Nurse staffing and patient outcomes in critical care: A concise review

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LEARNING OBJECTIVES
After participating in this educational activity, the participant should be better able to:
1. Measure nurse staffing ratios.
2. Evaluate impact of nurse staffing in intensive care unit on intensive care unit outcomes.
3. Assess adequacy of staffing in intensive care units at the local level.

Background: Studies over the past several decades have shown an association between nurse staffing and patient outcomes. Most of those studies were generated from general acute care units. Critically ill patients demand increased nurse staffing resources and nurses who have specialized knowledge and skills. Appropriate nurse staffing in critical care units may improve the quality of care of critically ill patients.

Objectives: To review the literature evaluating the association of nurse staffing with patient outcomes in critical care units and populations.

Methods: An annotated review of major nursing and medical literature from 1998 to 2008 was performed to find research studies conducted in intensive care units or critical care populations where nurse staffing and patient outcomes were addressed.

Results: Twenty-six studies met inclusion for this review. Most were observational studies in which outcomes were retrieved from existing large databases. There was variation in the measurement of nurse staffing and outcomes. Outcomes most frequently studied were infections, mortality, postoperative complications, and unplanned extubation. Most studies suggested that decreased nurse staffing is associated with adverse outcomes in intensive care unit patients.

Conclusions: Findings from this review demonstrate an association of nurse staffing in the intensive care unit with patient outcomes and are consistent with findings in studies of the general acute care population. A better understanding of nurse staffing needs for intensive care unit patients is important to key stakeholders when making decisions about provision of nurse resources. Additional research is necessary to demonstrate the optimal nurse staffing ratios of intensive care units. (Crit Care Med 2010; 38:1521–1528)

Key Words: nursing staff; hospital; outcome and process assessment; intensive care unit; critical care; personnel staffing and scheduling; hospital mortality; postoperative complications; nursing workload

A t the conclusion of this CME activity, participants should be able to measure nurse staffing ratios in their intensive care unit (ICU) and use this information to improve patient outcomes. Determining the right number and characteristics of nurses needed to meet patient needs has been a topic of interest because of limited resources, financial constraints, and the nursing shortage. California was the first state in the United States to mandate nurse-to-patient-ratios in 2004, and other states are considering adopting similar mandates. California’s mandates for staffing were over a variety of hospital nursing settings. However, results from a study 2 yrs after regulation in California indicated that although this mandate did result in an increased licensed nurse staffing, an improvement in patient outcomes was not found in medical–surgical and step-down units. The anticipated decreases in two key nursing-sensitive outcomes, falls or prevalence of hospital-
acquired pressure ulcers, were not observed (1).

Over the past few decades, nurse staffing ratios have been associated with patient outcomes (2–16) such as mortality (2, 4, 5, 8, 9, 11–13), adverse events, complications, failure to rescue (5, 8, 11–13), quality of care (7), costs (2, 5, 8), length of stay (5, 8), as well as nurse burnout and job dissatisfaction (11). Most of these studies were performed in general acute care units or conglomerate of hospital/unit types.

Nurse staffing in critical care differs from other acute care units for a variety of reasons. Nurses are typically assigned to fewer patients in critical care than in other types of acute care units based on higher acuity, frequency of observation and measurements, and multiple aspects of care required for the critically ill patient. Therefore, information gained from studies of nurse staffing on outcomes from the general acute care population may not be translatable to critical care units. Critically ill patients require a high degree of acute care resources and nurses who have specialized knowledge and skills, necessitating education and preparation beyond their basic nursing degree to function competently. Given the additional training and expense of critical care nurses, specific knowledge about nurse staffing and outcomes specific to critical care is essential. The purpose of this concise review is to summarize the literature on the relationship of nurse staffing and patient outcomes in critical care populations over the past decade.

