Résumé

La fréquence et le type d'erreurs et de quasi-erreurs signalés par les infirmières œuvrant en soins de phase aiguë

Michele C. Balas, Linda D. Scott et Ann E. Rogers

Selon la recherche, les taux d'erreurs médicales dans le domaine des soins aux patients en phase aiguë pourraient être très élevés. L'objectif de cette étude descriptive est de déterminer le type et la fréquence d'erreurs et de quasi-erreurs signalées par un échantillon aléatoirement choisi de 502 infirmières en soins de phase aiguë. Des données portant sur des erreurs et des quasi-erreurs ont été consignées quotidiennement dans un journal, pendant une période de 28 jours. Plus d'un quart des participantes ont dit avoir commis une ou plusieurs erreurs et plus d'un tiers ont dit avoir pris conscience d'être sur le point de commettre une erreur. Durant la période ciblée, 224 erreurs et 350 quasi-erreurs ont été signalées. Le type d'erreur le plus fréquent (56,7 %) portait sur l'administration de médicaments. Les participantes ont également signalé des erreurs et des quasi-erreurs de procédure, ainsi que des erreurs de transcription et de consignation au dossier. Ces résultats comportent des conséquences importantes en ce qui a trait à la sécurité des patients en phase critique, une population qui a peu de résilience naturelle ou de capacité de se protéger contre des accidents d'ordre médical.

Mots clés : erreurs médicales, sécurité des patients, soins de phase aiguë, infirmières

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Frequency and Type of Errors and Near Errors Reported by Critical Care Nurses

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Research suggests that critically ill patients may be at high risk for medical errors. The purpose of this descriptive study was to determine the type and frequency of errors and near errors reported by a randomly selected sample of 502 critical care nurses. Data on errors and near errors were recorded in logbooks daily for 28 days. Over one quarter of the participants reported making an error and more than one third reported catching themselves making an error. There were 224 errors and 350 near errors reported during the study period. The most frequent type of error (56.7%) involved medication administration. Procedural errors and near errors, as well as transcription and charting errors, were also reported. These findings have significant implications for patient safety among a seriously ill population that has little natural resilience or ability to protect itself from health-care mishaps.

Keywords: medical errors, patient safety, critical care, nurses, intensive care

Medical errors are common, costly, and dangerous threats to patient safety. Each year in the United States, 1.3 million patients are injured because of errors during hospitalization and approximately 100,000 deaths are attributed to adverse events and medical errors (Kohn, Corrigan, & Donaldson, 2000; Leape, 1994). Adverse events are unintended injuries or complications caused by health-care management rather than by the patient's underlying condition (Baker et al., 2004; Kohn et al.), while errors are "the failure of planned actions to be completed as intended or the use of the wrong plans to achieve a goal" (Kohn et al.). While the prevalence of adverse events has been estimated to occur during 2.5% to 3.7% of US hospitalizations (Brennan et al., 1991; Thomas et al., 2000), prevalence rates are almost double those figures, occurring during 7.5% of all Canadian hospitalizations (Baker et al.). Furthermore, adverse events have been reported to occur during 10.8% and 16.8% of all hospitalizations in the United Kingdom and Australia, respectively (Vincent, Neal, & Woloshyowych., 2001; Wilson et al., 1995). Each year, adverse events add approximately $750 million to health-care costs in Canada (Kondro, 2004) and between $37.6 and $50 billion in the United States (Kohn et al.).

Critically ill patients may experience higher rates of adverse events and errors than other groups of patients. For example, Berenholtz, Dorman, and Pronovost (2003) estimate that all five million patients admitted to critical care units each year in the United States experience at least one preventable adverse event. Other investigators report that the number of adverse events in critical care settings ranges from 13 to 80.5 per 1,000 patient days (Ferraris & Propp, 1992; Giraud et al., 1993; Osmon et al., 2004; Rothschild, Landrigan, et al., 2005; Rubins & Moskowitz, 1990). The rate of preventable adverse drug events in critical care settings is nearly twice the rate found in non-critical care settings (Cullen et al., 1997).

