Role of registered nurses in error prevention, discovery and correction

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ABSTRACT

Background: Registered nurses have a vital role in discovering and correcting medical error.

Objective: To describe the type and frequency of errors detected by American critical care nurses, and to ascertain who made the errors discovered by study participants.

Methods: Daily logbooks were used to collect information about errors discovered by a random sample of 502 critical care nurses during a 28-day period.

Results: Although the majority of errors discovered and corrected by critical care nurses involved medications (163/367), procedural errors were common (n = 115). Charting and transcription errors were less frequently discovered. The errors discovered by participants were attributed to a wide variety of staff members including nurses, doctors, pharmacists, technicians and unit secretaries.

Conclusions: Given the importance of nurses in maintaining patient safety, future studies should identify factors that enhance their effectiveness to prevent, intercept and correct healthcare errors.

Traditional roles of nursing include surveillance, for example, watching patients for changes in their condition and protecting them from harm/errors. Even as students, nurses are taught that it is their duty and obligation to question doctors' orders and to refuse to administer medications or carry out procedures that they feel are inappropriate.[1] Despite their important role in maintaining safety, most studies of patient safety have focused exclusively on the role of registered nurses in administering medications, and not on their role in error prevention, discovery or correction.[2]

Few studies have examined the part that nurses play in discovering and correcting inappropriate or dangerous medication orders, transcription errors and dispensing errors. When evaluating 334 medication errors, Leape and colleagues[3] found that half of the errors were caught before they reached the patient, with 85% of these errors intercepted by registered nurses; the remaining 15% were detected by pharmacists. In another study,[4] registered nurses reported more adverse medical events than doctors in training (resident doctors and pulmonary/critical care fellows), intensive care attending doctors and other members of the intensive care unit (ICU) staff such as pharmacists, unit secretaries, and students (59.1% vs 27.2%, 2.6% and 4.7%, respectively). In addition, over 50% of the critical incidents documented in a paediatric ICU were discovered by registered nurses.[5] Finally, several of the examples included in a paper by Elfering and colleagues[6] allude to the part registered nurses play in discovering and correcting errors made by others.

The surveillance role of nurses is particularly important in the intensive care environment since the rate of preventable adverse drug events and potential adverse drug events in ICU settings is nearly twice the rate in non-ICU settings.[7] Not only are ICU patients exposed to more medications and treatments than patients in general care areas, they are critically ill, with little natural resilience or ability to defend themselves from the consequences of human error. Thus the potential for patient harm is greater. In fact, approximately 29% of the errors observed in an ICU (Israel) were categorised as potentially harmful, causing significant deterioration in the patient's status or death.[8]

Little is known about nurses' discovery of errors that do not involve medications, or who makes the errors that are subsequently discovered by nurses. Therefore, the purpose of this study is to describe the type and frequency of errors detected by critical care nurses, and to ascertain whenever possible who made the error discovered by the participants. It is hoped that this information will assist in future root cause analysis for error prevention among healthcare providers.

METHODS

The data for this diary-based descriptive study were collected as part of a large American study evaluating the relationship between fatigue reported by hospital staff nurses and errors. Since the methodology and sample have been described in detail elsewhere, they are described only briefly below.[9]

Subjects

A total of 502 American critical care nurses participated in this study. As expected, the sample was predominately female (92.8%), Caucasian (86.7%), middle-aged (mean (SD) age 44.4 (8.0) years, range 23–66 years), and were experienced (mean years experience 18.4 (8.5) years). Almost all participants worked 12-hour shifts (87.8%). All participants were registered nurses who worked full-time (at least 36 hours per week) as a staff nurse in a critical care area (table 1).

Instruments

Data were collected on a daily basis for 28 days using logbooks. Participants completed 15 items about their sleep and mood each day, and an additional 17 items on days they worked. On workdays, nurses were asked about their scheduled and actual work hours, their level of alertness, and whether or not they made any errors, or discovered

Table 1 Employment settings of the registered nurses participating in the present study

	No. (%)
Size of hospital (no. of licensed beds)	
<100 beds	42 (8.3)
100–300 beds	210 (41.8)
>300 beds	250 (49.9)
Type of critical care unit	
Combined ICU/CCU	189 (37.6)
Surgical ICU	89 (17.7)
ICU	80 (15.9)
Coronary care unit (CCU)	56 (11.2)
Pediatric ICU	32 (6.4)
Medical ICU	31 (6.2)
Neonatal ICU	5 (1.0)
Other	20 (4.0)

someone else's error. Space was also provided for participants to describe any practice deviations (errors) that they may have made or discovered during their work shift. Prior to beginning the study, all items and the logbook format itself was pilot tested.

