe clinical trials are urgently needed. Altogether these papers support the idea that more elaborated computer tools do not necessarily bring more effective clinical processes and suggest that gaps in semantic interoperability (e.g. CONSORT) and design of knowledge bases (e.g. drug-drug interactions) must often be addressed first. Furthermore, while significant research efforts are invested into translational & “omics” medicine; it is interesting to observe that simple data capture applications can reasonably lead to positive changes in healthcare.

Acknowledgement

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3. Pakhomov SV, Buntrock JD, Chute CG. Automating the assignment of diagnosis codes to patient

Table 1 Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2012 in the section ‘Decision Support’. The articles are listed in alphabetical order of the first author’s surname.

Section
Decision Support
<ul style="list-style-type: none"> ▪ Augestad KM, Bernitsen G, Lassen K, Bellika JG, Wootton R, Lindsetmo RO; Study Group of Research Quality in Medical Informatics and Decision Support (SQUID). Standards for reporting randomized controlled trials in medical informatics: a systematic review of CONSORT adherence in RCTs on clinical decision support. <i>J Am Med Inform Assoc</i> 2012 Jan-Feb;19(1):13-21. ▪ Cuggia M, Besana P, Glasspool D. Comparing semi-automatic systems for recruitment of patients to clinical trials. <i>Int J Med Inform</i> 2011 Jun;80(6):371-88. ▪ Orlando LA, Hauser ER, Christianson C, Powell KP, Buchanan AH, Chesnut B, Agbaje AB, Henrich VC, Ginsburg G. Protocol for implementation of family health history collection and decision support into primary care using a computerized family health history system. <i>BMC Health Serv Res</i> 2011 Oct 11;11:26. ▪ Saverno KR, Hines LE, Warholak TL, Grizzle AJ, Babits L, Clark C, Taylor AM, Malone DC. Ability of pharmacy clinical decision-support software to alert users about clinically important drug-drug interactions. <i>J Am Med Inform Assoc</i> 2011 Jan-Feb;18(1):32-7 ▪ Wetterneck TB, Walker JM, Blosky MA, Cartmill RS, Hoonakker P, Johnson MA, Norfolk E, Carayon P. Factors contributing to an increase in duplicate medication order errors after CPOE implementation. <i>J Am Med Inform Assoc</i> 2011 Nov-Dec;18(6):774-82. Epub 2011 Jul 29

encounters using example-based and machine learning techniques. *J Am Med Inform Assoc* 2006 Sep-Oct;13(5):516-25.

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Appendix: Content Summaries of Selected Best Papers for the IMIA Yearbook 2012, Section Decision Support*

Saverio KR, Hines LE, Warholak TL, Grizzle AJ, Babits L, Clark C, Taylor AM, Malone DC Ability of pharmacy clinical decision-support software to alert users about clinically important drug-drug interactions

* The complete papers can be accessed in the Yearbook’s full electronic version, provided that the article is freely accessible or that your institution has access to the respective journal.

J Am Med Inform Assoc 2011 Jan-Feb;18(1):32-7

Purpose

Clinical decision-support (CDS) software can help pharmacists to identify problematic drug-drug interactions. However, studies show that these systems are often not able to identify well-known potentially life-threatening interactions. The authors aim at assessing the performance of pharmacy CDS systems to alert about problematic drug-drug interactions (DDI).

Methods

During twelve months, the authors of the article visited sixty-four pharmacies to assess the ability of pharmacy information systems and associated CDS to detect DDIs. Assessments were conducted to determine whether DDI alerts arose from prescription orders entered into the pharmacy computer systems for a standardized fictitious patient. The fictitious patient’s orders consisted of a set of drugs with about two third of it with clinically significant DDIs, and one third having no interacting drug pairs. The sensitivity, specificity, positive predictive value, negative predictive value, and percentage of correct responses were measured.

Results

Slightly more than a quarter of the 64 pharmacies correctly identified eligible interactions and non-interactions. The median percentage of correct DDI responses was below 90%. The median sensitivity to detect well-established interactions was 0.85; median specificity was 1.0; median positive predictive value was 1.0 (range 0.88-1.0); and median negative predictive value was 0.75 (range 0.38-1.0).

Conclusion

The results suggest many pharmacy clinical decision-support systems are not effective to detect well-known, clinically important DDI.

Wetterneck TB, Walker JM, Blosky MA, Cartmill RS, Hoonakker P, Johnson MA, Norfolk E, Carayon P

Factors contributing to an increase in duplicate medication order errors after CPOE implementation

J Am Med Inform Assoc 2011 Nov-Dec;18(6):774-82. Epub 2011 Jul 29

Purpose

To evaluate the incidence of duplicate medication orders before and after computerized provider order entry (CPOE) with clinical decision support (CDS) implementation and identify contributing factors in a large tertiary care teaching hospital.

Methods

CPOE with duplicate medication order alerts was implemented in two intensive care units (ICUs). Professional nurses were trained nurses using the following channels: chart review, computer-generated reports of medication orders, provider alerts, and staff reports. A multidisciplinary team comprising a physician and a human factor engineer evaluated the prescription errors.

Results

Data were collected in a balanced way after and before implementation of the system for more than 4000 days. It is

reported that duplicate medication ordering errors increased after CPOE implementation by a factor 3, from 2.6% to 8.1 % ($p < 0.0001$). Most post-implementation duplicate orders were either for the identical order or the same medication. Contributing factors included: (1) provider ordering practices and computer availability; (2) communication; (3) CDS and medication database design, e.g. high false-positive alert rate, and CDS algorithms missing true duplicates; (4) CPOE data display, for example, difficulty reviewing existing orders; and (5) local CDS design, for example, medications in order sets defaulted as ordered.

