Chapter 25. Nurse Staffing and Patient Care Quality and Safety

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The importance of nurse staffing to the delivery of high-quality patient care was a principal finding in the landmark report of the Institute of Medicine's (IOM) Committee on the Adequacy of Nurse Staffing in Hospitals and Nursing Homes: "Nursing is a critical factor in determining the quality of care in hospitals and the nature of patient outcomes"[1] (p. 92). Nurse staffing is a crucial health policy issue on which there is a great deal of consensus on an abstract level (that nurses are an important component of the health care delivery system and that nurse staffing has impacts on safety), much less agreement on exactly what research data have and have not established, and active disagreement about the appropriate policy directions to protect public safety.

The purpose of this chapter is to summarize and discuss the state of the science examining the impact of nurse staffing in hospitals and other health care organizations on patient care quality, as well as safety-focused outcomes. To address some of the inconsistencies and limitations in existing studies, design issues and limitations of current methods and measures will be presented. The chapter concludes with a discussion of implications for future research, the management of patient care and public policy.

Background

For several decades, health services researchers have reported associations between nurse staffing and the outcomes of hospital care.[2–4] However, in many of these studies, nursing care and nurse staffing were primarily background variables and not the primary focus of study.[5] In the 1990s, the National Center for Nursing Research, the precursor to the National Institute of Nursing Research, convened an invitational conference on patient outcomes research from the perspective of the effectiveness of nursing practice.[6] It was hoped that as methods for capturing the quality of patient care quantitatively became more sophisticated, evidence linking the structure of nurse staffing (i.e., hours of care, skill mix) to patient care quality and safety would grow. However, 5 years later, the 1996 IOM report articulating the importance of nurses and nurse staffing on outcomes concluded that, at that time, there was essentially no evidence that staffing exerted an effect on acute care hospital patients' outcomes and limited evidence of its impact on long-term care outcomes.[1]

There has been remarkable growth in this body of literature since the 1996 IOM report. Over the course of the last decade, hospital restructuring, spurred in part by a move to managed care payment structures and development of market competition among health care delivery organizations, led to aggressive cost cutting. Human resources, historically a major cost center for hospitals, and nurse staffing in particular, were often the focus of work redesign and workforce reduction efforts. Cuts in nursing staff led to heavier workloads, which heightened concern about the adequacy of staffing levels in hospitals.[7, 8] Concurrently, public and professional concerns regarding the quality and safety of patient care were sparked by research and policy reports (among them, the IOM's *To Err is Human*[9]), and then fueled by the popular

media. A few years ago, reports began documenting a new, unprecedented shortage of nurses linked to growing demand for services, as well as drops in both graduations from prelicensure nursing education programs and workforce participation by licensed nurses, linked by at least some researchers to deteriorating working conditions in hospitals.[10, 11] These converging health care finance, labor market, and professional and public policy forces stimulated a new focus of study within health services research examining the impact of nurse staffing on the quality and safety of patient care. An expected deepening of the shortage in coming years[12] has increased the urgency of understanding the staffing-outcomes relationship and offering nurses and health care leaders evidence about the impacts of providing care under variable nurse staffing conditions. This chapter includes a review of related literature from early 2007.

Identifying Nurse-Sensitive Outcomes

The availability of data on measures of quality that can be reasonably attributed to nurses, nursing care, and the environments in which care is delivered has constrained research studying the link between staffing and outcomes. While nurse leaders have been discussing the need to measure outcomes sensitive to nursing practice back to at least the 1960s, widespread use of the terms "nurse/nursing-sensitive outcomes" and "patient outcomes potentially sensitive to nursing" is a relatively recent development. Nurse-sensitive measures have been defined as "processes and outcomes that are affected, provided, and/or influenced by nursing personnel, but for which nursing is not exclusively responsible."[13, 14] While some scholars feel the term "nurse-sensitive measure" is fundamentally incorrect because patient outcomes are influenced by so many factors, health care is practiced in a multidisciplinary context, and few aspects of patient care are the sole purview of nurses, there is a broad recognition that some outcomes reflect differences in the quality of nursing care patients receive and therefore presumably respond to the characteristics of the environments in which care is provided (including staffing levels).

