

# Preventing Medication Errors

## An Annotated Bibliography

Biron AD, Loiselle G, Lavoie-Tremblay M. Work interruptions and their contribution to medication administration errors: an evidence review.

*Worldviews Evid Based Nurs.* 2009;6(2):70-86.

**BACKGROUND:** In many surveys, nurses cite work interruptions as a significant contributor to medication administration errors. **OBJECTIVES:** To review the evidence on (1) nurses' interruption rates, (2) characteristics of such work interruptions, and (3) contribution of work interruptions to medication administration errors. **APPROACH:** Search strategy: CINHALL (1982-2008), MEDLINE (1980-2008), EMBASE (1980-2008), and PSYCINFO (1980-2008) were searched using a combination of keywords and reference lists. Selection criteria: Original studies published in English using nurses as participants and for which work interruption frequencies are reported. Data collection and analysis: Studies were identified and selected by two reviewers. Once selected, a single reviewer extracted data and assessed quality based on established criteria. Data on nurses' work interruption rates were synthesized to produce a pooled estimate. **RESULTS:** Twenty-three studies were considered for analysis. A rate of 6.7 work interruptions per hour was obtained, based on 14 studies that reported both an observation time and work interruption frequency. Work interruptions are mostly initiated by nurses themselves through face-to-face interactions and are of short duration. A lower proportion of interruptions resulted from work system failures such as missing medication. One non-experimental study documented the contribution of work interruptions to medication administration errors with evidence of a significant association ( $p = 0.01$ ) when errors related to time of administration are excluded from the analysis. Conceptual shortcomings were noted in a majority of reviewed studies, which included the absence of theoretical underpinnings and a diversity of definitions of work interruptions. **CONCLUSIONS:** Future studies should demonstrate improved methodological rigor through a precise definition of work interruptions and reliability reporting to document work interruption characteristics and their potential contribution to medication administration errors, considering the limited evidence found. Meanwhile, efforts should be made to reduce the number of work interruptions experienced by nurses. PMID: 19413581 [PubMed - indexed for MEDLINE]

Davey P, Brown E, Fenelon L, Finch R, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev.* 2005;(4):CD003543. **Background:** Up to 50% of antibiotic usage in hospitals is inappropriate. In hospitals, infections caused by antibiotic-resistant bacteria are associated with higher mortality, morbidity and prolonged hospital stay compared with infections caused by antibiotic-susceptible bacteria. *Clostridium difficile*

associated diarrhoea (CDAD) is a hospital acquired infection that is caused by antibiotic prescribing. **Objectives:** To estimate the effectiveness of professional interventions that alone, or in combination, are effective in promoting prudent antibiotic prescribing to hospital inpatients, to evaluate the impact of these interventions on reducing the incidence of antimicrobial resistant pathogens or CDAD and their impact on clinical outcome. **Main results:** Thirty-nine studies examined the effect of printed educational materials for physicians, audit and feedback, educational meetings, educational outreach visits, financial and healthcare system changes, physician reminders, patient-based interventions and multi-faceted interventions. These interventions addressed the overuse of antibiotics for viral infections, the choice of antibiotic for bacterial infections such as streptococcal pharyngitis and urinary tract infection, and the duration of use of antibiotics for conditions such as acute otitis media. Use of printed educational materials or audit and feedback alone resulted in no or only small changes in prescribing. The exception was a study documenting a sustained reduction in macrolide use in Finland following the publication of a warning against their use for group A streptococcal infections. Interactive educational meetings appeared to be more effective than didactic lectures. Educational outreach visits and physician reminders produced mixed results. Patient-based interventions, particularly the use of delayed prescriptions for infections for which antibiotics were not immediately indicated effectively reduced antibiotic use by patients and did not result in excess morbidity. Multi-faceted interventions combining physician, patient and public education in a variety of venues and formats were the most successful in reducing antibiotic prescribing for inappropriate indications. Only one of four studies demonstrated a sustained reduction in the incidence of antibiotic-resistant bacteria associated with the intervention.

