Identification of Medication Errors by Nurses During a Simulated Ward, Medication Safety Orientation Program

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ABSTRACT

Aim: To assess the ability of nurses to identify medication errors and apply strategies to prevent adverse drug events.

Method: This was a prospective study of the incidence of error detection in simulated medication scenarios at a teaching hospital. All newly employed registered nurses (n = 591) were asked to administer medications in six scenarios containing errors with potential for patient harm. Feedback was provided to participants at the end of each scenario. The main outcome measures were: self-reported incidence of detection of errors and modification of practice in accordance with knowledge, knowledge of concept but error not detected, or the error being a new concept.

Results: 63 to 85% of nurses reported that they would have detected the error and taken appropriate action; 11 to 30% had some concept of the error but would not have detected it; and for 2 to 7% the error was a new concept. 32% could identify the errors in all six scenarios and initiate appropriate action.

Conclusion: In this study, nurses frequently failed to detect medication errors. Practical medication risk awareness training, improvements in the safety of medication systems and pharmacist review of medication are of paramount importance.

J Pharm Pract Res 2005; 35: 190-4.

INTRODUCTION

Adverse drug events resulting in patient harm are frequently associated with prescribing and subsequent administration errors.[1,2] Many of these adverse drug events are the result of a combination of human errors and system failings.[3] There is increasing evidence of successful strategies that improve the safety of the medication management system.[4-8] Examples include standardising medication charts, prescriber decision support, individualised administration systems and clinical pharmacy services. The awareness of all staff of risks and errors in the medication system, and their ability to identify errors and take appropriate action is paramount in improving safety and reducing harm.[9,10]

Medication administration is the final step in which a prescribing, dispensing or administration error can be detected and addressed. Nurses and pharmacists play a vital role in ensuring medication safety by detecting errors prior to administration.[11,12]

The effectiveness of the nurse as a final 'defence' in preventing medication errors assumes that they:

- are aware that errors exist;
- are able to identify errors; and
- will act appropriately by discussing the error with medical, pharmacy or other colleagues.[13,14]

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Nurses are trained well to care for patients but less so on the potential errors in the system, particularly adverse drug events.[10] Some nurses do not consider or perceive omission of a dose, or an extra dose, as an error.[15] Even if errors are detected, there is a reluctance to discuss it with colleagues and to report the error of others (leads to under-reporting of medication errors).[16,17] Steep hierarchies and different perceptions of how teams can or should work effectively together further aggravate the situation.[13,18,19]

The traditional approach to assess a nurse's ability to administer medications safely has been accurate drug calculations.[20] However, their ability to address other common errors, such as re-exposure to drugs causing adverse drug reactions (ADRs), wrong drugs or frequency of dosing, are not addressed. Calculation tests may not accurately reflect how safely nurses will perform in practice, or assess their ability to address common errors that may be encountered.[21] A simulation or scenario approach to medication delivery as a component of a nursing orientation program has been suggested as a preferred approach to increase their understanding of the medication system and of raising awareness of safety.[22]

Staff at all levels need to be aware of the risks of human error at every stage of the medication system, and be able to intervene when errors are detected.[23]

As part of a broader program to improve medication safety, a problem-based medication risk awareness program was developed as a core component of nursing staff orientation. The program was developed by a multidisciplinary group of medical, pharmacy and nursing staff from the hospital's medication safety and nursing education teams. The objectives were to:

- illustrate the complexity and error prone nature of the medication system and raise awareness of error frequency and severity;
- facilitate the detection of common errors;
- discuss how to apply safety interventions to address common medication errors; and
- demonstrate effective communication strategies between nurses and other staff to facilitate discussion of detected errors.

The aim of this study was to assess the ability of nurses to identify medication errors and apply strategies to prevent adverse drug events.

METHOD

This was a prospective study undertaken as part of a medication safety orientation program in a simulated ward environment at a teaching hospital in Brisbane. During 2003 and 2004, all newly employed registered nurses (n = 591) were asked to administer medications in six scenarios containing errors with potential for patient harm. The six scenarios were based on frequently occurring errors and were designed to illustrate the complexity of the medication system (Table 1). They addressed the 'five rights' of medication administration (right patient, drug, dose, route, frequency) and discharge medication.