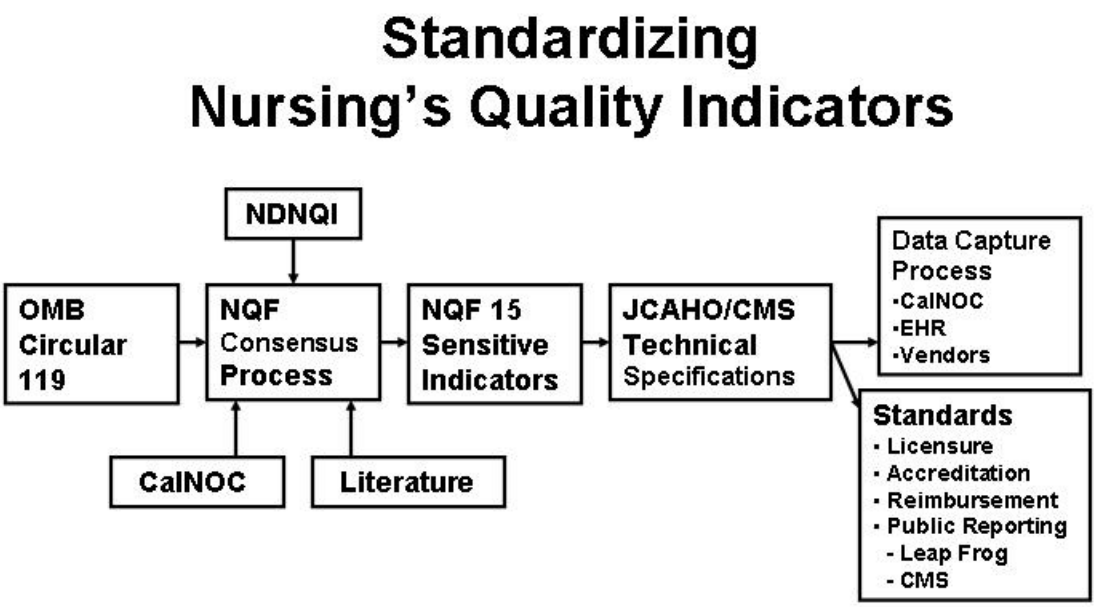
No matter what label these measures are given, measures that have conceptual and clinical links to the practice of nursing and are sensitive to variations in the structure and processes of nursing care are an essential ingredient in this area of research. Data sources from which to construct these measures must be identified, and exact definitions indicating how measures are to be calculated must be drafted. This is particularly critical if different individuals or groups are involved in compiling quality measures. There have been calls for standardization of measures of the quality of health care for some time,[1, 15] along with outcome measures related to the quality of nursing care. Inconsistent definitions have slowed progress in research and interfered with comparability of results across studies. A paper, now under review, examines and compares common measures of adult, acute care nurse staffing, including unit-level hospital-generated data gleaned from the California Nursing Outcomes dataset, hospital-level payroll accounting data obtained from the California Office of Statewide Health Planning and Development, hospital-level personnel data submitted to the American Hospital Association, and investigator research data obtained from the California Workforce Initiative Survey. Findings reveal important differences between measures that may explain at least some inconsistencies in results across the literature (Spetz, Donaldson, Aydin, personal communication February, 2007).

Efforts to address the standardization imperative began with the American Nurses Association's (ANA) first national nursing quality report card initiative. This initiative began with a literature search to identify potential nurse-sensitive quality indicators. Next, expert reviewers examined and validated a smaller, selected group of indicators and measures from

among these.[16] The ANA then funded six initial nursing quality report card indicator feasibility studies, which developed and refined these first sets of measures, documenting the quality of nursing care in acute care settings. The California Nursing Outcomes Coalition (CalNOC) was among the first State-based feasibility projects conducted by the ANA that ultimately served as the basis for the National Database for Nursing Quality Indicators (NDNQI) established in 1997. Maintaining an informal collaboration with the NDNQI, CalNOC continues to function as a regional nursing quality database, and more recently, CalNOC methods have been adapted by both the emerging Military Nursing Outcomes Database and VA Nursing Outcomes Database projects. All four groups currently collect and analyze unit-level data related to the associations between nurse staffing and the quality and safety of patient care. Together, they have formed an unofficial collaborative of nursing quality database projects.[17–21]

The most recent initiative in standardizing staffing and outcomes measures for quality improvement and research purposes was undertaken by the National Quality Forum (NQF). The mission of the NQF is to improve American health care through consensus-based standards for quality measurement and public reporting related to whether health care services are safe, timely, beneficial, patient centered, equitable, and efficient. To advance standardization of nurse-sensitive quality measures and respond to authoritative recommendations from multiple IOM and Federal reports,[9, 15, 22] the NQF convened an expert panel and established a rigorous consensus process to generate the Nation's first panel of nursing-sensitive measures for public reporting. The aim of the expert panel was to explicate and endorse national voluntary consensus standards as a framework for measuring nursing-sensitive care and to inform related research. Potential nursing-sensitive performance measures were subjected to a rigorous and systematic vetting under the terms of the NQF Consensus Development Process, which included a thorough examination of evidence substantiating each measure's sensitivity to nursing factors, alignment with existing requirements being made of providers, and validation/recommendations of advisory bodies to Federal agencies. As illustrated in Figure 1, the resulting first 15 NQF nursing-sensitive measurement standards were informed by earlier work by the NDNQI and CalNOC, as well as measures arising from formal research studies.