**Authors' conclusions:** The results show that interventions to improve antibiotic prescribing to hospital inpatients are successful, and can reduce antimicrobial resistance or hospital acquired infections. **Implications for practice:** A wide variety of interventions has been shown to be successful in changing antibiotic prescribing to hospital inpatients. Interrupted Time Series analysis is a valuable and practical method for evaluation of interventions in single hospitals. Standardising methods for time series in single hospitals (for example using monthly intervals and aiming for a minimum of one year of post-intervention data) would enhance the ability to compare results from single hospitals. This is currently essential because only five of the 66 studies were conducted in ten or more hospitals so there is very little evidence about the generalisability of the study results. However, even after definitive evidence of effectiveness has been provided by multi-centre studies it is likely that hospitals will still need to evaluate the impact of interventions themselves in order to obtain local information about cost effectiveness. Our meta-regression was severely limited by the small number of comparable studies and we were unable to compare the long term effects of persuasive or restrictive interventions. Hospitals should resist the temptation to adopt restrictive interventions without evaluation of their long term effects and clinical outcomes. **A number of interventions have been used to effectively change antibiotic prescribing to hospital inpatients. "Interrupted time**

**Implications for research:** Greater external validity can be achieved by evaluating interventions in multiple hospitals, especially interventions that aim to reduce antimicrobial treatment. We have enough evidence to show that a variety of interventions can improve hospital antibiotic prescribing. Now we need more evidence about the effectiveness of interventions in a format that facilitates combining the results from several studies in order to provide robust estimates of effect size. Combining results is likely to be particularly important in relation to clinical outcomes, studies from single hospitals usually being underpowered. We found no direct comparisons of the efficacies of different interventions, including simple versus multifaceted interventions. The ideal would be comparison by a cluster randomised trial design, but such a design is expensive and must be directed towards high priority research questions. Multiphase time series data represents a more practical design format for generating reasonably robust data about the incremental impact of the components of multifaceted interventions. The paucity of evidence about the cost-effectiveness of guideline implementation in general is inexcusable and future studies should provide information about the resources required for development, dissemination and implementation of guidelines and other interventions. It is important that this information is expressed in terms of both quantities of resource and costs. It is neither necessary nor possible to measure clinical and microbiological outcomes in all studies. However, it does seem strange that we have several examples of studies with clinical or microbiological outcomes that do not provide rigorous information about drug outcomes. There is some justification in a large multicentre study where mortality is the primary outcome measure, because measurement of drug outcomes would have added considerably to the cost of the study. However, in the majority of cases the problem was simply that the drug outcome data were described in terms of averages rather than as time series analyses, and correcting this would probably not have added significantly to the cost of the study. Several of the studies which reported microbiological outcome data were unplanned interventions. This is a serious threat to the validity of any time series but is a particular problem with studies of infection because of the shape of the epidemic curve.

de Vries EN, Ramrattan MA, Smorenburg SM, Gouma DJ, Boermeester MA. The incidence and nature of in-hospital adverse events: a systematic review. *Qual Saf Health Care*. 2008 Jun;17(3):216-23.

**INTRODUCTION:** Adverse events in hospitals constitute a serious problem with grave consequences. Many studies have been conducted to gain an insight into this problem, but a general overview of the data is lacking. We performed a systematic review of the literature on in-hospital adverse events. **METHODS:** A formal search of Embase, Cochrane and Medline was performed. Studies were reviewed independently for methodology, inclusion and exclusion criteria and endpoints. Primary endpoints were incidence of in-hospital adverse events and percentage of preventability. Secondary endpoints were adverse event outcome and subdivision by provider of care, location and type of event. **RESULTS:** Eight studies including a total of 74 485 patient records were selected. The median overall incidence of in-hospital adverse events was 9.2%, with a median percentage of preventability of 43.5%. More than half (56.3%) of patients experienced no or minor disability, whereas 7.4% of events were lethal.

Operation- (39.6%) and medication-related (15.1%) events constituted the majority. We present a summary of evidence-based interventions aimed at these categories of events. **CONCLUSIONS:** Adverse events during hospital admission affect nearly one out of 10 patients. A substantial part of these events are preventable. Since a large proportion of the in-hospital events are operation- or drug-related, interventions aimed at preventing these events have the potential to make a substantial difference.

PMCID: PMC2569153 PMID: 18519629 [PubMed - indexed for MEDLINE]

Fick DM, Mion LC, Beers MH, L Waller J. Health outcomes associated with potentially inappropriate medication use in older adults. *Res Nurs Health*. 2008 Feb;31(1):42-51.