Actual errors, not all of which result in adverse events, may occur at even higher rates. For example, investigators who used self-report and direct observation to study errors in a medical-surgical intensive care unit (ICU) report a mean of 1.7 errors per day (Donchin et al., 1995). Similarly, the authors of the Critical Care Safety Study estimate that 148,000 serious or life-threatening intercepted and non-intercepted errors occur annually in US teaching hospitals (Rothschild, Landrigan, et al., 2005). Approximately one fifth (19%) of medication errors in critical care are life-threatening (Tissot et al., 1999) and almost half (42%) are clinically important enough to warrant additional life-sustaining treatments (Osmon et al., 2004). Given the advanced age and poor health status of today's critically ill patients (Chelluri, Grenvik, & Silverman, 1995), it is not surprising that these errors are associated with substantial increases in patient morbidity and mortality (Bates et al., 1995).

Because of the potential seriousness of these errors, much of the attention given to medical errors in critical care settings has focused on order-writing errors and medication-administration errors (Herout & Erstad, 2004; Leape et al., 1999; Rothschild, Keohane, et al., 2005; Tissot et al., 1999; van den Bemt et al., 2002). Administering medications, while of utmost importance, is only one facet of critical care nursing practice. Critical care nurses must be alert to changes in patient conditions, properly use numerous types of equipment, and communicate with patients and their families as well as with other members of the health-care team.

Errors are not limited to medication administration; nurses may make errors in performing various procedures, transcribing orders, or charting, or by missing subtle changes in a patient's condition (e.g., failure to rescue) (Clark & Aiken, 2003). In fact, Balas, Scott, and Rogers (2004) found that only 58% of the errors reported by a random sample of US hospital staff nurses were associated with medication administration; the remaining errors were associated with incorrect performance of procedures, transcription errors, or charting errors. Unfortunately, the investigators did not examine the prevalence of errors by type of nursing unit.

Thus it remains unknown whether critical care nurses would report similar numbers of non-medication-related errors and near errors. Nor is it known if the distribution of the medication-administration errors will more closely resemble that of American hospital staff nurses (Balas et al.) or the prevalence of errors made by French ICU nurses (Tissot et al., 1999). While Balas and colleagues found that time-related medication errors were the most common type of medication error (33.6%), followed by administration of incorrect medications (17.2%) and omission of medications (15.5%), French investigators found that the most common errors were those due to physicochemical incompatibility (18.6%) (Tissot et al.).

With these findings in mind, the purpose of this study was to examine the type and frequency of errors reported by a large sample of randomly selected critical care nurses in the United States.

Method

The data for the current study were collected as part of a large American study examining the relationship between fatigue reported by critical care nurses and errors (Scott, Rogers, Hwang, & Zhang, 2006). Since the methodology and sample have been described in detail elsewhere (Scott et al.), they will be only briefly outlined below.

Participants

The sample of 502 registered nurses (RNs) was predominantly female (93%), Caucasian (87%), and middle aged (mean 44 ± 8 years, range 23–66 years), with an average of 17 ± 8 years of experience as a staff nurse (range 0–43 years). Participants worked in a variety of critical care units (Table 1), and most worked 12-hour shifts (88%). Over half the participants reported working during the day (55%), while only a few reported working a rotating shift pattern (12%) or evening shift (2.7%);

Table 1 ***Practice Settings of Nurse Participants***

Type of Critical Care Unit	Frequency (%)
Combined ICU/CCU	188 (38)
Surgical ICU	89 (18)
Intensive Care Unit (ICU)	80 (16)
Coronary Care Unit (CCU)	56 (11)
Pediatric ICU	32 (6)
Medical ICU	31 (6)
Neonatal ICU	5 (1)
Other	18 (4)

the remaining participants (31%) reported working night shifts. Most participants were employed in hospitals with over 300 beds (49.7%), with the remainder employed in hospitals with 100 to 300 beds (41.7%) or fewer than 100 beds (8.6%). These hospitals were located in mainly urban (51.8%) and suburban areas (26.7%), with fewer than one quarter of the participants working in hospitals located in small towns (14.9%) or rural areas (5.8%).

