INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS XXX (2015) XXX–XXX

journal homepage: www.ijmijournal.com

Pilot evaluation of an optimized context-specific drug–drug interaction alerting system: A controlled pre-post study

Pieter Cornu[a,*], *Stephane Steurbaut*[a], *Kristof Gentens*[b], *Rudi Van de Velde*[b], *Alain G. Dupont*[a]

[a] *Research Group Clinical Pharmacology & Clinical Pharmacy (KFAR), Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel, Laarbeeklaan 101, 1090 Brussels, Belgium*
[b] *Department of Medical Informatics, UZ Brussel, 1090 Brussels, Belgium*

ARTICLE INFO

Article history:
Received 24 September 2014
Received in revised form
8 December 2014
Accepted 13 May 2015

Keywords:
Pre-post evaluation
Clinical decision support systems
Drug–drug interactions
Hospital
Alert specificity

ABSTRACT

Objectives: Clinical decision support (CDS) systems are frequently used to reduce unwanted drug–drug interactions (DDIs) but often result in alert fatigue. The main objective of this study was to investigate whether a newly developed context-specific DDI alerting system would improve alert acceptance.

Methods: A controlled pre-post intervention study was conducted in 4 departments in a university hospital. After a 7-month pre-intervention period, the new system was activated in the intervention departments, while the old system remained activated in the control departments. Post-intervention data was collected for a 7-month period.

Results: A significant increase of the overall acceptance rate was observed between the pre- and post-intervention period (2.2% versus 52.4%; $p < 0.001$) for the intervention departments and between the intervention and control departments (2.5% versus 52.4%; $p < 0.001$) in the post-intervention period. There were no significant differences in acceptance rates between the pre- and post-intervention period in the control departments and also not between the control and intervention departments in the pre-intervention period.

Conclusions: The improvement was probably related to several optimization strategies including the customization of the severity classification, the creation of individual screening intervals, the inclusion of context factors for risk assessment, the new alert design and the creation of a follow-up system. The marked increase in alert acceptance looks promising and should be further evaluated after hospital wide implementation. System aspects that require further optimization were identified and will be developed. Further research is warranted to develop context-aware algorithms for complex class–class interactions.

1. Introduction

Drug–drug interactions (DDIs) are an important threat to patient safety [1,2]. A common approach to reduce unwanted DDIs in hospital practice is the use of clinical decision support (CDS) systems [1,3,4]. However, most CDS systems for

* Corresponding author. Tel.: +0032 2 477 6432; fax: +0032 2 477 6431.
E-mail address: Pieter.Cornu@vub.ac.be (P. Cornu).

http://dx.doi.org/10.1016/j.ijmedinf.2015.05.005
1386-5056/

DDI screening generate alerts with low specificity leading to alert fatigue [3,5]. Reported override rates range from 33 to 96% with most studies reporting rates exceeding 80%, even for high severity DDI alerts only [5–9]. A first step for improving alert acceptance is the tiering of alerts [6,10,11]. Criteria for evaluating the clinical importance of DDIs and tiering of alerts have been proposed [1,6,11,12]. However, even with tiering high override rates remain [6,10,11].

As indicated by Slight et al. [13], it is important to investigate why providers overrode DDI alerts. In a previous study, we compared the performance of the CDS system for DDI screening which was in place at that time in the hospital and of clinical pharmacists in preventing DDIs on a geriatric ward. We found a low alert acceptance mainly because of low specificity of the CDS alerts [14]. Based on the comparison with the clinical pharmacist approach, it was suggested that the alert specificity can be increased by including contextual factors into the CDS logic and adjusting the screening interval in function of individual DDIs while taking into account the drug sequence.