The purpose of this study was to examine the prevalence of potentially inappropriate medication use (PIMs) among community-dwelling older adults and the association between PIMs and health care outcomes. Participants were 17,971 individuals age 65 years and older. PIM use was defined by the Beers criteria. Drug-related problems (DRPs) were defined using ICD-9 codes. Forty percent of the 17,971 individuals filled at least 1 PIM prescription, and 13% filled 2 or more PIM prescriptions. Overall DRP prevalence among those with at least 1 PIM prescription was 14.3% compared to 4.7% in the non-PIM group ( $p < .001$ ). In conclusion, preventing PIM use may be important for decreasing medication-related problems, which are increasingly being recognized as requiring an integrated interdisciplinary approach.

PMCID: PMC2247370 PMID: 18163447 [PubMed - indexed for MEDLINE]

Hertzel C, Sousa VD. The use of smart pumps for preventing medication errors. *J Infus Nurs*. 2009 Sep-Oct;32(5):257-67.

The use of smart pumps can be helpful for preventing medication errors, especially with high-alert drugs in vulnerable critical care patient populations. A literature review was conducted to determine the evidence supporting the use of smart pumps for preventing medication errors. CINAHL and MEDline databases from January 2003 through July 2008 were searched for English-language publications on the use of smart pumps and medication errors. Review of these publications revealed that well-designed research is still lacking with respect to the effectiveness of smart pumps in preventing medication errors. Nevertheless, findings indicate new directions for clinical practice and future research.

PMID: 20038875 [PubMed - indexed for MEDLINE]

Keady S, Thacker M. National Patient Safety Agency: improving patient safety across all critical care areas. *Intensive Crit Care Nurs*. 2008 Apr;24(2):137-40. Epub 2007 Oct 22.

The National Patient Safety Agency (NPSA) reviews patient safety incidents throughout the National Health Service (NHS) in the United Kingdom and aims to initiate preventative measures. Recent alerts include injectable medication, oral

syringes for internal administration, preventing hyponatraemia in children and anticoagulation. This article gives an insight into the rationale and steps currently being undertaken to respond to these recommendations.

PMID: 17933537 [PubMed - indexed for MEDLINE]

Pape T. Applying airline safety practices to medication administration. *Medsurg Nurs*. 2003;12(2):77-94.

Medication administration errors (MAE) continue as major problems for healthcare institutions, nurses, and patients. However, MAEs are often the result of system failures leading to patient injury, increased hospital costs, and blaming. Costs include those related to increased hospital length of stay and legal expenses. Contributing factors include distractions, lack of focus, poor communication, and failure to follow standard protocols during medication administration.

PMID: 12736927 [PubMed – indexed for MEDLINE]

Schillinger D, Wang F, Rodriguez M, Bindman A, Machtiger EL. The importance of establishing regimen concordance in preventing medication errors in anticoagulant care. *J Health Commun*. 2006 Sep;11(6):555-67.

Miscommunication between patients and providers can have serious consequences, especially where medications are concerned. We examined whether regimen discordance between patient and provider, a possible result of miscommunication, contributes to unsafe medication management. We studied 220 patients taking warfarin in an anticoagulation clinic to characterize two medication assessment methods. We measured (1) adherence by asking patients to report any missed doses and (2) concordance between patients' and providers' reports of warfarin regimens. We categorized patients as having regimen adherence if they missed no doses, and concordance if there was patient-provider agreement in weekly dosage. We characterized anticoagulant outcomes as unsafe if international normalized ratio (INR) values were <2.0 (at risk for thrombosis) or >4.0 (at risk for hemorrhage), and explored relationships among adherence, concordance, and anticoagulant outcomes. One hundred fifty-five patients (71%) reported no missed doses during the prior 30 days. Poor adherence was associated with underanticoagulation (AOR 2.33, 1.56-3.45), but not overanticoagulation (AOR 1.36, 0.69-2.66). One hundred ten patients (50%) reported regimens discordant with clinicians' report. There was no relationship between patients' reports of adherence and concordance. Among adherent patients, discordance was associated with underanticoagulation (AOR 1.67, 1.00-2.78) and over-anticoagulation (AOR 3.44, 1.32-9.09). Discordance regarding warfarin regimens is common and places patients at risk for adverse events. To promote safe and effective care, clinicians should separately determine adherence and regimen concordance during routine medication assessments. Systems need to be developed to ensure concordance in medication regimens.

PMID: 16950728 [PubMed - indexed for MEDLINE]

Shojania KG, Jennings A, Mayhew A, et al. The effects of on-screen, point of care computer reminders on processes and outcomes of care. *Cochrane Database Syst Rev.* 2009;(3):CD001096.