MATERIALS AND METHODS

A focused search of the English language literature was performed using Ovid MEDLINE, PubMed, and the Cumulative Index of Nursing and Allied Health Literature databases for research on the impact of nurse staffing and patient outcomes in critical care from January 1998 through December 2008. Search terms used included intensive care units (intensive care, critical care), outcome and process assessment (health care), infection, infection control, hospital mortality, length of stay, treatment outcome, outcome assessment, nursing outcome, personnel staffing and scheduling, personnel management, critical care nursing, nurses, and nursing staff. This review was combined and narrowed to include original research articles. A total of 59 from each database were found and redundancies and irrelevant publications were eliminated. Reference lists from studies were reviewed for potential inclusion of studies not found in the original search. All abstracts were reviewed using the following criteria to meet inclusion into this concise review: nurse staffing was measured against patient outcome(s); the study was specific to critical care units or populations with critical illness; or the study included a specific subanalysis of data within a critical care unit or population.

Only publications of completed studies in the English language were included, and unpublished studies or abstracts were excluded. Because nurse staffing measures vary across studies, for purposes of this review “nurse staffing” refers to the numbers of patients or workload assigned to nurses, or hours of nursing provided per patient. Higher nurse staffing indicates more nurses (or higher proportion) for assigned patients or less nurse workload. Lower nurse staffing is defined as fewer nurses (or lower proportion) for the number of assigned patients or higher nurse workload.

RESULTS

Twenty-six publications met inclusion for this review and were evaluated for their methodology, measures of nurse staffing, outcome of interest, and results related to staffing and outcome. The Table 1 summarizes studies that are included in this review.

Study methods and designs were predominately observational and nonexperimental, with the use of information retrieved from existing databases. No randomized controlled or experimental studies were found. Two studies were meta-analyses (15, 24), 10 were observational studies of data from large existing databases and surveys (18, 21, 23, 30, 31, 33–36, 40), four were observational studies from prospectively collected databases (19, 20, 22, 39), and five were prospective, observational studies (17, 25, 27, 28, 32). Two investigations were case-control studies (29, 38) and three were systematic investigations from prospectively collected infection control surveillance databases (26, 37, 41). Twenty-three studies were conducted in adult ICUs (15, 17–27, 30–32, 34–41), one was in a pediatric ICU (29), and two were in neonatal ICUs (28, 33).

Measures of nurse staffing varied considerably across studies, including nurse-to-patient ratios, hours per patient-day, and different calculations of nurse workload. The Table includes nurse staffing measures used for each study. The majority of studies (n = 20) used some form of calculation of nurse-to-patient ratio to measure nurse staffing. Three studies used hours per patient-day as a measure of nurse staffing, and in four studies (17, 26, 27, 39) nurse workload was calculated. Kiekkas (17) expressed nurse staffing as patient “exposure” to nursing workload by calculating a ratio of patient demands (Therapeutic Intervention Scoring System-28 sum) to the daily number of nurses over three levels. Tarnow-Mordi (39) used three measures for ICU workload, including peak occupancy, average nurse requirement per occupied bed per shift, and ratio of occupied to appropriately staffed beds, as defined by a locally agreed on formula. Patient outcomes measured in the reviewed studies may be summarized into the following categories: infections, mortality, postoperative complications, and unplanned extubation and reintubation.

Nurse Staffing and Infections

Eleven studies had a primary focus on infectious outcomes and nurse staffing (19, 20, 22, 25–28, 32, 37, 38, 41). Two studies included an infectious complication as one of the variables studied (15, 21). Two studies reviewed evaluated the impact of nurse staffing on nosocomial infectious complications (19, 20), and five studies were investigations of outbreaks or spread of specific organism infections (25–27, 37, 41). Four studies focused on specific types of infections (22, 28, 32, 38).