Table 1. Nurses' recognition and response to simulated medication risk situations

Code	Medication risk scenario	Key messages	Detected error, appropriate action taken	Aware of error, would not detect or intervene	Error a new concept
KCl	A junior doctor asks nurse to administer 40 mmol of potassium in 100 mL of 0.9% sodium chloride peripherally over 1 hour to an orthopaedic patient with a potassium of 3.0 mmol/L, who is otherwise well.	The maximum peripheral concentration of potassium is 40 mmol/L, the maximum rate of administration is 10 mmol/h in an unmonitored, non-critical care patient. The nurse must get the order changed to 40 mmol in 1 L to be given over a minimum of 4 hours.	459 (79%)	81 (14%)	41 (7%)
ADR	An ACE inhibitor is prescribed for a patient with a recent life threatening adverse drug reaction (ADR) to another ACE inhibitor. The ADR is clearly documented on the medication chart and the patient has a red ADR alert bracelet. No pharmacist has yet seen the chart or patient. The patient is awake and able to communicate.	Even though the error was initiated at the prescribing stage, the nurse must check previous ADRs with the patient and identify any drugs of similar class that may have been prescribed in error. Key intervention was to withhold the drug, block out the dose section on the chart and contact the doctor.	414 (71%)	150 (26%)	17 (3%)
Form	Verapamil 240 mg SR and Coversyl Plus (perindopril 4 mg + indapamide 1.25 mg) are prescribed. The patient's blood pressure has dropped and pulse increased in the 2-3 hours after yesterday's dose of verapamil. The 'standard' non-SR forms of verapamil 80 mg tablets and perindopril 4 mg tablets are in the bedside drawer. The patient is aware they were taking 'a green Isoptin' and 'a Coversyl tablet at home.	The patient is an important active barrier; as there was no clinical reason to change antihypertensive therapy. Giving standard-release in place of sustained-release forms of antihypertensives or anti-anginals can have a profound adverse effect. Many antihypertensives are available in combination with diuretics, but with similar names. The key intervention is not to give the non-SR drug, inform doctor and request two separate orders for perindopril and indapamide if the combination product is not available.	369 (63%)	175 (30%)	40 (7%)
Dose	A confused patient has arrived on the ward from the emergency department and is prescribed digoxin daily, enalapril twice daily, metformin three times daily. There is no information to determine the actual dose on the medical chart.	Where no dose is specified, it is **not** the nurse's responsibility to determine the dose or give the lowest dose available on the ward but to contact the doctor. The doctor must be called to make a clinical decision.	498 (85%)	75 (13%)	12 (2%)
Frequency	A patient with pneumonia who has the dose and frequency of their antibiotics changed by a doctor (6-hourly to 12-hourly) but the administration times entered by the previous nurse are not amended, and remain at 6, 12, 18, 24.	Dose and frequency of dose must correlate with administration times. The dose and frequency instructions on Queensland Health medication charts necessitates doctors to enter dose, frequency and dosing times, to reduce errors in misinterpretation of unclear abbreviations. When doses are changed orders must be rewritten.	475 (82%)	96 (17%)	11 (2%)
Discharge	An anxious patient with heart failure wants to go home immediately. The discharge prescription has only just been written and he says he has everything at home. There have been six changes to his medication during his stay.	Nurses should not give unlabelled medicines to patients from ward stock on discharge. Most patients require counselling about changes to medicines. Old medicines must be checked and relabelled with correct doses. Poor understanding of medication on discharge and ineffective communication with community practitioners are common causes of unplanned readmission and adverse events.	481 (83%)	64 (11%)	32 (6%)

For the first four minutes the trained nurse or pharmacist facilitator role played the scenario as either a patient or a doctor. Medication charts, observation charts and actual medications, where appropriate, were available at each workstation. Participants (in groups of two or three) were asked to approach each scenario as if they were on the ward and were given a short description of the environment, patient and specific task. They were asked to identify any medication errors and discuss with each facilitator the strategies that they would apply in order to prevent patient harm.

Participants were allowed to discuss the issues and use reference texts. A 'time keeper' was used to simulate some of the pressures on nurses on busy medication administration rounds.