Although not often used to collect information about medical error, there is some evidence that daily, anonymous, end-of-shift reporting of errors is a valid data collection approach. Several studies have shown that nurses and resident doctors are more likely to report medication errors, needle sticks, potential injuries to patients and other adverse events using anonymous end-of-shift reports than completing traditional incident reports.[10–13]

Procedure

A letter describing the study and a demographic questionnaire was sent to 5261 members of the American Association of Critical Care Nurses. Of the 2184 nurses who returned the questionnaires, only 1148 met the criteria for participation—for example, worked at least 36 hours per week providing direct patient care as a critical care staff nurse on a specific unit and not employed as a member of a hospital float pool or nursing agency. Nurses who were employed in specialised roles such as advanced practice nurses, nurse clinicians and nurse managers were not eligible to participate.

Eligible participants received two 14-day logbooks, directions for recording information in the logbooks, and prepaid envelopes to return the completed logbooks. A modified Dillman method[14] was used to increase subject participation rates. Participants were paid $5.00 for each completed logbook page, with the maximum payment being $140.00. The study was approved by institutional review boards at the University of Pennsylvania and Grand Valley State University.

Analysis

The data from the study instruments were first summarised using descriptive statistics and frequency tables. All narrative statements regarding discovered errors were transcribed verbatim. These errors were then classified into five categories using the procedure developed for studying errors and near errors during the Staff Nurse Fatigue and Patient Safety Study.[15 16] Using exemplars to illustrate each type of discovered error, the principal investigator and two nurse researchers with expertise in critical care nursing classified all of the discovered errors into one of five mutually exclusive error categories (medication, procedural, charting, transcription and unable to classify because of insufficient information). Similar procedures were used to further subdivide medication administration errors into six subcategories: wrong patient, wrong medication, wrong dosage, wrong route of administration, wrong time and omitted dose.

Next, all narratives were examined to determine who made the error (doctor, pharmacist, another nurse, unit clerk, technician). If participants did not identify who made the error or if it could not be determined who made the error, it was included in the unable to classify category. All errors were examined to determine if they were discovered prior to reaching the patient. Minimal discrepancies in coding were identified at each step and resolved with 100% agreement among the investigators. Finally, clustered χ^2 tests were performed to determine if the number of discovered errors were related to hospital size or type of critical care unit.

RESULTS

There were 367 errors discovered by 184/502 participants during the 28-day data-gathering period. The number of errors discovered by an individual nurse ranged from 0 to 12. Errors involving medication administration were the most frequently discovered by nurses (44.4%), followed by procedural errors (31.3%). Charting and transcription errors were less frequently discovered (15.0% and 2.7%, respectively). The most common medication error discovered by critical care nurses participating in this study was the administration of an incorrect dose of a prescribed medication (45.1%). Discovering that the wrong drug had been administered or that a dose of a prescribed medication had been omitted was also relatively common. Examples of discovered errors are presented in table 2.

Errors made by other registered nurses were the most frequently reported by participants (40.6%), followed by doctor ordering errors (8.5%). There were 130 errors that could not be attributed to a particular type of provider (see tables 3 and 4). Only 43 of the 367 errors (11.7%) were discovered before they reached the patient. Many of the errors intercepted before they reached patients involved ordering errors, incorrect dispensing of medications, and allergies that were overlooked when medications were ordered and/or dispensed (see table 5).

The number of discovered errors did not differ significantly with regard to the critical care unit ($p>0.2$) or the hospital size ($p>0.5$) (table 6).

DISCUSSION

Our present findings, combined with earlier findings from the Staff Nurse Fatigue and Patient Safety Study,[9 16] suggest that critical care nurses have an important role in maintaining the safety of seriously ill patients. The 502 nurses participating in the study reported catching themselves making an error on 350 occasions,[9] intercepting a colleague in the process of making an error on 43 occasions, and discovering an additional 324 errors made by other staff members. Some errors, such as discovering that an incorrect medication had been dispensed by the pharmacy or that an inappropriate dose of a particular medication had been ordered, were intercepted before they reached the patient. The majority of errors (88%), however, were discovered only after they had occurred.