The meta-analysis by Kane et al (15) included a subanalysis of studies from ICUs, which included evaluation of infectious complications. Pooled analysis showed a 30% reduction in odds for nosocomial pneumonia with higher registered nurse (RN) staffing in the ICU (odds ratio, 0.7; 95% confidence interval, 0.56–0.88). The authors estimated that increasing RN staffing by one full-time equivalent per patient-day in the ICU could potentially avoid seven cases of nosocomial pneumonia for every 1000 hospitalized patients. Additionally, when the number of patients per RN per shift in the ICU decreased from 3.3 to less than 1.6, there was an associated 43% odds reduction of nosocomial sepsis, with a potential avoidance of 10 cases per 1000 ICU patient admissions.

Four studies examined the effect of nurse staffing on bloodstream infections (21, 28, 32, 38). In all four studies, during time periods of reduced nurse staffing, patients had more central line bloodstream infections; during periods of increased nurse staffing, patients had fewer central line bloodstream infections. More central line bloodstream infections also
### Table 1. Studies of nurse staffing studies in critical care included for review

<table>
<thead>
<tr>
<th>Author, Year of Publication</th>
<th>Population Studied</th>
<th>Study Method</th>
<th>Nurse Staffing Measure</th>
<th>Outcome of Interest</th>
<th>Findings</th>
</tr>
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<tbody>
<tr>
<td>Kiekkas et al (17), 2008</td>
<td>n = 396; Medical–surgical ICU patients in Greece</td>
<td>Prospective, observational, single center</td>
<td>Level of exposure to nursing workload, Therapeutic Intervention Scoring System-to-nurse ratio</td>
<td>Mortality</td>
<td>NS, positive trend in increased workload</td>
</tr>
<tr>
<td>Cho et al (18), 2008</td>
<td>n = 27,372; 42 tertiary and 194 secondary hospital ICUs in Korea</td>
<td>Retrospective study from a large administrative database</td>
<td>Ratio of average daily census to total number RN FTE</td>
<td>Mortality</td>
<td>Additional patients/RN associated with incremental increased odds ratio for mortality; NS nurse experience</td>
</tr>
<tr>
<td>Kane et al (15), 2007</td>
<td>28 studies, included subanalysis of ICU patients</td>
<td>Meta-analysis and systematic review</td>
<td>Ratio of RN FTE per patient-day and NPR</td>
<td>Adverse events and complications, mortality, infections</td>
<td>Reduced nurse staffing associated with adverse patient outcomes</td>
</tr>
<tr>
<td>Hugonnet et al (19), 2007</td>
<td>n = 1883; Medical ICU in Switzerland</td>
<td>Observational, single-center, prospective cohort study</td>
<td>24-hr NPR</td>
<td>Nosocomial infection</td>
<td>Higher staffing associated with &gt;30% reduction of infection risk</td>
</tr>
<tr>
<td>Hugonnet et al (20), 2007</td>
<td>n = 366; Medical ICU in Switzerland with ICU length of stay &gt;7 days</td>
<td>Comparison of case-crossover, case-time-control, and cohort designs, prospective surveillance for ICU nosocomial infections</td>
<td>24-hr NPR</td>
<td>Nosocomial infections</td>
<td>In all three designs, lower nurse staffing associated with approximately 50% increased risk for infections</td>
</tr>
<tr>
<td>Stone et al (21), 2007</td>
<td>n = 15,846; Elderly patients in 51 adult ICUs in 31 New York hospitals</td>