During the second four minutes, key messages on the error involved, strategies to address the error and a description of system changes that had been implemented to try to reduce opportunity for error were delivered by the facilitators. Each nurse was provided with printed summaries of the key messages for each scenario (Table 1). Feedback was provided to participants on their error detection and appropriateness of their actions, and relevant risk minimisation strategies that should have been used.

At the end of each scenario, nurses were asked whether:

- they detected the errors and would have modified their practice accordingly in the ward setting;
- they were aware of the error concept but would not have detected it or intervened in this case; and
- the error concept was new to them.

For example, in the ADR scenario, the responses could be either of the following:

- They were aware of the concept of risk in that scenario and would have acted accordingly. That is, they knew or could look up that lisinopril was an angiotensin converting enzyme inhibitor similar to the drug (captopril) to which the patient had had a previous severe and life-threatening ADR, and that they were not prepared to administer the drug as ordered and were confident in informing the doctor of the issue and requesting a change to the order.
- They were aware of the concept that these risks existed but would not have detected the error or intervened in this given scenario. That is, they knew that ADRs existed and re-exposure could occur but did not detect or consider lisinopril to be a re-exposure risk in this scenario and may have given it.
- They were not previously aware of the concept described in the scenario. That is, they were not aware that patients having previous ADRs to drugs were commonly re-exposed to the same class of drug.

It was stressed to participants that it was not an examination, but a process to raise awareness of medication errors and provide education. Participants were informed that the self reports were anonymous.

Responses were entered into Excel and summarised with means, medians and interquartile ranges. Proportions were compared with a chi-square test with a level of significance set at $p < 0.05$.

After rotating through the workstations, an overview was presented outlining the concepts of human error and risks associated with the medication system. Other system changes that had been introduced at the institution to prevent medication errors were discussed. It was emphasised that, despite these changes, errors still occurred and that everyone involved with the medication system had a significant role and responsibility in detecting errors and appropriately intervening to prevent harm. The importance of communicating their concerns on any errors or ambiguities to the appropriate staff was the final key message.

Feedback was obtained on nurses' attitudes and beliefs about their role in ensuring safety in the medication management process. Finally, feedback was sought on the medication safety orientation program.

Ethics approval was not required because the program was provided to all staff and was part of the standard hospital orientation program for all new employees.

RESULTS

The study was conducted over a two-year period (2003 to 2004) and 591 nurses participated. Three-quarters (76%) had undertaken their pre-registration training in Queensland, 9% in New South Wales, 5% elsewhere in Australia, and 9% in other countries. Thirty-eight per cent were new graduates and 62% with experience of one to eighteen years. The subjects were believed to be a representative sample of new nurses entering hospitals across Queensland, as their experience and background ranged from recent graduates from various universities to experienced nurses, trained in a variety of Australian and overseas universities and hospitals.

For any one scenario, 63 to 85% of nurses reported that they would have detected the error and taken appropriate action, 11 to 30% had some concept of the error but would not have detected it and for 2 to 7% the error was a new concept (Table 1).

A significantly greater proportion of experienced nurses were able to identify and act on the errors in the KCl, dose, frequency, and discharge scenarios (Table 2). However, there was no significant difference in the proportion of nurses identifying errors and risks in the ADR and wrong dosage form scenarios (Table 2).

The combined sample of participants would have identified the risks and taken appropriate action in a median of five (interquartile range 4–6) and an average of 4.23 of the six scenarios. Only 32% could apply risk reduction strategies for all scenarios, while 2% could not apply any risk reduction strategies for any. The ability of nurses to apply risk reduction strategies for individual scenarios is shown in Table 1.