Medication errors, although the most common type of error discovered by participants in this study, are not the only types of error that occur in a hospital setting. Several studies have shown that equipment-related errors, procedural errors, charting errors, and errors related to diagnostic studies and

Table 2 Number and types of error discovered by 502 critical care nurses

Types of error discovered (n = 367)	Example
Medication errors (n = 163)	
Wrong patient	Coworker about to give medications to wrong patient at 4 am
	Antibiotics given to wrong patient twice, at noon and 6 pm
Wrong drug	Dialysis technician hung wrong dialysate
	Found lactated Ringer's solution hanging on acute renal failure patient
	Pharmacy sent clonidine instead of Klonopin [clonazepam]
	[Doctor] ordered three medications patient was allergic to
Wrong dosage	Pharmacy sent wrong antibiotic dose, label was right. Drug sent back to pharmacy
	Found insulin drip hanging on a patient that was a different mix/ratio than had been hanging earlier, patient was receiving four times the ordered dose [of insulin]
	Dialysis patient had received nafcillin 2 g IV q6 instead of 1 g as ordered for 3 days
	Patient received 12 500 U bolus of heparin, patient ended up going back to OR
	Patient with CHF to be receiving [IV] fluids at 21 cc/h, found fluids at rate of 121 cc/h when I took over care of patient at 11 pm
Wrong route	Doctor wrote order for medication to be given IV, drug has caused fatalities when given IV
	RN wanted to change IM phenobarbital to IVP in patient with subarachnoid bleed
Wrong time	Scheduled mineral oil at the same time as Synthroid [levothyroxine], meds hadn't been staggered to allow absorption
	Post op pt was supposed to have Celebrex [celecoxib] before knee surgery—med given [after surgery]
Omission	IV push med attached to line but not infused
	Dose of medication scheduled for 4 pm not given, found at midnight and given
Procedural errors	Patient on insulin drip, blood sugars should have been obtained every hour
	Respiratory [therapy] did not give scheduled treatment to [patient with] COPD
	Received patient from OR, medications (Dobutrex [dobutamine] and epinephrine) not infusing, stopcock turned the wrong way
	Someone gave a sickle cell crisis patient a tray without changing his 50% Venturi mask to nasal cannula, O_2 saturation [dropped to] 69% in 15 minutes and c/o pain
	Anesthesiologist gave Neo-Synephrine [phenylephrine] bolus for low blood pressure when the arterial line was kinked, patient's BP was okay
	7:20 am found IVP/ventriculostomy was clamped and probably clamped from 11 pm to 7 am as no CSF drainage during that time and had 140 cc drainage during preceding shift
	Speech therapy [*sic*] changed the angle of the head of bed on patient with ventriculostomy
	Respiratory therapy [*sic*] over-stimulated closed head injury patient with suctioning, ICP into 40s, patient became bradycardic
	Found IV infusions of isotropic agents flowing out an open stopcock onto floor
	Nitric oxide tank empty. Respiratory therapy did not switch tanks correctly, patient without nitric oxide for 10 minutes, called respiratory therapy supervisor
	Agency RN taking care of a patient with a blood sugar of 23, not aware of hypoglycemic protocol, waiting for [doctor] to call back, I started D50.
Transcription errors	Nurse did not write correct insulin order; wrote 5 U, supposed to be 15 U
	Orders on medication administration record had added a zero to a dose of Decadron, increasing its dose 10 times more than ordered
	Night nurse (who worked a 16-h shift) transcribed medication order incorrectly on MAR
	Order for KCl written for today only X2, transcribed as BID
	Incorrect order entry by unit secretary. Insulin sliding scale transcribed with wrong type of insulin
Charting errors	MI pt left off O_2, but RN had charted that O_2 was in use
	Night RN charted wrong dose of dopamine drip, caught it at 8:15 am
Unable to categorise	

procedures are common.[4 17 18] Almost a third of the errors discovered by participants involved procedural errors. Some of these procedural errors were relatively minor (eg, pharmacy failing to pick up medications that had been discontinued) whereas others (eg, injecting a medication through an arterial line or a speech therapist changing the elevation of the head of the bed for a patient with a ventriculostomy) could have harmed the patient had they not been intercepted. Other procedural errors discovered by critical care nurses that could have resulted in serious adverse effects included excessively vigorous suctioning in a patient with an increased intracranial pressure and failure to provide a nasal cannula to a patient in sickle cell crisis to increase oxygenation while eating.