<td>Observational data from NNIS and Medicare files, nurse survey, American Hospital Association annual survey</td>
<td>RN HPPD</td>
<td>CLBSI, VAP, catheter-associated urinary tract infection, 30-day mortality, decubiti</td>
<td>Higher staffing associated with lower CLBSI, VAP, 30-day mortality, and decubiti</td>
</tr>
<tr>
<td>Hugonnet et al (22), 2007</td>
<td>n = 2470; Medical ICU patients with mechanical ventilation in Switzerland</td>
<td>Prospective, observational, single-center cohort study</td>
<td>24-hr NPR</td>
<td>Late onset VAP</td>
<td>High NPR associated with a decreased risk for late-onset VAP</td>
</tr>
<tr>
<td>Tourangeau et al (23), 2006</td>
<td>n = 46,993; 75 hospitals in Ontario, Canada; acute myocardial infarction, stroke, pneumonia, septicemia patients</td>
<td>Retrospective, large, clinical and administrative databases and surveys</td>
<td>Proportion of RN staffing; nurse-reported staffing adequacy</td>
<td>30-day mortality</td>
<td>Lower mortality associated with higher proportion RN staff and adequacy of staffing</td>
</tr>
<tr>
<td>Numata et al (24), 2006</td>
<td>Nine studies of critically ill patients</td>
<td>Meta-analysis and literature review</td>
<td>NPR</td>
<td>Hospital mortality</td>
<td>No consistent association with mortality</td>
</tr>
<tr>
<td>Halwani et al (25), 2005</td>
<td>n = 430; Adult mixed ICU in United Kingdom</td>
<td>Prospective longitudinal</td>
<td>Number of nurses and patients daily</td>
<td>Cross-transmission of nosocomial pathogens</td>
<td>Understaffing associated with increased risk for cross-transmission</td>
</tr>
<tr>
<td>Dancer et al (26), 2006</td>
<td>n = 174; One ICU in Scotland</td>
<td>Retrospective</td>
<td>Weekly nurse workload calculation</td>
<td>MRSA infections</td>
<td>Increased MRSA with nurse understaffing</td>
</tr>
<tr>
<td>Blatnik and Lesnicar (27), 2006</td>
<td>n = 297; Surgical ICU in Slovenia</td>
<td>Prospective study</td>
<td>Daily nurse workload using Therapeutic Intervention Scoring System</td>
<td>MRSA infections</td>
<td>Increased MRSA when &gt;25% excess nurse workload</td>
</tr>
<tr>
<td>Cimiotti et al (28), 2006</td>
<td>n = 2675 infants; Two level II–IV neonatal intensive care units in New York</td>
<td>Prospective cohort study</td>
<td>Average RN HPPD per infant</td>
<td>Time to first episode of healthcare-associated bloodstream infection</td>
<td>Higher HPPD associated with decreased healthcare-associated bloodstream infection</td>
</tr>
<tr>
<td>Marcin et al (29), 2005</td>
<td>n = 1004; Pediatric ICU in California</td>
<td>Matched case-control study</td>
<td>NPR</td>
<td>Unplanned extubation Mortality</td>
<td>Higher NPR associated with unplanned extubation</td>
</tr>
<tr>
<td>Person et al (30), 2004</td>
<td>n = 118,940; Medicare patients with acute myocardial infarction in United States</td>
<td>Retrospective record review from American Hospital Association and Centers for Medicare and Medicaid Services databases</td>
<td>NPR</td>
<td></td>
<td>Higher RN staffing associated with lower mortality</td>
</tr>
</tbody>
</table>
occurred in neonatal ICU patients during less RN care hours (28) and fewer central line bloodstream infections occurred in elderly ICU patients with increased nurse staffing (21). Findings from two studies revealed a higher risk of central line bloodstream infections during periods when more nursing care was provided by pool (38) or float nurses (32).