Table 2. Nurses' ability to identify medication risk situations and modify practice according to level of experience

	New graduates		More experienced nurses		
Type of risk	Can apply	Cannot apply, or new concept	Can apply	Cannot apply, or new concept	p value*
KCl	160 (71%)	66 (29%)	307 (84%)	58 (16%)	< 0.001
ADR	165 (73%)	61 (27%)	256 (70%)	109 (30%)	0.51
Form	131 (58%)	95 (42%)	241 (66%)	124 (34%)	0.06
Dose	179 (79%)	47 (21%)	325 (86%)	40 (14%)	0.002
Frequency	170 (75%)	57 (25%)	314 (84%)	51 (16%)	< 0.001
Discharge	172 (76%)	54 (24%)	321 (88%)	44 (12%)	< 0.001

*Chi square test

Three of the scenarios were considered to have the greatest clinical significance in terms of potential for patient harm: rapid potassium chloride infusion, re-exposure to a previous, severe ADR and non-sustained release form of antihypertensive. The frequency to which the participants reported that they could identify risks and apply a strategy is illustrated in Table 1. Only 40% could identify the risks in all three high-risk scenarios.

Descriptive feedback from participants indicated that the sessions were informative in illustrating and raising awareness of risks inherent in the medication system (Table 3). A small number of nurses reported that they felt they were not responsible for identifying prescribing errors—attributing this responsibility to the medical staff. There were reports of unwillingness or feeling unable to confront other members of the team, particularly doctors, even when they were aware that the patient may experience drug-related harm. Pharmacists were seen as being in a 'better' position to discuss medication errors with medical staff in view of their medication knowledge.

Table 3. Nurses' feedback on simulated medication scenarios

Theme	Key comments
Structure and overview of the program	*'great exercise', 'worthwhile', 'realistic', 'practical', 'more beneficial than standard programs'*
Personal benefits	*'made me more aware of the problem', 'very good revision' 'reminded me of our important role'*
Some nurses were unaware of their individual responsibilities and potential contribution to medication safety	*'if the patient wants to go home without his new medications, that's his own decision', 'if the doctor wrote the patient up for another ACE inhibitor it would be his fault not mine if they had a reaction'*
Some nurses indicated they would be unwilling or unable to confront other members of the team	*'it would depend on which senior nurse or medical staff were on call as to whether I would bother them about the potassium order'*

The majority commented positively on the content, format and ability to represent 'real life' situations in the program (Table 3). Even those who would have identified each error and acted accordingly believed the program was of value and effective in raising their awareness of risks and complexity of the medication system.

DISCUSSION

Our results suggest that nurses should not be relied on as a robust barrier to prevent patient harm from medication errors. Despite the fact that nurses were aware that there would be medication errors in each scenario, only one-third reported that they could identify all six common errors and initiate appropriate action. As these results were elicited in a simulated environment without the usual distractions and stresses, the actual frequency of undetected errors in a busy ward is likely to be higher.

Of most concern was that 2% of nurses could not identify any errors and 7% could not identify two of the three most significant errors. A larger proportion of those who were aware that the errors occurred would not have identified them or initiated appropriate action in the scenarios. For example, 26% were aware that re-exposure of a patient with an ADR to a similar class of drug may result in harm but would not have detected the prescribing error and taken action to prevent harm. Clinical application of theoretical knowledge and system changes are essential components of any program to reduce medication errors. These findings support the requirement for introducing system-based changes that do not rely solely on the knowledge and intervention of individuals[3] and challenge the common perception that nurses will detect and prevent prescribing errors causing harm.[11] To address the problems identified, we propose a combination of interventions:

- medication risk awareness education and training for nurses;
- promoting a team environment and raising the importance of all staff in preventing errors in the medication system;[11]
- educating medical staff on safe prescribing and understanding that nurses may not detect some errors; and
- introducing system changes which force individuals to address safety issues and reduce opportunity for medication errors.

Over 40% of nurses could not recognise high risk and relatively high frequency errors, probably reflecting a lack of knowledge. These results reinforce findings that there are limitations in nurse education and skill development in medication risks and their potential to contribute to medication safety.[14,24]

There was no significant difference between the proportions of graduate and experienced nurses who identified the errors in the ADR and wrong form scenarios. This suggests that experience is not a factor in the ability to detect these problems but that cognitive skills may be more important. The differences between graduates and more experienced nurses in the other scenarios (dose, frequency, discharge, KCl) demonstrated that experience and the application of skills could assist in the detection and management of these errors.

