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Understanding handling of drug safety alerts: a simulation study

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ABSTRACT

Purpose: To study correctness of drug safety alert handling and error type in a computerized physician order entry (CPOE) system in a simulated work environment.
Methods: Disguised observation study of 18 physicians (12 from internal medicine and 6 from surgery) entering 35 orders of predefined patient cases with 13 different drug safety alerts in a CPOE. Structured interviews about how the generated drug safety alerts were handled in the simulation test and resemblance of the test to the normal work environment. Handling and reasons for this were scored for correctness and error type.
Results: Thirty percent of alerts were handled incorrectly, because the action itself and/or the reason for the handling were incorrect. Sixty-three percent of the errors were categorized as rule based and residents in surgery used incorrect justifications twice as often as residents in internal medicine. They often referred to monitoring of incorrect substances or parameters. One alert presented as a second alert in one screen was unconsciously overridden several times. One quarter of residents showed signs of alert fatigue.
Conclusion: Although alerts were mainly handled correctly, underlying rules and reasoning were often incorrect, thereby threatening patient safety. This study gave an insight into the factors playing a role in incorrect drug safety alert handling that should be studied in more detail. The results suggest that better training, improved concise alert texts, and increased specificity might help. Furthermore, the safety of the predefined override reason 'will monitor' and double alert presentation in one screen is questioned.

1. Introduction

Overriding of drug safety alerts in computerized physician order entry systems (CPOEs) is very common and occurs in 49–96% of cases [1]. However, frequent overriding may cause alert fatigue, important alerts being overridden along with unimportant ones, thus impairing patient safety. Research into overriding has been focused on the extent of overriding, reasons and causes for overriding in general, effects of overriding and suggestions for useful alerts [1]. Studies on the role played by cognitive processes in overriding drug safety alerts are lacking [1]. It is not clear which cognitive level is used in interpretation and handling of drug safety alerts, which kind of errors are made and which factors determine these processes. Understanding the reasons for, and causes of, over-

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riding in particular cases is necessary for the development of effective alerting systems that are safe and acceptable to users [1].

The aim of this study is to gain an insight into errors occurring in drug safety alert handling. The research questions are:

1. How many, and which type of, errors are made in handling drug safety alerts?
2. Are there any signs of alert fatigue or dependency on the alerting system?

2. Background

The handling of drug safety alerts can be divided into several steps: the alert has to be read and understood, the consequences of the intended plan have to be weighed, and the intended action has to be performed [1]. In each step different types of errors can be made.

Reason divides human errors into slips, lapses and mistakes [2,3]. Slips are acts not intended, nor attended; errors in which the right intention is incorrectly carried out, for example clicking the override button instead of the cancellation button [4]. Lapses are errors of omission, for example forgetting to place a remark in the order that drugs should be administered separated by an interval of 2 h. Slips and lapses are examples of execution failures. Mistakes are made when the intended action is wrong, which may be due to misinterpretation of the situation or to errors in planning an intended action, for example by applying wrong rules. Mistakes are categorized as problem-solving failures [2]. If Reason's model of accident causation is applied to drug safety alerts, three types of active failures can be discerned: ignoring alerts, misinterpretation and wrong selection [1].

Rasmussen identifies three levels of human performance in information processing: skill-based (SB), rule-based (RB), and knowledge-based (KB) behavior [5]. SB performance takes place without conscious attention or control and the person generally does not know why he acted in a particular way or on what information he based his action. In RB behavior the actor uses rules of the type 'if–then', which have been derived empirically or have been learned from textbooks or other persons. At the KB level, the person resorts to functional reasoning after pre-existing solutions have failed, making a plan with different scenarios, based on the environment and ultimate goal [5].

This SRK framework is a basic model often used in cognitive psychology. The framework describes how individuals process information and make decisions on their own [3] and which level of cognitive control is guiding their behavior [6]. The SRK framework is often used as a tool for *post hoc* analysis of accidents. Errors made on different cognitive levels require different interventions to prevent them [4,6]. Therefore, insight into the error type is a prerequisite to developing suitable interventions for error reduction.

Physicians handling drug safety alerts have to process the alert information and to decide whether alert overriding or annulment is appropriate and whether additional information or monitoring is required. It is likely that errors are being made, because alert override rates are high, even if only alerts that require action are generated [1,7]. As alert handling is generally performed individually, the SRK framework seems to be an appropriate model.

People intuitively prefer handling strategies that depend on sequences of simple operations instead of switching to a higher performance level requiring more mental energy [2,5]. Preprogrammed SB behavior is therefore preferred to RB behavior. SB errors are easily made because of inattention, but are generally easily detected when the feedback of the output fails to match the expected feedback [2,4].

Similarly, RB behavior is preferred to KB behavior. RB errors can be divided into misapplication of good rules, application of bad rules, and failure to apply good rules. Rules that have frequently been employed successfully in the past are extremely strong ones that are easily applied even if the circumstances no longer warrant their use [2,4]. The two error-prone mechanisms that play a role in this are similarity matching, deciding that one situation more or less resembles another, and frequency gambling, using the most frequently used successful rules [2–4]. Performance at the KB level is more error prone than at the RB and SB level, because the workspace for problem solving is limited and information acquisition and integration can fail in many different ways [2,4]. For example, one could give attention to the wrong features, give undue weight to facts that come readily to mind, to evidence that favors the chosen course of action, or to perceived causality [2]. RB and KB errors are generally not easily detected because actions are performed according to plan [2].

With decreasing familiarity with the environment or the task the person resorts to KB instead of SB behavior [2] and consequently, the performance level is influenced by both the level of training and the experience with the situation or the alert.

3. Methods

3.1. *Setting*

The Erasmus University Medical Center in Rotterdam, the Netherlands is a 1237-bed academic medical center that started introducing CPOE in December 2001. Since March 2005 all inpatient wards, intensive care units excluded (1107 beds), have been using the Windows-based CPOE system Medicatie/EVS® (iSOFT, Leiden, the Netherlands) [8].

3.2. *Test development*

A simulation test was developed with 6 patient cases, 35 orders and 13 drug safety alerts of different types (2 duplicate orders, 8 drug–drug interactions (DDIs), and 3 overdoses) and different familiarity. Seven alerts needed to be overridden, 6 required order adjustment. The percentage alerts per order (37%) and the relative number of DDI alerts (62%) were comparable to those encountered during daily drug prescribing in the hospital [7–9]. One duplicate order (DO) was relevant, the other irrelevant. One DDI was irrelevant, the others required monitoring of glucose serum level, international normalized ratio (INR), recording an electrocardiogram (ECG), prescribing an extra drug, adjusting administration times, or dose reduction.