Five studies addressed cross-transmission and outbreak of specific pathogens and their association with nurse staffing in the ICU (25–27, 37, 41). Halwani et al (25) found that patients who spent their entire ICU stay in understaffed environments tripled their chances for cross-transmission of a pathogen. Dorsey et al (37) found a temporal relationship between higher infection rates with *Enterobacter cloacae* or *Serratia marcescens* and lower RN staffing each shift. Three studies focused on acquisition of methicillin-resistant *Staphylococcus aureus* and nurse staffing (26, 27, 41). All three studies reported increased methicillin-resistant *Staphylococcus aureus* infections in ICU patients during periods of lower nurse staffing or increased nursing workload.

The association of nurse staffing with the risk of nosocomial infections in general was the focus of two studies (19, 20). Hugonnet et al (19) reported a increased mortality with higher nurse workload associated with months of peak nurse workload and reduced NPRs.

### Table 1—Continued

<table>
<thead>
<tr>
<th>Author, Year of Publication</th>
<th>Population Studied</th>
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<th>Nurse Staffing Measure</th>
<th>Outcome of Interest</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metnitz et al (31), 2004</td>
<td>n = 26,186; 31 ICUs in Austria</td>
<td>Observational multicentered cohort study</td>
<td>NPR, work-to-utilization ratio</td>
<td>Mortality</td>
<td>NS association with mortality</td>
</tr>
<tr>
<td>Alonso-Echanove et al (32), 2003</td>
<td>n = 4535 8 ICUs in the United States</td>
<td>Prospective, observational multicentered cohort study</td>
<td>NPR</td>
<td>CLBSI</td>
<td>NS association with NPR to CLBSI, increased CLBSI when 60% care by float nurses</td>
</tr>
<tr>
<td>Tucker et al (33), 2002</td>
<td>n = 13,334 infants; 54 neonatal intensive care unit s in the United Kingdom</td>
<td>Retrospective study from large national census databases</td>
<td>NPR, percentage maximum occupancy</td>
<td>Hospital mortality, postnatal cerebral damage, nosocomial bacteremia</td>
<td>Mortality higher with increased nurse workload</td>
</tr>
<tr>
<td>Dang et al (34), 2002</td>
<td>n = 2606 Abdominal aortic surgery in 38 ICUs in Maryland</td>
<td>Secondary analysis of statewide database; surveys</td>
<td>Survey of NPR</td>
<td>Postoperative complications</td>
<td>Respiratory and cardiac complications associated with lower nurse staffing</td>
</tr>
<tr>
<td>Dimick et al (35), 2001</td>
<td>n = 569; Hepatectomy in 33 Maryland ICUs</td>
<td>Observational cohort study from state database; surveys</td>
<td>Survey of NPR</td>
<td>Mortality, length of stay, costs, postoperative complications</td>
<td>Fewer nurses associated with increased risk for respiratory failure and reintubation</td>
</tr>
<tr>
<td>Pronovost et al (36), 2001</td>
<td>n = 2606; Abdominal aortic surgery in 46 hospitals in Maryland</td>
<td>Observational study from state database; surveys</td>
<td>Survey of NPR</td>
<td>Postoperative complications</td>
<td>Fewer nurses associated with increased risk for pulmonary, medical, and other complications</td>
</tr>
<tr>
<td>Dorsey et al (37), 2000</td>
<td>n = 52; One surgical ICU in San Francisco</td>
<td>Prospective investigation of infectious outbreak</td>
<td>NPR</td>
<td>Invasive disease attributable to <em>Enterobacter cloacae</em> and <em>Serratia marcescens</em></td>
<td>Lower nurse staffing associated with months of outbreaks</td>
</tr>
<tr>
<td>Robert et al (38), 2000</td>
<td>n = 28; One inner city hospital surgical ICU</td>
<td>Retrospective, nested case-control study</td>
<td>Average NPR each shift; HPPD, pool vs. regular nursing staff</td>
<td>Primary bloodstream infections</td>
<td>Higher pool NPRs and lower regular nurse NPRs associated with bloodstream infections</td>
</tr>
<tr>
<td>Tarnow-Mordi et al (39), 2000</td>
<td>n = 1050; Adult ICU in one hospital in Scotland</td>
<td>Retrospective analysis from a prospective cohort study; risk-adjusted</td>
<td>Nurse workload; ratio of occupied to appropriately staffed beds</td>
<td>Mortality</td>
<td>Increased mortality with increased ratio of occupied to appropriately staffed beds</td>
</tr>
<tr>
<td>Amaravadi et al (40), 2000</td>
<td>n = 366; Esophagectomy patients in 35 Maryland hospitals</td>
<td>Statewide observational cohort study; surveys</td>
<td>Night-time NPR</td>
<td>Complications and economic outcomes</td>
<td>NS mortality, pneumonia, reintubation, and septicemia associated with lower nurse staffing</td>
</tr>
<tr>
<td>Vicca (41), 1999</td>
<td>n = 50; One hospital ICU in Leicestershire</td>
<td>Retrospective study from infection control database</td>
<td>NPR; total staff-to-patient ratio; total staffing level</td>
<td>MRSA infection spread</td>
<td>MRSA associated with periods of peak nurse workload and reduced NPRs</td>
</tr>
</tbody>
</table>

