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Original Article

Errors in prescribing and administration of intravenous anti-infective therapy and preventability by smart pump technology

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ABSTRACT

Aims: The aims of this study were to assess errors that occurred during the prescribing and administration of intravenous (IV) anti-infective therapy with standard infusion devices and to retrospectively determine preventability with smart pump technology.

Methods: Data was collected at the Peninsula Health Frankston Hospital, Melbourne, Australia. Errors in terms of non-adherence to the hospital's IV prescribing and administration protocols as well as administration and formal prescribing errors were defined. Preventability using the smart pump technology was determined based on a retrospective evaluation.

Results: IV medication errors occurred frequently: almost half (42/100) anti-infectives used with standard infusion pump technology were associated with errors. Non-adherence to protocols in prescribing or administration was identified as the most common source for errors ($n = 35$) followed by administration ($n = 12$) and prescribing ($n = 3$) errors. Thirty-two out of 50 (64%) errors including those rated to be most severe were considered to be preventable if smart pump technology had been implemented.

Conclusions: Errors happened frequently with the use of standard infusion devices. Errors in terms of non-adherence to protocols/guidelines were the most common and administration was identified as the stage in the medication-use process that is most susceptible to errors. The most severe errors were those likely to be reduced by the implementation of smart pump technology. Factors other than technology have to be emphasized as well, e.g. standardization of doctors' and nurses' practices on the wards in order to reduce errors in the future.

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1. Introduction

Medication errors are common in hospitals and their impact on patient health can be significant, especially when high-risk intravenous (IV) medications are involved. Different strategies and practices, including the use of new technologies such as computerized prescriber order entry, bar code medication administration, and smart infusion pumps, are available for hospitals as means to reduce the occurrence of medication errors.

The majority of errors that impact the patient happen at the point of administration. In contrast to other steps of the medication-use process, no extensive control systems exist for IV administration. Infusion pumps that deliver IV medications help critically ill patients. At the same time, the combination of a broad range in programming of standard infusion devices and the flexibility needed to serve an entire hospital population is a potential danger. As the rate is variable, IV medications can be delivered within a 10.000-fold rate range, and programming errors may easily result in a 10-fold over- or underdose.[1] Smart pumps are computerized infusion devices with dose-error reduction software that checks programmed doses against pre-established limits specific to the medication and the clinical location.[2] Depending on present limits, the clinician can either override an alarm (''soft limit'') or not be allowed to continue (''hard limit''). Smart pumps have previously been shown to have the potential to reduce medication errors, especially those occurring at continuous medication infusion.[3,4]

Antibiotics are life-saving drugs, but unlike drugs used in other therapeutic areas, the future utility of many antibiotics is threatened by the emergence and spread of resistant bacteria.[5–8] The current pipeline for new antibiotics is limited, and if antibiotic resistance continues to grow, there may be no effective antibiotics in the future.[9] To prevent development of resistance patients undergoing antibiotic therapy should be aimed to receive the right drug at the right dose. Inappropriate antibiotic dosing and infusion duration may not only result in severe side effects harming the patient (too high dosage, too short infusion time) but may also be ineffective and lead to development of bacterial resistance (too low dosage).[9,10]

In this study we characterized errors occurring during the prescribing and administration of continuous or intermittent intravenous (IV) anti-infective therapy with standard infusion pump technology. Further we assessed preventability with smart pump technology.

2. Materials and methods

This prospective observational cohort study was conducted from October 2007 to December 2007 at Peninsula Health Frankston Hospital, Melbourne, Australia. At the time of the study standard infusion pumps (IMED® Gemini) were used throughout the hospital. Data was collected for a two-month period. Three data sources were reviewed on a daily basis: the doctor's handwritten prescription, the IV medication additive label on the infusion bag and the displayed rate and volume on the infusion pump. Errors in terms of non-adherence to protocols as well as administration and formal prescribing errors were defined.

''Non-adherence to protocol'' was defined as non-adherence (e.g. wrong dose, incorrect frequency, wrong volume, incompatible fluid, and rate deviation) to the hospital's IV prescribing and administration protocols, the SHPA (The Society of Australian Hospital Pharmacists of Australia) Australian Injectable Drugs Handbook or international recommendations. An ''administration error'' occurred when the information on the additive label or the setting of the infusion pump did not correspond with the doctor's orders (e.g. the IV medication additive label involved a wrong drug, an incorrect dose, an incompatible fluid, a wrong fluid volume and/or a wrong drug concentration compared to the doctor's orders).

''Prescribing errors'' included an omitted signature on the medication chart or an incomplete order (necessary details regarding dose, volume, rate and/or frequency were absent in the order). Each observed IV medication could contain one or more errors; each error was documented and evaluated independently. Data collection and evaluation were conducted by two different persons in order to ensure objective decisions. Preventability using the smart pump technology (Alaris® GP Volumetric Pumps and Guardrails Safety Software) was determined based on a retrospective evaluation.

The severity of medication errors was classified by using a five-point scale ranging from level 1, ''incidence is likely to have little or no effect on the patient'', to level 5, ''incidence is likely to lead to patients death'', as published previously.[11,12] The study was approved by the local ethics review board.

3. Results

IV medication errors with anti-infective therapy occurred frequently: 42 out of 100 anti-infectives used with standard infusion pump technology were associated with errors. Errors happened with nearly all anti-infectives used. Non-adherence to protocols in prescribing or administration was identified as the most common source for errors ($n = 35$) followed by administration ($n = 12$) and prescribing ($n = 3$) errors. Rate deviations accounted for the vast majority of non-adherence to protocol errors.

With regard to the severity the majority of errors was classified as level 1 or level 2 errors (= minor errors). Five medication errors, however, were classified as level 3 errors (''incident is likely to lead to permanent reduction in bodily functioning leading to, for example, increased length of stay'') and in four of those vancomycin was the drug administered.

Thirty-two out of 50 (64%) errors – including the five level 3 errors – were considered to be preventable if smart pump technology had been implemented. Details on errors as well as smart pump preventability in the different anti-infectives observed are outlined in Table 1.

4. Discussion

By investigating errors that occurred during the prescribing and administration of continuous or intermittent IV anti-infective therapy with standard infusion pump technology we found that (a) errors occurred frequently and (b) more than 60%