**Background:** The opportunity to improve care by delivering decision support to clinicians at the point of care represents one of the main incentives for implementing sophisticated clinical information systems. Previous reviews of computer reminder and decision support systems have reported mixed effects, possibly because they did not distinguish point of care computer reminders from e-mail alerts, computer generated paper reminders, and other modes of delivering 'computer reminders'. **Objectives:** To evaluate the effects on processes and outcomes of care attributable to on-screen computer reminders delivered to clinicians at the point of care. **Main results:** Twenty-eight studies (reporting a total of thirty-two comparisons) were included. Computer reminders achieved a median improvement in process adherence of 4.2% (interquartile range (IQR): 0.8% to 18.8%) across all reported process outcomes, 3.3% (IQR: 0.5% to 10.6%) for medication ordering, 3.8% (IQR: 0.5% to 6.6%) for vaccinations, and 3.8% (IQR: 0.4% to 16.3%) for test ordering. In a sensitivity analysis using the best outcome from each study, the median improvement was 5.6% (IQR: 2.0% to 19.2%) across all process measures and 6.2% (IQR: 3.0% to 28.0%) across measures of medication ordering. In the eight comparisons that reported dichotomous clinical endpoints, intervention patients experienced a median absolute improvement of 2.5% (IQR: 1.3% to 4.2%). Blood pressure was the most commonly reported clinical endpoint, with intervention patients experiencing a median reduction in their systolic blood pressure of 1.0 mmHg (IQR: 2.3 mmHg reduction to 2.0 mmHg increase). **Authors' conclusions:** Point of care computer reminders generally achieve small to modest improvements in provider behaviour. A minority of interventions showed larger effects, but no specific reminder or contextual features were significantly associated with effect magnitude. Further research must identify design features and contextual factors consistently associated with larger improvements in provider behaviour if computer reminders are to succeed on more than a trial and error basis. **Implications for practice:** On-screen computer reminders may become more prevalent as healthcare institutions advance in the use of computer technology. There appears to be a wide range of effects of the intervention, making it difficult to provide specific suggestions about how to maximize the benefits. **Implications for research:** Although some studies have clearly shown substantial improvements in care from point of care computer reminders it is concerning that the majority of studies have shown fairly small improvements across a range of process types. This finding of small to modest improvements is not unique to computer reminders. As had been said before, there are no 'magic bullets' when it comes to changing provider behavior and improving care. However, given that the opportunity to deliver computer reminders at the point of care represents one of the major incentives to implementing sophisticated clinical information systems, future research will need to identify key factors (related to the target quality problem or the design of the reminder) that reliably predict larger improvements in care from these expensive technologies.

Walliser G, Grossberg R, Reed MD. Look-alike medications: a formula for possible morbidity and mortality in the long-term care facility. **J Am Med Dir Assoc.** 2007 Oct;8(8):541-2.

Medication errors remain an important cause of patient morbidity and mortality. Although all medications have the potential to induce unwanted adverse effects, data on the actual incidence and overall severity of preventable adverse drug reactions remains unknown. An Institute of Medicine report (Institute of Medicine. *Preventing medication errors: Quality chasm series.* Washington DC, National Academies Press. 2007-06-15) estimated that 1.5 million preventable adverse drug events occur annually in the US and that from 44,000 to 98,000 individuals die in hospitals annually from preventable medication errors. The types of medication errors of clinical relevance leading to moderate to severe outcomes are unfortunately numerous. Such errors would include wrong drug, wrong dose / wrong dose interval and represent the more serious form of a medication error. Institutionalized patients and those patients cared for in long-term care facilities appear to be at heightened risk for a medication error. These patients often receive multiple medications and suffer from variable degrees of cognitive impairment which complicates or negates patient-caregiver communication, one of the most important means to prevent medication errors. Moreover, the increasing financial constraints placed upon treatment facilities encourage the use of generic, rather than name brand medications by their pharmacy provider. While the use of bioequivalent generic medications is completely appropriate and can be very cost-effective, generic drug manufacturers are less often manufacturing their generic medications to look like the name brand drug. Rather, more and more generic medications are plain appearing with no resemblance whatsoever to the name brand product. This difference in drug appearance between the generic and the brand name product as well as differences in drug appearance between different generic drug manufacturers for the same medication represents another important means by which patients may experience moderate to serious consequences from a medication error. We report such an experience where a patient in a long-term care facility received multi-day, excessive dosing of glipizide rather than her anti-spasticity medication, baclofen.