ICU, intensive care unit; CLBSI, central-line-associated bloodstream infections; VAP, ventilator-associated pneumonia; MRSA, methicillin-resistant *Staphylococcus aureus*; NS, nonsignificant; RN, registered nurse; FTE, full-time equivalent; NNIS, National Nosocomial Infection Surveillance; NPR, nurse-to-patient ratio; RN HPPD, RN hours per patient day.
tested three different research designs and analysis of nurse staffing and nosocomial infections and found that lower nurse staffing was associated with approximately double the risk for nosocomial infections. In an outcomes study of elderly ICU patients, increased overtime in the ICU was associated with higher catheter-associated urinary tract infections and other infections (21).

Hugonnet et al (22) reported that increased nurse staffing was associated with less risk for development of late-onset ventilator-associated pneumonia. Stone et al (21) and Kane et al (15) also found an association with reduced nosocomial pneumonia with increased nurse staffing. Kane et al (15) estimated that if this association were causal, then increasing nurse staffing by one additional RN per patient-day would avoid seven cases of hospital-acquired pneumonia in ICU patients.

Nurse Staffing and Mortality

Eight studies included mortality as the major independent variable (17, 18, 23, 24, 30, 31, 33, 39). Five other studies (15, 21, 35, 36, 40) included mortality as one of their outcome variables. Two of those studies were meta-analyses (15, 24) and nine (18, 21, 23, 30, 31, 35, 36, 39, 40) were retrospective reviews from large, standardized databases. Two (17, 33) were prospective, observational studies.

Results on the impact of nurse staffing on mortality are mixed. Some of the studies demonstrated a trend toward or significant association with increased nurse staffing on reduced mortality (15, 18, 21, 23, 30, 33, 39). However, six studies did not find an association between nurse staffing and mortality (17, 24, 31, 35, 36, 40).

In the study by Tourangeau et al (23), backward regression yielded eight predictors explaining 45% of variance in risk-adjusted mortality. Higher percentage of nurses and perceived adequacy of RN staffing and lower workload were associated with lower mortality. Interestingly, lower reported manager capability and support and higher nurse burnout rates were also predictors of lower mortality. Other studies found a relationship of increased staffing levels with lower mortality. Cho et al (18) found a significant relationship of nurse staffing with mortality and found that increases in patients assigned to a nurse per shift were associated with a 9% increase in odds of death. Using these estimates, she calculated that adding one, two, and three patients per nurse assignment would translate to 15, 28, and 44 excess deaths per 1000 patient admissions, respectively. Tarnow-Mordi et al (39) measured nurse staffing in terms of patient exposure to incremental levels of workload using a formula derived from a ratio of occupied ICU beds to nurse staffing. After adjusting for patient risk for mortality, they found that when patients were exposed to higher workload, the adjusted mortality more than doubled (odds ratio, 3.1; 95% confidence interval, 1.9–5.0). Associations with mortality were also found with extremes in age across populations. Increased nurse staffing was associated with lower mortality in neonatal ICU (33) and elderly ICU patients (21). Kane et al (15) also found lower mortality in ICUs with increased nurse staffing, and they estimated that increasing nurse staffing by one RN per patient-day could potentially result in five lives saved per 1000 ICU patients if this association were causal. Person et al (30) found significantly lower inhospital mortality in acute myocardial infarction patients in units staffed with higher numbers of RNs vs. licensed practical nurses.

