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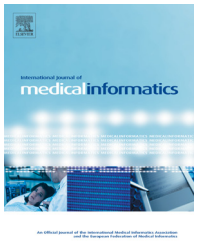

The effectiveness of computerized drug-lab alerts: A systematic review and meta-analysis

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ABSTRACT

Background: Inadequate lab monitoring of drugs is a potential cause of ADEs (adverse drug events) which is remediable.
Objectives: To determine the effectiveness of computerized drug-lab alerts to improve medication-related outcomes.
Data sources: Citations from the Computerized Clinical Decision Support System Systematic Review (CCDSSR) and MMIT (Medications Management through Health Information Technology) databases, which had searched MEDLINE, EMBASE, CINAHL, Cochrane Database of Systematic Reviews, International Pharmaceutical Abstracts from 1974 to March 27, 2013.
Study selection: Randomized controlled trials (RCTs) of clinician-targeted computerized drug lab alerts conducted in any healthcare setting. Two reviewers performed full text review to determine study eligibility.
Data abstraction: A single reviewer abstracted data and evaluated validity of included studies using Cochrane handbook domains.
Data synthesis: Thirty-six studies met the inclusion criteria (25 single drug studies with 22,504 participants, 14 targeting anticoagulation; 11 multi-drug studies with 56,769 participants). ADEs were reported as an outcome in only four trials, all targeting anticoagulants. Computerized drug-lab alerts did not reduce ADEs (OR 0.89, 95% CI 0.79–1.00, $p = 0.05$), length of hospital stay (SMD 0.00, 95%CI −0.93 to 0.93, $p = 0.055$, 1 study), likelihood of hypoglycemia (OR 1.29, 95% CI 0.31–5.37) or likelihood of bleeding, but were associated with increased likelihood of prescribing changes (OR 1.73, 95% CI 1.21–2.47) or lab monitoring (OR 1.47, 95% confidence interval 1.12–1.94) in accordance with the alert.

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Conclusions: There is no evidence that computerized drug-lab alerts are associated with important clinical benefits, but there is evidence of improvement in selected clinical surrogate outcomes (time in therapeutic range for vitamin K antagonists), and changes in process outcomes (lab monitoring and prescribing decisions).

1. Introduction

Adverse drug events (ADEs), defined as injuries occurring as a result of medication use are common, and frequently preventable [1]. A systematic review [2] reported that 7.1% of hospital admissions were medication-related (IQR 5.7–16.2%), of which 59% (IQR 50–73%) were classified as preventable. Estimates of the incidence of ADEs in nursing homes range from 1.19 to 9.8 ADEs per 100 resident-months [3]. In ambulatory care, where most medications are prescribed, between 2.8% and 34.7%, median 12.8% (IQR 5.5–24.5%), of patients experience one or more ADEs [4], of which a median of 16.5% (IQR 12–23.8%) are potentially preventable.

One of the strategies proposed for preventing ADEs is to incorporate laboratory monitoring into the prescribing process, particularly for older adults or those with polypharmacy [5]. Inadequate laboratory monitoring of drugs has been associated with 60.8% of preventable ADEs in ambulatory care (both failure to order relevant lab tests and inadequate response to laboratory evidence of toxicity) [6] and may have a role in the prevention of ADEs in nursing homes [7,8] and emergency departments [9,10].

Policy makers have proposed that electronic medical records (EMRs) with computerized alerts will improve patient safety and quality of care. Computerization in health care still lags behind other sectors, in part because of complexity, expense, and lack of evidence of benefit on clinical outcomes [11–18]. The effectiveness of computerized drug lab alerts, defined as computer-based systems that remind clinicians to consider clinically important effects of lab tests on prescribing or monitoring decisions is unclear. Recent reviews [19,20] evaluated the impact of health information technology on medication-laboratory monitoring, but only considered ambulatory settings, excluded alerts addressing anticoagulation and only addressed the impact of alerts on lab ordering, not on prescribing or ADEs. We therefore sought to systematically evaluate the highest quality evidence for the effectiveness of computerized drug lab alerts in reducing ADEs in any clinical setting, with a secondary goal to assess the impact on process outcomes.

2. Methods

We prepared an unregistered study protocol that is available on request.

2.1. Data sources and searches

We based our search for citations on the databases from two large systematic reviews examining the broader impact of computerization on health care, namely the Computerized Clinical Decision Support Systems Systematic Review (CCDSSR) and the Medication Management through Health Information Technology (MMIT) projects.

CCDSSR searched Medline, EMBASE, EBM review databases, INSPEC, and relevant reference lists from 1974 to Jan 6, 2010 and included randomized controlled trials, involving health care professionals in clinical practice or post-graduate medical trainees, comparing CCDSS (computerized systems that provided patient specific advice to clinicians) to no CDSS, reporting on process specific and/or patient specific outcomes [21]. MMIT searched MEDLINE, EMBASE, CINAHL, Cochrane Database of Systematic Reviews, IPA (International Pharmaceutical Abstracts), Compendex, INSPEC, LISTA, E-LIS, PsychINFO, Sociological Abstracts and Business Source Complete to summer 2010 [22]. The search strategy combined search terms for medication management with computer and technology terms, limited to intervention studies with a comparison group. We performed an updated search of MEDLINE, EMBASE and the EBM review databases to March 27, 2013.

3. Study selection

We included randomized controlled trials of computerized drug lab reminder systems addressing prescribing for adult patients from all health care settings including hospitals, ambulatory care and nursing homes. We included alerts that targeted prescribing of a single drug (single drug systems) and of multiple drugs (multi-drug systems). We included multifaceted intervention studies (studies in which drug-lab safety alerts were one of a series of interventions) when it was possible to determine the impact of the drug lab reminder system alone. We excluded studies of systems with no clinician decision-making role (such as those using automated computer-modelled dose adjustment) or those in which drug lab alerts were not focused on improving prescribing safety (such as those addressing improved adherence to guideline based care, but not related to drug safety).

The primary outcome was reduction in ADEs, as defined in primary studies. Secondary outcomes included change in hospitalization rates, mortality rates, recognized surrogate outcomes such as time in therapeutic range and recognized process outcomes such as proportion of lab tests ordered or proportion of prescriptions in which the medication was discontinued or the dose was changed. A single reviewer (IB or SMH) screened the abstracts of collected citations to deter-