Procedure

During the summer of 2002 a covering letter describing the study and a demographic questionnaire were mailed to a random sample of 5,261 members of the American Association of Critical Care Nurses. Of the 2,184 nurses who expressed interest in the study, only the 1,148 nurses who met the inclusion criteria (e.g., employed at least 36 hours per week as a hospital staff nurse, working in a critical care unit) received two logbooks, directions for completing the logbooks, and postage-paid envelopes for returning the logbooks. Each logbook contained 14 pages, one page for each day of a 2-week period. In all, 382 nurses completed both logbooks (providing 28 days of data) and 120 completed only one of the logbooks (providing 14 days of data). As a result, 502 of the 1,148 eligible nurses provided data for at least 14 days, yielding an overall response rate of 43.7%. Agency nurses, members of a hospital float pool, nurse managers, clinical educators, and advanced practice nurses were ineligible to participate. The participants were paid for their input. All study procedures were approved by the Institutional Review Board at Grand Valley State University (in Michigan) and at the University of Pennsylvania.

Instruments

Each logbook page contained 41 questions. Participants completed the first 17 questions, regarding their sleep, mood, and caffeine intake, every day. The remaining questions, about work hours, drowsiness, and overtime, were completed on days when participants worked. Questions regarding errors and near errors were included, and space was provided for the participants to describe any errors or near errors that might have occurred during their work shift. Participants were first asked to indicate if they had made any medication or other errors during the shift, as well as if they had caught themselves before making an error. They were then asked to describe the episode, including the time of day (or night) when it occurred. Participants were not asked to determine whether the error resulted in patient harm (adverse event), nor were they given a specific definition of what constituted an error. This approach allowed participants to describe any perceived deviations from standards of practice.

As discussed elsewhere (Rogers, Hwang, Scott, Aiken, & Dinges, 2004), these logbooks are considered reliable and were pilot tested prior to their use in this study.

Analysis

Descriptive statistics were used to summarize the quantitative data obtained from the demographic questionnaires and logbooks. Data collected did not include any patient characteristics, diagnoses, or acuity levels, nor did they pertain to the number of patients cared for during the work shift.

All narrative statements regarding errors and near errors were transcribed verbatim. Errors and near errors were then classified using the procedures developed during the initial study on fatigue among hospital staff nurses and patient safety (Balas et al., 2004). The principal investigator identified five mutually exclusively categories — charting errors, procedural errors, medication-related errors, transcription errors, and not specified — and provided these categories and exemplar statements to two other investigators with critical nursing experience and expertise in content analysis. Minimal discrepancies in coding were identified and were resolved with 100% agreement. Similar procedures were used to further subdivide medication-related errors and near errors into six subcategories: wrong patient, wrong drug, wrong dose, wrong route, wrong time, and omission. Medications were considered to have been given at the wrong time if the nurse reported that they were administered more than 30 minutes before or after they should have been.

Results

One hundred and thirty-four nurses (26.7%) reported making at least one error and 190 nurses (37.8%) reported catching themselves making an error at least once, for a total of 224 errors and 350 near errors. Although the majority of nurses who reported making errors described only one error (n = 87, 17.3%), 21 (4.2%) reported making two errors, 14 (2.8%) making three errors, and 12 (2.4%) making four or more errors. The findings were similar for near errors, with 115 nurses (22.9%) reporting catching themselves making a single error, 39 (7.8%) catching themselves twice, 22 (4.4%) three times, and 14 (2.8%) four or more times, including one nurse who reported catching him/herself making an error 11 times.

Over half of the errors involved medication administration (56.7%), with procedural errors, transcription, and charting errors being reported less often. Medication errors were also the most common type of error that nurses reported catching (intercepting) (see Table 2).

Table 2 *Type and Frequency of Errors and Near Errors Reported by 502 Critical Care Nurses*

Type of Error	Number of Errors (%)	Number of Near Errors (%)
Medication	127 (56.7)	99 (28.3)
Procedural	44 (19.6)	16 (4.6)
Charting	3 (1.3)	3 (0.9)
Transcription	2 (0.9)	2 (0.2)
Not specified	48 (21.4)	230 (65.7)
Total	224	350

Although sufficient information was given to categorize the majority of errors (78.6), approximately two thirds of the near errors (65.7%) could not be categorized because a narrative description was not provided. The number and type of errors and near errors by critical care unit is shown in Table 3.