Conclusion

It is concluded that duplicate medication order errors did increase after introduction of CPOE and CDS implementation.

Cuggia M, Besana P, Glasspool D

Comparing semi-automatic systems for recruitment of patients to clinical trials

Int J Med Inform 2011 Jun;80(6):371-88. Epub 2011 Apr 2

Objectives

The authors aim at reviewing the state of the art of decision support systems applied to the automatic recruitment of patients to clinical trials (Clinical Trial Recruitment Support Systems, CTRSS). More specifically, they attempt to identify the main features of this problem, as well as the power, limits and perspectives of previously studied studies.

Methods

The authors search for Medical Subject Headings in digital libraries such as MEDLINE, EMBASE, and Google Scholar from January 1st 1998 to August 31st 2009. As result of the search equations, they extracted 73 references. Out of the results, 33 citations describing 28 distinct studies were selected and reviewed. The reviewed papers were then categorized into an existing 10-

axis classification describing clinical decision support systems.

Results

Only a few dimensions were needed to comprehensively describe CTRSS. About a quarter of the papers evaluated the decision-support system's effectiveness regarding trial pre-inclusion or enrolment rate. All systems were able to exploit structured and medically-encoded patient data. None of the reviewed study attempted to exploit unstructured contents. Only a small fraction of the reviewed study attempted to assess the acceptance of CTRSS by clinicians, as well as the integration into an existing clinical workflow. Finally, most of the studies seem to ignore the use of interoperability standards.

Conclusion

It is concluded that the design, scope, and evaluation procedures of the reviewed studies is so heterogeneous that it is difficult to clearly define the impact of the different approaches on quantitative outcomes such as the recruitment rate. Nevertheless, the pre-screening phase of the trial recruitment is obviously the most important part of the process. Ultimately, the seamless integration of CTRSS in a sound clinical workflow and good acceptance by professionals are critical for this type decision support instruments.

Augustad KM, Berntsen G, Lassen K, Bellika JG, Wootton R, Lindsetmo RO; Study Group of Research Quality in Medical Informatics and Decision Support (SQUID)

Standards for reporting randomized controlled trials in medical informatics: a systematic review of CONSORT adherence in RCTs on clinical decision support

J Am Med Inform Assoc 2012 Jan-Feb;19(1):13-21. Epub 2011 Jul 29

Purpose

The authors aim at improving the quality of clinical trials' description by publishing an emerging standard: the Consolidated Standards for Reporting Tri-

als (CONSORT). More specifically, the authors attempt to measure the CONSORT adherence of randomized clinical trials (RCT) of disease specific clinical decision support (CDS).

Methods

The author performed a search in the following digital libraries: MEDLINE, EMBASE, and Cochrane databases. Compliance with RCTs on CDS was assessed against CONSORT guidelines and the Jadad score. CONSORT recommendations and Jadad scoring were used to measure the compliance of RCT on CDS.

Results

Only a fraction (32) of the 3784 originally retrieved papers were finally selected for a total distribution as follows: 181 702 patients and 7315 physicians. Most trials were performed in primary care (22). RCTs assessing CDS for the following pathologies were the most frequent: asthma, diabetes, and hyperlipidemia. About 40% of the CDS systems (40%) were embedded EHRs (Electronic Health Records) and about the same proportion (43%) were able to trigger clinical alerts. CONSORT and Jadad scores were generally low: mean score was 30.75 (95% CI 27.0 to 34.5), median score 32, range 21-38. 43% of the reviewed trials did not clearly define the objective of the study, while 34% did not describe the sample size calculation methodology. 71% of the the studies were provided with clear outcome measures. Almost two third of the studies (62%) did not report at all on adverse effects. 40%

of the trials were classified as “superior quality” according to the Jadad score (e”3 points). A small fraction of the trials (18%) elaborated on the long-term implementation of decision support system.

Conclusion

It is concluded that current quality of RCT is relatively low, suggesting that standards need to be further developed and promoted in medical informatics.

Orlando LA, Hauser ER, Christianson C, Powell KP, Buchanan AH, Chesnut B, Agbaje AB, Henrich VC, Ginsburg G

Protocol for implementation of family health history collection and decision support into primary care using a computerized family health history system

BMC Health Serv Res 2011 Oct 11;11:264

Purpose

The CDC’s Family History Public Health Initiative aims at promoting awareness of family health history. The authors use the personalized medicine implementation science research agenda to develop and integrate a computerized family history system. The system is self-administered and implemented into 2 primary care clinics in North Carolina.

Methods

The current system is able to capture 48 features over a time span of three generations. It provides decision support (pedigree and tabular family history, provider recommendation report and patient summary report) for the

following conditions: breast, ovarian and colon cancers, and thrombosis. All adult English-speaking, non-adopted, patients can complete the data capture procedure before the medical visit. Generated documents are inserted into the medical record to be available prior to the appointment. Primary outcomes can then be modified in appropriate testing for hereditary thrombophilia and screening for past breast, colon and ovarian cancers one year after study enrollment. The authors also measure secondary outcomes to assess the benefits and burdens of the family health system, as well as its impact on clinic workflow, patients’ risk perception, and intention to change health related behaviors. Chart reviews, patient surveys at baseline and follow-up, and provider surveys are indicators used to assess the outcomes. The medical validity of the decision support is compared to recommendations made by a trained genetic counselor, while ultimately clinical utility will be evidenced through reclassification rates and changes in appropriate screening.

Conclusion

This study integrates a computerized family health history system within the context of a routine medical appointment. The idea is to provide solutions to overcome barriers, hindering the data capture of family health history data by primary care providers. Results of the implementation process should finally guide the design of the personalized medicine instruments, such as health risk assessments