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Review

Interventions to reduce nurses' medication administration errors in inpatient settings: A systematic review and meta-analysis

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ABSTRACT

Background and objectives: Serious medication administration errors are common in hospitals. Various interventions, including barcode-based technologies, have been developed to help prevent such errors. This systematic review and this meta-analysis focus on the efficacy of interventions for reducing medication administration errors. The types of error and their gravity were also studied.

Methods: MEDLINE, EMBASE, the Cochrane Library and reference lists of relevant articles published between January 1975 and August 2014 were searched, without language restriction. Randomized controlled trials, interrupted time-series studies, non-randomized controlled trials and controlled before-and-after studies were included. Studies evaluating interventions for decreasing administration errors based on total opportunity for error method were included. Nurses administering medications to adult or child inpatients were considered eligible as participants. Two reviewers independently assessed studies for eligibility, extracted data and assessed the risk of bias. The main outcome was the error rate without wrong-time errors measured at study level. A random effects model was used to evaluate the effects of interventions on administration errors.

Results: 5312 records from electronic database searches were identified. Seven studies were included: five were randomized controlled trials (including one crossover trial) and two were non-randomized controlled trials. Interventions were training-related ($n = 4$; dedicated medication nurses, interactive CD-ROM program, simulation-based learning, pharmacist-led training program), and technology-related ($n = 3$; computerized prescribing and automated medication dispensing systems). All studies were subject to a high risk of bias, mostly due to a lack of blinding to outcome assessment and a risk of contamination. No difference between the control group and the intervention group was found (OR = 0.72 [0.39; 1.34], $p = 0.3$). No fatal error was observed in the three studies evaluating the gravity of errors.

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Conclusions: This review did not find evidence that interventions can effectively decrease administration errors. In addition, most studies had a high risk of bias. More evaluation studies with stronger designs are required.

What is already known about the topic?

- Administration of medications by nurses is the last step before a possible error and its consequences for the patient.
- Numerous interventions have been developed to reduce administration errors, including nurse training and education, automated delivery systems and barcode-assisted medication administration systems.

What this paper adds

- Seven studies using a rigorous design, evaluating an intervention aimed at improving medication administration, have been published. Those studies were at high risk of bias, and a meta-analysis of those studies did not find any effect of the interventions.
- More studies using rigorous designs are needed to evaluate the effectiveness of such interventions.

1. Introduction

Medication errors are common in hospitals and can lead to adverse drug events and a prolonged hospital stay. Medication errors can occur at any of the three steps in the medication process: prescription, medication delivery and administration. In the American MEDMARX (Hicks et al., 2004) database, 21% of the reported errors concern prescription, 22% concern medication delivery and 33% concern administration. The final step in the medication process, administration, is the least well studied, even though it directly concerns nurses and patients and is the last barrier before possible consequences for the patient.

Administration errors are defined as a deviation from the physician's medication order, as written on the patient's chart (Allan and Barker, 1990). They are generally assessed relative to the total opportunity for error, defined as the sum of doses observed plus the doses that were not administered (omission) (Allan, 1987). Administration errors can be detected by spontaneous reporting, a review of patient charts or direct observation. Reporting systems require the person responsible for reporting errors to be aware that an error was made, and the reviewing of patient charts is highly time-consuming. The direct observation is considered to be the gold standard for error detection, as it yields more objective and reliable results than the other methods (Allan and Barker, 1990; Barker and McConnell, 1962). Briefly, an observer follows the nurse responsible for administering medication to patients and notes the administration of each dose. The notes administered are then compared with the prescription. An error is considered to have occurred if the nurse does not carry out the order accurately. A comparison of methods for detecting medication administration errors showed that the direct observation of nurses was more effective and accurate than reviewing charts and incident reports for the detection of medication errors (Flynn et al., 2002). It has been stressed that observers may have an impact on the behavior of the nurse who is observed. Therefore, the practice of the nurse could be better that its current practice. But this effect would be observed in both arms (intervention and control arms) leaving the same magnitude of the opportunity for improvement between the arms. However, Allan and Barker showed that disguised observation decreases the Hawthorne effect on observed nurses (Allan and Barker, 1990). With the direct observation, administration error rates can reach about 26%, falling to about 10% if wrong-time errors are not analyzed (Berdot et al., 2012, 2013; Keers et al., 2013).

Numerous interventions have been developed for decreasing medication errors. They are professional interventions (nurse training and education, safety vest, double checking of medication, etc.) and organizational interventions (computerization of hospital medical systems: automated delivery system, barcode-assisted medication administration systems, etc.).

Reviews concerning medication errors in general (Manias et al., 2012; Rinke et al., 2014; Soe et al., 2013) and administration errors specifically (Hassink et al., 2012; Keers et al., 2014) have been published. Other reviews have focused on a specific intervention, such as barcode-assisted medication administration systems or the double-checking of medication, but the strength of the studies evaluating such interventions is unclear. It is also unclear to know which type of intervention could address which type of error. No systematic review of various interventions focusing on direct observation and rigorous study designs for detecting medication administration errors has been published to date.

This systematic review focuses on interventions aiming at decreasing the number of administration errors detected by the direct observation of nurses administering medications to inpatients. The primary objective of this review was to assess the effect of these interventions on administration error rates. The secondary objectives were to evaluate the impact of interventions on the types of errors made and to describe the clinical impact of errors.

2. Materials and methods

2.1. Search strategy

We conducted a systematic search of MEDLINE, EMBASE and the Cochrane Library, to identify relevant papers published between January 1966 and August 2014, without language restriction (search strategy in Additional file 1).

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