In contrast, in the meta-analysis by Numata et al (24), although four of five studies showed a statistically significant association with mortality between higher and lower nurse staffing, only one study found significant statistical significance after adjusting for covariates in the model. Kiekkas et al (17) also found increased trends in mortality during periods when patients were exposed to peak nurse workloads, although it did not reach statistical significance. Metnitz et al (31) did not find a statistically significant association of nurse staffing indices with mortality. In studies on postoperative outcomes (35, 36, 40), no association was found between nurse staffing and mortality.

Nurse Staffing and Postoperative Complications

Four studies examined the effect of nurse staffing on outcomes in three distinct surgical patient populations from a large state database: hepatectomy (35), esophagectomy (40), and abdominal aortic surgery (34, 36). In all of these studies, periods of decreased nurse staffing was associated with increased risk for several types of postoperative complications, including pulmonary failure, pneumonia and reintubation (34–36, 40), septicemia (40), pulmonary, cardiac, and other complications (34, 36), and increased costs (35, 40).

Nurse Staffing and Unplanned Extubation and Reintubation

Marcin et al (29) study found that decreased nurse staffing and patient agitation was associated with unplanned extubations in the pediatric ICU. Kane et al (15) also found an association of nurse staffing with unplanned extubations and estimated that an increase in nurse staffing by one RN per patient-day would result in 51% fewer unplanned extubations and estimated that six cases of unplanned extubations per 1000 ICU admissions might be avoided. In the postoperative studies (34–36, 40) from Maryland, they found increased reintubation rates during times of decreased nurse staffing. This finding may suggest a relationship with unplanned extubation.

DISCUSSION

Most of the studies in this concise review showed a trend toward or association between lower nurse staffing or increased workload with adverse ICU patient outcomes. These findings are consistent with much of the literature described in studies of the general acute care hospital population. Whereas the consistency of the results suggests that the association may be real, because these studies are observational, it is not possible to demonstrate a causal relationship of nurse staffing on patient outcomes (15). Many factors may impact patient outcomes, and nurse staffing is only one potential contributor (15, 16, 23).

One difficulty with interpreting and translating findings from these studies is variability in measurement of nurse staffing and patient outcomes. Nurse staffing was defined and calculated in different ways (nurse workload, nurse-to-patient ratio, hours per patient-day) and impacts the ability to establish equivalence of this independent variable across studies. Many of these studies used large databases and medical record review for measured variables, which vary in accuracy and may influence findings (15, 16). These measurement issues limit comparability between studies and complete understanding of the impact of any single effect of staffing on outcomes. In an effort to help standardize and streamline measures of nurse staffing and identify outcomes most sensitive to nursing care, Van den Heede (45) assembled a panel of experts in this field to gain consensus on key nurse staffing, patient outcome, and...
when nurses are assigned to care for critically ill patients. There may be a critical limit to how much time and number of nursing personnel are needed for effective observational, preventive, and interventional nurse actions to meet the needs of critically ill patients.

In this review, the major focus was what was known about the association between nurse staffing and patient outcomes. There are other factors that may impact the effectiveness of nursing care on patient outcomes, and simply providing more nurses to improve patient outcomes would be short-sighted. The quality of nursing staff, including their capabilities and use of best practices and processes of care, may impact certain outcomes of the critically ill.

Individual nurse factors may also impact their ability to manage the care of critically ill patients, including their knowledge, skills, abilities, and other human factors. Aiken (42) studied the relationship between the level of nursing education and patient outcomes. When surgical patients were cared for in environments with a 10% increase in the proportion of baccalaureate-prepared RNs, there was an associated 5% decrease in the likelihood of death and odds for failure to rescue. This is consistent with the findings from the study by Tourangau et al (23), in which a higher percentage of baccalaureate-prepared nurses assigned to patients was associated with lower 30-day mortality.