According to the results of this study, there are no differences in the type and frequency of errors discovered by critical care unit or hospital size. Inasmuch as all of the units involved in this study were critical care units that involve high-alert medications and intricate calculations, complex care and special procedures, it was not surprising that the type and frequency of errors made and discovered were similar across units. Other researchers have documented that critical care units are extremely busy environments, observing on average 187 activities per patient per day.[8] In addition, processes for medication administration and healthcare procedures are similar across healthcare institutions despite their organisational size. These findings suggest that system and process-related factors should be examined for their role in error prevention, discovery and correction. Finally, future studies should determine if high workloads and fatigue impair critical care nurses' vigilance and alertness to prevent, discover and correct errors made by themselves and other members of the healthcare team.

Table 3 Discovered errors by provider type

Staff member	Example
Pharmacist (n = 26)	Pharmacy sent wrong antibiotic dose, label was right. Drug sent back to pharmacy
	Pharmacist dispenses wrong dose of Solu-Medrol [methylpredisolone]
Physician (n = 31)	[Doctor] ordered three medications patient was allergic to
	Doctor wrote order for medication to be given IV, drug has caused fatalities when given IV
	Clonazepam dose was too high, called to get dosage reduced
	Doctor ordered 35 cc bolus of $D_{10}W$ for low chemstrip on infant weighing 1.75 kg (protocol is 2 cc/kg).
Other technician or services (n = 8)	Speech therapy [*sic*] changed the angle of the head of bed on patient with ventriculostomy
	Respiratory therapy [*sic*] over-stimulated closed head injury patient with suctioning, ICP into 40s, patient became bradycardic
	Nitric oxide tank empty. Respiratory therapy [*sic*] did not switch tanks correctly, patient without nitric oxide for 10 minutes, called respiratory therapy supervisor
Registered nurse (n = 149)	Another RN took a verbal order for Tylenol 3 [paracetamol and codeine] on a patient with history of anaphylaxis to codeine
	Patient with CHF to be receiving [IV] fluids at 21 cc/h, found fluids at rate of 121 cc/h when I took over care of patient at 11 pm
	Night shift medicated patient with a med that was due at 9 am today and it is only given only 7 days, so an extra dose was given
Student nurse, orientee, new staff member or agency nurse (n = 20)	New nurse had patient with SBP in the 60s and on Cardizem [diltiazem], nurse didn't know to turn off Cardizem and start dopamine
	Agency RN taking care of a patient with a blood sugar of 23, not aware of hypoglycemic protocol, waiting for [doctor] to call back, I started D50.
Ward clerk (n = 3)	Orders for evening potassium supplements accidentally removed from Kardex by secretary
	Incorrect order entry by unit secretary. Insulin sliding scale transcribed with wrong type of insulin
Unknown (n = 130)	During a code a drip was given out of sequence
	Under dosing of labetalol drip on hypertensive, haemorrhagic CVA patient
	Antibiotics ordered for 24 h were transcribed wrong, resulting in extra doses
	CT scan never done on patient

Although critical care nurses reported discovering more errors made by others (n = 367) than catching themselves about to make an error or actually making an error,[9] it is possible that they discovered and corrected more errors than were reported in their logbooks. Because participants recorded information about errors in their logbooks at home after the end of their work shift, it is quite possible that they forgot about some of the errors they discovered and corrected several hours earlier.