Nearly half of the medication-related errors and intercepted errors (43.7%) involved antimicrobials, antihypertensives, vasopressors, or antiarrythmics. Other high-risk medications, such as narcotics, anxiolytics, antipsychotics, electrolytes, anticoagulants, and medications for regulating blood sugar, accounted for an additional 28.5% of the total medication-related errors and intercepted errors. Medications with similar names — for example, dobutamine and dopamine, vancomycin and gentamycin, and heparin and hespan — were also regularly cited as being problematic.

As shown in Table 4, over half of the medication-administration errors involved the inadvertent omission of a dose (22.0%) or the administration of a medication later than prescribed (37.8%). Potentially more serious errors, such as administering the wrong dose or the wrong drug, were less frequently reported. In contrast, the most commonly intercepted errors involved either the wrong drug (28.3%), the wrong dose (32.3%), or administering a drug to the wrong patient (17.2%).

Many of the nurses provided information about the reason for their medication error or near error (Table 5). The most common reasons cited included simply forgetting ($n = 20$) or heavy workload, distraction, and high patient acuity levels ($n = 17$). In 19 cases the nurse reported either "missing or misreading the orders" or "having the orders taken off wrong" as the reason for the medication error or near error. Nurses also described not having medications available from the pharmacy ($n = 3$), receiving the wrong dose or the wrong medication from the pharmacy ($n = 5$), and pulling the wrong drug from the medication cart or refrigerator ($n = 9$).

Table 3 *Number and Type of Errors and Near Errors by Critical Care Unit*

ERRORS									
Type		**Combined ICU/CCU**	**Surgical ICU**	**ICU**	**CCU**	**Pediatric ICU**	**Medical ICU**	**Neonatal ICU**	**Other**
Medication	(*n* = 127)	42	29	18	14	8	11	3	2
Procedural	(*n* = 44)	17	9	6	6	2	2	2	
Charting	(*n* = 3)	1				1		1	
Transcription	(*n* = 2)	1					1		
Not specified	(*n* = 48)	6	14	10	8	2	5	2	1
Total	(*n* = 224)	67	52	34	28	13	19	8	3
NEAR ERRORS									
Medication	(*n* = 98)	48	13	14	7	6	9		1
Procedural	(*n* = 15)	6	3	3		2			1
Charting	(*n* = 3)	2					1		
Transcription	(*n* = 2)	1			1				
Not specified	(*n* = 230)	98	36	41	29	17	4		6
Total	(*n* = 348)	155	52	58	37	25	14		7

Table 4 *Number and Type of Medication-Related Errors and Near Errors*

Type of Error	Number of Errors (%)	Number of Near Errors (%)
Wrong patient	6 (4.7)	17 (17.2)
Wrong drug	13 (10.2)	28 (28.3)
Wrong dose	26 (20.5)	32 (32.3)
Wrong route	5 (3.9)	3 (3.0)
Wrong time	48 (37.8)	13 (13.1)
Omitted dose	28 (22.0)	6 (6.1)
Not specified	1 (0.8)	0 (0)
Total	127	99

Table 5 *Narrative Examples of Medication Errors and Near Errors*

Wrong patient

"Answered call light IVPB for another patient in hand and started to hang in room where I answered call light." (Combined ICU/CCU)

"Almost gave drug on wrong patient. Busy critical care unit." (Surgical ICU)

"Gave digoxin to wrong patient." (Surgical ICU)

Wrong drug

"Nearly bolused patient with dopamine which was connected to normal saline." (Combined ICU/CCU)

"I needed to give 64 [units] Regular insulin; I grabbed the vial of NPH and noticed it was the wrong vial when I went to draw up the med." (Other, neuro ICU)

"Hung the wrong antibiotic on a septic patient." (CCU)

"I hung a Primacor [milrinone] drip for amiodarone, I caught the mistake before any infused." (Surgical ICU)

Wrong dose

"Very busy time of day. I almost gave an antibiotic that had been D/C. I was distracted." (Medical ICU)