Optimizing strategies for improving alert specificity were also proposed by Seidling et al. [15]. They reported that for the vast majority ($n = 83$) of a subset of 100 critical DDI alerts, the alert severity depends on individual patient data, factors related to the prescription, the co-medication, or combinations of these. To our knowledge there is only one institution that already successfully implemented context-aware DDI alerts where the severity and content of alerts varies in function of individual patient data [16]. The effect of context enhanced alerts on physician adherence in the outpatient setting was evaluated by Duke et al. [17] for DDIs known to cause hyperkalemia. They found that the display of relevant laboratory data did not improve adherence [17].

Based on the results of previous studies and after discussions with the stakeholders in our hospital, we started with redesigning the CDS system for DDI screening two years ago [14,18]. In this study we report the results of the pilot launch of the new context-specific DDI system in two departments in the UZ Brussel hospital. If the system proves to be successful during pilot testing, it will be implemented in all other clinical departments.

The main objective of this study was to investigate whether the new context-specific DDI alerting system improved alert acceptance. Additionally, we examined the results of the interventions conducted by a clinical pharmacist based on the real time follow-up of alerts.

2. Materials and methods

2.1. Design and setting

This was a controlled pre-post intervention study conducted at the UZ Brussel, a 721-bed university hospital in Brussels, Belgium. The intervention was the implementation of a new context-specific DDI alerting system for physicians in a 29-bed acute geriatric department and a 21-bed infectious disease department. The controlled pre-post design on physically separated departments was evaluated as the best possible design for this pilot evaluation [19,20]. The geriatric department was chosen because of previously conducted research and the infectious disease department was chosen for practical reasons and convenience because it was located next to the geriatric department [14,21,22]. A 29-bed cardiology department and 29-bed neurology department were selected as control departments. These control departments were chosen because these are also non-surgical departments located on different floors than the intervention departments, and because there were no planned transfers of interns from the intervention to the control departments during the study period, which could lead to data contamination. Interns (during their first years) switch from hospital department every 4 months. Baseline data was collected from April 19th, 2013, till November 18th, 2013. After giving a brief presentation of the new DDI screening system, the system was activated for all physicians of the intervention departments on November 19th, 2013. The old system remained active for the physicians of the control departments. Post-intervention data was collected from November 19th, 2013, till June 19th, 2014. The study was approved by the UZ Brussel Medical Ethics Committee. We followed the STARE-HI statement for writing the manuscript [23,24].

2.2. The software system

The in-house developed software system was introduced in 1994 [25,26]. This home-grown system, called the "Clinical Workstation", evolved further and is fully integrated within the workflow of various medical services. This holistic approach provides an integrated view giving birth to various functionalities such as an integrated electronic medical record (EMR), computerized physician order entry (CPOE) and CDS for drug prescribing [14,18]. In Belgium, only physicians are allowed to prescribe drugs so physicians are the intended end-users for prescribing CDS. After confirmation of a prescription in the CPOE module, prescriptions are directly sent electronically to the pharmacy for distribution.

2.3. History of the DDI screening system

In the old system non-interruptive DDI alerts were provided during prescribing, meaning that override reasons were not required and the prescription could be confirmed without any additional action (Fig. 1). The alert included the alert level, the drugs involved and a description of the effect. Detailed information could be obtained by selecting the additional information button. Fig. 2 shows an example of the additional information. The knowledge base supporting DDI checking was the commercially available DelphiCare® database and the user interface was self-developed [27].

In the Delphicare® database, DDIs were categorized in 6 levels until October 2013 and 8 levels thereafter depending on their clinical relevance and seriousness (Table 1).

In October 2013, the commercial database provider added two levels to the severity classification. 'Contraindicated' alerts from before October 2013 were subsequently divided in 'contraindicated' (always) and 'contraindicated if certain risk factors are present', and the level 'concurrent use is not recommended' was added. The Delphicare® levels were mapped to in-house levels and before October 2013, level 1 Delphicare®

Please cite this article in press as: P. Cornu, et al., Pilot evaluation of an optimized context-specific drug–drug interaction alerting system: A controlled pre-post study, Int. J. Med. Inform. (2015), http://dx.doi.org/10.1016/j.ijmedinf.2015.05.005