The relatively small number of participants and low response rate may limit the generalisability of these findings. However, the nurses who participated in this study are similar in terms of age, gender and ethnicity to the probability-based sample of American nurses described in the National Sample of Registered Nurses[19] and an earlier sample of hospital staff nurses,[20] as well as representative of the membership of the American Association of Critical Care Nurses (J Medina, personal communication, 2002). Although our response rate (43.7%) is lower than usually reported for surveys of healthcare providers,[21] this study required more effort than the usual survey since subjects were required to respond to between 17 and 40 items every day for 28 days. Because of the heavy subject burden associated with this study, it is possible that those participating in the study may not be representative of the majority of critical care nurses. Since there were no differences

Table 4 Types and origin of errors discovered by critical care nurses

	Type of provider making error (n (%))							
Type of error discovered	Pharmacist	Doctor	Other technician or service	Registered nurse	Student nurse, orientee, new staff member or agency nurse	Ward clerk	Unknown	Total
Medication errors	13	22	1	99	10	0	18	163 (44.41)
Wrong patient	1	0	0	4	0	0	0	5
Wrong drug	5	9	1	19	2	0	3	39
Wrong dosage	6	11	0	40	6	0	11	74
Wrong route	0	2	0	1	0	0	0	3
Wrong time	0	0	0	2	1	0	0	3
Omission	1	0	0	32	1	0	1	35
Unable to categorise	0	0	0	1	0	0	3	4
Procedural errors	11	8	7	37	10	0	42	115 (31.34)
Charting errors	0	0	0	8	0	0	2	10 (2.72)
Transcription error	2	0	0	5	0	3	45	55 (14.99)
Unable to categorise	0	1	0	0	0	0	23	24 (6.54)
Total	26 (7.08)	31 (8.45)	8 (2.18)	149 (40.6)	20 (5.45)	3 (0.082)	130 (35.42)	367

Table 5 Examples of errors intercepted by study participants

Type of error intercepted	Example
Medication errors	
Wrong patient	Pharmacy sent IV fluids labeled with my patient's name but ordered for a different patient with the same last name
	An order for Ativan was written in the wrong patient's chart
Wrong drug	Patient has asthma, sotalol was ordered, [doctor] notified of asthma, sotalol discontinued
	Co-worker was about to give sublimaze instead of soluitrex
Wrong dosage	Pharmacy sent Norcuron [vecuronium] drip instead of morphine drip
	Stopped nurse from giving a medication that patient was allergic to
	Pharmacy dispensed the wrong dosage of a medication, caught it when I was about to give it to patient
	Nurse was about to give double dose of Ativan to a patient
	Checked dosage of digoxin, nurse was about to give 0.5 mg IV instead of 0.25 mg IV
Procedural errors	Discovered Narcan [naloxone] vials that had expired 2 months ago
	Blood bank sent incompatible blood, I did not give it, and sent it back to blood bank
	Stopped RN (recent grad) from administering a med through an arterial line
	Another RN was going to hang a unit of packed red blood cells on a new patient whose temperature was 102.5 without calling the doctor first (as required by unit policy)
	Pharmacy not removing medications that were discontinued
	Stopped a new ICU RN from doing a cardiac output and calculating other hemodynamic parameters before a chest X-ray was done to confirm placement [of Swan-Ganz line]
	Found tubes of morphine sulphate 5 mg in patient drawer without a label
	RN flushing Quinton catheter was going to use 10 000 U heparin instead of 200 U heparin
Transcription errors	Order incorrectly transcribed and patient could have been overdosed
	A zero had been added to a dose of Decadron in the medication administration record, increasing its dosage to 10 times that ordered

Table 6 Type of errors discovered by critical care nurses employed in hospitals of different sizes

	Number and per cent of errors			
	Number of licensed beds			
Type of error discovered	<100	100–300	>300	Total
Medication error	14	55	91	160
Procedural error	10	40	64	114
Charting error	1	5	4	10
Transcription error	8	25	22	55
Unable to categorise	1	10	13	24
Total	34	135	194	363*

*Four discovered errors with missing information regarding hospital size.

in terms of age, gender, ethnicity, working setting, years of experience, etc., between responders and non-responders (those who were interested and eligible to participate, but did not return any logbooks) we believe that the likelihood of a response bias is minimal.

Despite these limitations, this study suggests the role that critical care nurses have in maintaining patient safety. Although the nurses could intercept several errors before they reached the patient, the nurses were particularly effective at discovering and correcting errors that had been made by other nurses and other members of the healthcare team. Acknowledging the existence and effectiveness of this safety net is crucial; without recognition that errors occur and their source, it will make finding the root cause of errors more challenging and perpetuate a culture of blame. It is hoped that this study will provide a catalyst for future investigations and interventions that will maximise patient safety and error prevention.

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