"Could not figure out how to figure rate for vasopressin. …repeatedly kept forgetting vasopressin name." (Surgical ICU)

"Changed IV bag. Levophed [norepinephrine]. Did not initially realize that concentration was different." (Surgical ICU)

"Switched rates on dopamine and D5LR rates. 15 minutes [later] error was caught." (Combined ICU/CCU)

"Morphine dose to be given was drawn up at twice the ordered dose because RN forgot to dilute." (Neonatal ICU)

"10X the amount of med ordered." (Pediatric ICU)

Wrong route

"Gave Phenergan [promethazine] IV instead of IM as ordered." (CCU)

"Order for Demadex [torsemide] 20 mg PO written. Entered and verified for IV route. Given IV. Error caught during 7 pm report and chart review." (CCU)

"Route of heparin dose difficult to read [on] MAR so gave SQ instead of IV." (Surgical ICU)

Wrong time

"At 0900, I was so busy with patient care, I almost forgot to get their meds out on time." (ICU)

"Messy med sheet. Almost gave a noon Lopressor [metoprolol] at 10 am instead of 12 noon." (Combined ICU/CCU)

"Missed physician order for new medication. Gave med 3 hours late." (Combined ICU/CCU)

"Medication late because it had not been delivered by pharmacy." (Medical ICU)

"Forgot to unclamp IV antibiotic. Antibiotic given late due to this." (Surgical ICU)

"I was too busy to get 0900 meds out on time. Some weren't given until 11 am." (Combined ICU/CCU)

"Nitroglycerin patch due at 10 pm was given at 1130 pm because I was unable to leave my other patient's room and no else could help." (Medical ICU)

Omission

"Had an antibiotic due at 11 am. Had admission of very ill patient at 330 am who required my full attention." (Combined ICU/CCU)

"Missed med during and after patient code. Med was an antibiotic." (Combined ICU/CCU)

"Patient had a very large list of meds. Almost missed one pill due to pill not being available at due time and extended wait for medication." (Pediatric ICU)

One of the more interesting reasons given for intercepting an error appeared to be associated with correct storage of medications — for example, "JCAHO was in-house and we were not keeping patient medications at the bedside. [I] almost hung [the] other patient's naficillin instead of ancef which was due."

Although most errors and intercepted errors involving intravenous (IV) medications and fluids were categorized as medication errors, others were considered procedural errors. For example, pump-programming errors and attaching medications to the incorrect IV lines were considered medication errors, whereas inserting intravenous catheters (IVC) in patients who did not need them, inserting an IVC in the wrong arm, flushing IVs with the wrong solution, labelling incorrectly, and inadvertently disconnecting lines were considered procedural errors. In addition to being the most frequently reported procedural error and near error, mishaps involving IVs could, in many cases, have had serious if not fatal consequences. For example, a nurse with over 30 years' experience as an RN reported, "[My patient] just returned from the OR, restless. [I was] looking for IV access on tubing different from institutional norm and almost put MS into [the] ICP drain." Another participant reported, "Soon after I turned [my] patient, [his] BP [dropped into the] 70s. [I]thought [it was] due to morphine. Fifteen minutes later [I] found [the] levophed had been disconnected."

Other procedural errors and near errors were associated with laboratory procedures (n = 10) and the use of various types of equipment (n = 9). Nurses reported forgetting to draw blood specimens, either failing to report or failing to act on abnormal laboratory values, forgetting to draw drug levels, and accidentally discarding or inappropriately labelling laboratory specimens. They also reported errors and near errors with the use of equipment such as Swan-Ganz catheters, patient-controlled analgesia (PCA) pumps, intracranial drains, dialysis machines, rapid transfusers, chest tubes, epidural catheters, pacemakers, and even Foley catheters.

As with the medication category, most nurses attributed their procedural errors and near errors to forgetfulness, distracting environments, problems concentrating, or high patient acuity levels. Less frequent causes of procedural errors and near errors were the use of unfamiliar devices and difficulties with, or a lack of knowledge regarding, procedures for programming IV pumps.