Fatigue caused by extended nursing work hours may also contribute to nurse performance and patient outcome. Rogers et al (43) found that nurses who worked more than 12 hrs per shift and more than 40 hrs per week made more errors. She also found that 40% of nursing shifts exceeded 12 hrs and that nurses were three-times more likely to make an error when working more than 12.5 hrs. Nursing errors were more likely when nurses worked overtime, regardless of the scheduled duration of that shift. Scott et al (44) additionally noted that nurses worked longer than their scheduled shifts 86% of the time and, on average, worked nearly 1 hr longer. ICU nurses who worked more than 12.5 hrs had significantly decreased levels of alertness and nearly two-thirds struggled to stay awake. Not surprisingly, when nurses worked more than 12.5 hrs consecutively, the risk for making errors and near-errors was increased. These errors may potentially result in patient harm and ultimate outcome. Fatigue and reduced vigilance may impact the nurses’ abilities to perform at a high-quality level and reduce detection of physiologic changes in their patients with timely interventions.

This review only focused on the relationship of nurse staffing on patient outcome. Many healthcare professionals and factors influence the quality of patient outcomes and the effectiveness of the nurse performance. Organizational factors, leadership skills and teamwork, use of evidence-based and interdisciplinary protocols and guidelines, hospital resources, relationships, and dedication to quality of care are all factors that influence patient outcome and work atmosphere (15, 16, 23). Organizational factors more directly related to nursing practice are the strength of leadership in the work environment, professional engagement, nurse satisfaction and retention strategies, autonomy over practice, and shared governance.

Recommendations and Considerations for Nurse Staffing

Lessons learned from this review may be used to guide nurse leaders when staffing critical care units. Although the exact number of nurses needed to produce the best patient outcome is not known, managers are accountable to provide nurse staffing that best meets their patients’ needs and safety. Consideration for nurse workload should be based on patient acuity and treatment needs of the patient and additional resources provided as needed, rather than adding more patients to a nurse assignment. Front-line decision-makers for nurse assignments should take into consideration the complexity of care needed for the patients and their additional risk for complications, such as infection, and those who need close observation, i.e., mechanical ventilation. Those who are making patient assignments on a daily basis should be empowered to make decisions about those assignments and adjust them accordingly based on the changing needs of the patient and safe practice. Additionally, patient assignments should be made such that the nurse’s knowledge and skills match patient care needs. Finally, managers must avoid excessive hours, overtime, and shifts worked to avoid fatigue that can affect nurse performance and job satisfaction.

Future Directions

Whereas the importance of proper nursing staffing cannot be overstated,
there remains room for better understanding about what types and volumes of nurses are needed to adequately staff critical care units. In addition, exploration regarding nursing activities that are most effective and yield the best patient outcomes is needed. It is also important to better-understand the role of nurse knowledge, education, and experience on patient outcomes and how these relate to nurse staffing in critical care. It is also possible that with incorporation of nurse documentation in an electronic medical record, more time will be available for the critical care nurse at the bedside to provide high-quality interventions, monitoring, and prevention of complications.

Another area for further study is the impact of the presence of advanced practice nurses in critical care on patient outcomes. Advanced practice nurses are uniquely qualified to provide broader support and resources for critical care patients and have the potential to contribute to patient outcomes (46).

Finally, the American Association of Critical Care Nursing developed the Synergy Model for Patient Care (47). In this model, the most significant and important nursing care is based on the needs and characteristics of patients. The model proposes that synergy occurs when the needs of a patient are matched with a nurse’s competencies and abilities and that through this synergistic effect, patient outcomes may be improved. Using this model would potentially allow selection of the nurse best-suited to meet particular needs of critically ill patients based on their physiologic and psychosocial needs.

CONCLUSION

Nurse staffing levels are associated with patient outcomes in critical care units. These findings are consistent with the general research literature in other acute care settings. Standardizing measurement and definitions of study variables and more comprehensive study designs to incorporate other contributing factors may augment building the science behind the impact of nursing on patient outcomes. Participants should be able to measure nurse staffing ratios in their ICU and use this information to improve patient outcomes.

REFERENCES


42. Aiken LH, Clarke SP, Cheung RB, et al: Educational levels of hospital nurses and surgical patient mortality. JAMA 2003; 290:1617–1623