Berwick postulated that a proportion of the workforce would be unlikely to change their behaviour or embrace system-wide changes to improve the safety of the medication system. This is due to a lack of awareness of errors associated with patient harm.[16]

The traditional education of nurses on the application of the 'five rights' checklist (right patient, drug, dose, route, frequency)—largely delivered by nurses is laudable but fails to acknowledge the complexities of the system. It creates the false assumption that administration is a simple task. For example, giving medications to the 'right patient' or giving the 'right drug' also involves determining if the patient has had a previous ADR to the drug—an extra, critical cognitive step. These latter stages are vital to ensuring safe administration but are not a component of the checklist. Our intervention, utilising nursing and pharmacy staff, addressed medication management in much greater depth, identified common error traps and promoted appropriate action to be taken.

Our results suggest that even when nurses have sufficient knowledge of a medication error some would not take action. Nurses reported not feeling empowered to respond to issues: *'It would depend on which senior nurse or medical staff were on call as to whether I would bother them about the potassium order'*. This finding supports the continued existence of 'medical domination and horizontal violence' combined with perceived power and experience gradients between medical and nursing staff.[13] Anecdotal reports from facilitators and participants suggested that junior nurses believed pharmacists are better equipped with medication

knowledge and the ability to discuss errors with medical staff. It also supports other findings that training on effective communication when errors are detected and the use of graded assertiveness is required to empower nursing staff to effectively manage such situations.[14,18,19]

Doctors traditionally focus on determining the therapeutic need for a medicine and not the actual process of communicating the order to enable safe administration. After graduation, doctors should be competent prescribers and not rely on nurses or pharmacists to identify errors. The lack of preparedness felt by junior doctors to safely prescribe, combined with the small amount of teaching on the process of prescribing and the manner in which medication is discussed as a task sends a message that prescribing and the details of doses, frequency and route are relatively unimportant.[11,25,26] Learning on the job and depending on nurses and pharmacists to detect their errors are unacceptable alternatives. A structured undergraduate program for safe prescribing is required.[27-29] It needs to be complemented by senior medical staff playing a prominent role in supervising prescribing. In this way the essential changes proposed by Barber et al. may occur—to change the culture of prescribing from a process of naming a drug to a multifactorial, high-risk intervention.[24]

Feedback from this study supports the use of a combination of ward simulation, role playing, and self-evaluation with immediate feedback. This method introduces staff to the complexities, risks and fallibilities of the medication system, and highlights the roles of each team member. It also highlights the key actions to be undertaken when an error is identified. Similar methods are recommended in the safety and quality literature.[10,30,31]

This medication risk awareness program is problem-based, readily adaptable to different settings, low cost, and has been subsequently endorsed in principle as a core component of orientation for all new nurses in Queensland public hospitals.

Self-reporting rather than objective assessment may be associated with a social desirability and overstating of results among nursing staff about to begin working in a new institution. In this case the incidence of nurses not identifying errors may in fact be greater than reported.[32,33]

The study also assumed that there is a correlation between participants' intentions and actual behaviour, and simulation is becoming more widely used as an assessment of performance.[22,32,34] Future studies are planned to evaluate the effectiveness of the educational strategies in reducing harm using analogous scenarios in repeated self-assessment. In addition, observational studies have been conducted to determine actual error rates.[32] As our intention was to evaluate ability to detect errors or to identify the level of awareness of common medication errors, the study did not attempt to make any differentiation between frequency of detection and intention to act.

In summary, use of a novel orientation program identified a significant gap in the ability of nurses to identify and address common medication errors. These findings support the need for medication risk awareness training which should be considered for all members of the team. Pharmacy and medical staff should be aware that nurses frequently fail to detect medication errors. Therefore, practical medication risk awareness training for all staff is paramount. The study also supports the role of pharmacists in reviewing and clarifying medication orders, and the importance of their involvement in improving the safety of medication systems.

Acknowledgments

We acknowledge the input of the pharmacists and nursing educators from Princess Alexandra Hospital who participated in the orientation program. Development of the program, data analysis and documentation were undertaken by the Queensland Health funded Safe Medication Practice Unit. The program was a routine component of the Princess Alexandra Hospital's nursing orientation program.

Competing interests: None declared.

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Submitted: July 2005
Accepted after external peer review: August 2005