Discussion

The results of this study suggest that errors and near errors are common in critical care settings. Slightly more than one quarter (26.7%) of the critical care nurses in the sample reported making at least one error and

37.8% reported making at least one near error in the 28-day reporting period. If these results were extrapolated to a 1-year period, errors and near errors for this sample of 502 RNs would total 7,482 incidents. Although patients in critical care units typically require more medications and procedures than patients in general care units, the number of errors and near errors found in this study are only slightly higher than those found in a similar study examining the prevalence and nature of errors and near errors reported by staff nurses employed in a variety of hospital units (1.2 incidents/nurse vs. 1.0 incidents/nurse) (Balas et al., 2004).

Medication errors were the most frequent type of error reported by critical care nurses in the present study, and were quite similar, in terms of percentage, to medication errors reported in an earlier study (Balas et al., 2004) (56.7% vs. 57.7%). The majority of medication errors in the present study were associated with the administration of drugs at the wrong time (37.8%) or the omission of a prescribed medication (22.0%), again mirroring the findings of the earlier study (Balas et al.). Dosage errors and errors involving the wrong drug, wrong patient, or wrong route were less common. In fact, the number of wrong-time errors (37.8%) reported in this study is quite similar to the 40.5% time-related medication administration errors reported in two Dutch critical care units (van den Bemt et al., 2002), but much higher than the 3.7% reported in a French ICU (Tissot et al., 1999). Although Tissot and colleagues attributed the low rate of time-related errors in their observational study to having predefined times for administering all oral and injectable medications, most critical care units in the United States share this characteristic for administering routine medications. While time-related errors are usually considered less critical than other types of medication error (van den Bemt et al.), 55% of the wrong-time errors observed in the French ICU during the 30-day study period were judged clinically significant due to interruptions in therapeutic effects over a 24-hour period (Tissot et al.).

Most incidents in the sample involved antimicrobials and antihypertensive, vasopressor, or antiarrythmic agents. While this finding is not surprising, since these drugs constitute a high proportion of the medications administered to seriously ill patients, their inadvertent omission or ill-timed administration can have significant clinical implications. More surprising was the frequency of errors with medications recognized as high risk. These included insulin, potassium, and anticoagulants such as heparin and warfarin sodium. While strategies suggested by the Institute of Medicine (Kohn et al., 2000), such as implementing computerized physician order entry and unit dosing, having high-risk medications supplied by the central pharmacy, not storing concentrated solutions of

hazardous medications on patient-care units, and including pharmacists in patient-care rounds, have been implemented in some critical care units, these practices are not universal.

This study also revealed that procedural errors, although rarely studied, are very common in the critical care setting. Most procedural errors and near errors involved IV fluids and catheters. While some of the mistakes in this category could, arguably, be categorized as medication-administration errors, there are several reasons for categorizing them as procedural errors. Mistakes such as inserting IVs into patients who do not require them, mixing/pushing medications in incompatible IV fluids, or forgetting to unclamp IVs do not necessarily fit neatly into one of these categories. It was also believed that some of the errors and near errors reported by participants — for example, flushing IV lines with saline instead of heparin, incorrectly labelling IV lines, or monitoring IV insertion sites — may have been violations of institutional procedures rather than universally accepted practices.

Some procedural errors and near errors were clearly violations of accepted practice and could have led to significant complications. For example, one participant described the following situation: "Yesterday, when changing a pleuravac [chest tube] at shift change I needed to give general report, I forgot to unclamp it. Caught by night shift nurse and brought to my attention this AM." In terms of patient safety, moreover, these incidents appeared equally as dangerous as, if not more dangerous than, many of the medication errors reported by participants. Although two studies (Beckmann et al., 2003; Osmon et al., 2004) suggest that delays or omissions of prescribed non-medication treatments or diagnostic tests are one of the most common types of error reported in the critical care setting, delays or omissions of prescribed treatments were rarely reported by participants in the present study.

The present study is one of the few investigations in which nurses were asked to report incidents of catching themselves making an error (near error). Error interception is rarely mentioned in patient safety research, and when it is studied the focus is usually on the detection of order-writing or dispensing errors (Leape et al., 1995). It is obvious, however, that the nurses in this study, like those who participated in the first phase of the Staff Nurse Fatigue and Patient Safety Study (Balas et al., 2004), were vigilant and careful, preventing a large number of errors from reaching the patient. What is not known, however, is if the large number of near errors (n = 350) compared to actual errors (n = 224) reported represents the actual proportion of near errors to errors or a greater reluctance on the part of nurses to disclose having made an error. Nor is it known what kinds of error were most frequently intercepted, since participants provided information on only one third of the near

errors. However, given the results of this study, as well as previous results (Balas et al.), one can assume that the majority of the non-specified near errors involved medication administration (230 non-specified near errors x 56.7% = 130 intercepted medication-related errors).

Numerous studies have shown that nurses often under-report errors because they fear disciplinary action (Osborne, Blais, & Hayes, 1999; Wakefield, Wakefield, Uden-Holman, & Blegen, 1996). In fact, traditional error-reporting systems are believed to capture information on only the most serious life-threatening errors (Leape et al., 1995; Osborne et al.; Wakefield et al.). We believe that the blinding of the present researchers to participant and employer identification served to reduce the fear of disclosure, allowing participants to more freely report errors. However, it is acknowledged that our failure to collect data on participants' place of employment limited comparison between units in the same institution, between types of institution (e.g., teaching and non-teaching hospitals, for-profit and not-for-profit hospitals), and among units of different types or with different levels of patient acuity and/or staffing ratios.

It is also acknowledged that the self-report method used in this study may not have captured information on all the errors and near errors that occurred during the 28-day data-gathering period. Participants may not have been aware of making an error, or may not have taken the time to describe a case of making or intercepting an error. The latter may partly explain the high number of instances where participants indicated that they caught themselves making an error but did not describe the situation (65.7%). It is also possible that, since nurses in the United States are usually required to report actual errors but not intercepted errors, participants did not see the importance of describing near errors.

Critical care nurses make multiple decisions, during the course of each day, that have the potential to either elevate or diminish the likelihood that their patients will experience a medical error. Participants in the present study reported that their decision-making ability and performance were frequently affected by factors such as high patient acuity levels, distractions, and the need to juggle multiple tasks. Also, it is to be expected that medications such as vasopressors and antiarrythmics, which require complex calculations and patient monitoring in a distracting critical environment, will be more frequently involved in errors and near errors. In some cases nurses may have had to prioritize their administration of medications, choosing one agent over another and judging medications such as antibiotics as less important. One participant stated, "Missed med during and after patient code. Med was an antibiotic."

While little is known about the effect of staffing patterns, workload, and medical error in critical care units in the United States, research from the United Kingdom and France suggests a causal relationship between

these factors and increased mortality risk (Giraud et al., 1993; Tarnow-Mordi, Hau, Warden, & Shearer, 2000). Results of studies with US hospital nurses employed in a variety of units support this presumption (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Kovner & Gergen, 1998; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). Participants in the present study reported being unable to count on their colleagues for help — "I was unable to leave my patient's room and no one else could help out" — and only on one occasion mentioned a colleague discovering their error. Fatigue and long work hours could also have been a contributing factor (Rogers et al., 2004; Scott et al., 2006).

Future research should include assessments of patient acuity, staffing, and institutional factors (e.g., hospital size, number of critical care beds, type of hospital), as well as revision of the data-gathering tool. Modifications might include the addition of the operational definitions of error and near error, use of predefined categories with forced responses, and perhaps the addition of a category to capture communication issues. Comparisons between types of unit and identification of factors predictive of errors in each type of unit would also be helpful for the development of error-reduction strategies.

In summary, a large number of errors and near errors were reported by RNs employed in the critical care setting. While many of these episodes involved medication administration, an almost equal number involved other nursing functions. These errors and near errors were often attributed to factors such as distraction, high patient acuity levels, and communication failure. Critical care nurses need to take an active role in designing and implementing strategies for improving patient safety. Identifying, acknowledging, and understanding the frequency and types of errors that may occur in critical care nursing practice is an integral step in fostering a paradigm shift from a culture that is punitive to one that rewards efforts to maximize patient safety.

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