Figure 1. Standardizing Nursing's Quality Indicators



Notes: CMS = Centers for Medicare and Medicaid Services; EHR = electronic health record; JCAHO = Joint Commission on Accreditation of Healthcare Organizations, now known as the Joint Commission; OMB = Office of Management and Budget.

These measures represent a first (but by no means final) attempt to make nurse-sensitive outcomes visible to the broader community of payers and policymakers. The first 15 voluntary consensus standards for nursing-sensitive care intended for use in public reporting and policy initiatives included[23]

1. Failure to rescue
2. Pressure ulcer prevalence
3. Falls
4. Falls with injury
5. Restraint (vest and limb) prevalence
6. Urinary catheter-associated urinary tract infections (intensive care unit, ICU)
7. Central line catheter-associated bloodstream infections (ICU)
8. Ventilator-associated pneumonia (ICU)
9. Smoking cessation counseling for acute myocardial infarction
10. Smoking cessation counseling for pneumonia
11. Smoking cessation counseling for heart failure
12. Skill mix
13. Nursing hours per patient day
14. Practice Environment Scale-Nursing Work Index
15. Voluntary turnover

A Framework Relating Nurse Staffing to Patient Care Quality and Safety

Figure 2 illustrates a set of conceptual relationships between the key variables in this review, including influences on staffing levels and factors influencing outcomes. These relationships form a set of interrelated pathways that link nurse staffing to patient care quality, safety, and outcomes. Notable is that each of the elements enclosed in a box—specifically administrative decisions, quality of nursing care, care needs, and safety and clinical outcomes—is influenced by a host of factors that are not detailed in the diagram and could each be the subject of its own literature review.

Figure 2. Nurse Staffing, Quality of Care, and Outcomes

- Staffing levels are set by administrators and are affected by forces that include budgetary considerations and features of local nurse labor markets. Administrative practices result in a structure of the nursing staff of an agency (nature of supervision) and staff or staff hours assigned to different subunits in a facility. These practices also affect the mix and characteristics of the nurse workforce, the model of care used in assigning staff and in providing care, and a wide range of workplace environments that affect how nurses practice. Other characteristics of the workplace environments noted in the literature included the physical environment, communication systems and collaboration, information systems, and relevant support services. All of these factors ultimately influence the "dose" or quantity of nursing time, as well as the quality of nursing care.
- Variables included in the category of care needs of the patient include the acuity and complexity of the patient's health status, as well as the patient's comorbid medical conditions, functional status, family needs/resources, and capacity for self-care. The vulnerabilities of patients for adverse events varies and changes over the course of a hospital stay or episode of care.
- The quality of nursing care relates to the appropriate execution of assessments and interventions intended to optimize patient outcomes and prevent adverse events. For

example, the extent to which nurses assess the risk for falls in hospital patients upon admission, implement evidence-based fall-prevention protocols, and sustain such preventive interventions could each be developed into measures of nursing care quality. The quality of nursing care also includes attention to safety issues, for example, the accuracy of medication administration. Safe care also entails consistent monitoring tailored to patients' conditions to guarantee early recognition of patient deterioration and, if problems are identified, benefit from a rapid, appropriate interdisciplinary team response to these issues.[24]

The quality of care that nurses provide is influenced by individual nurse characteristics such as knowledge and experience, as well as human factors such as fatigue. The quality of care is also influenced by the systems nurses work in, which involve not only staffing levels, but also the needs of all the patients a nurse or nursing staff is responsible for, the availability and organization of other staff and support services, and the climate and culture created by leaders in that setting. The same nurse may provide care of differing quality to patients with similar needs under variable staffing conditions and in different work environments.

- Safety outcomes include rates of errors in care as well as potentially preventable complications in at-risk patients. Safe practices that avoid errors and foreseeable complications of care can be thought of as either a basic element of or a precondition for delivering high-quality care, but are generally thought of as only one component of quality.
- Clinical outcomes (endpoints) of importance vary from patient to patient or by clinical population and include mortality, length of stay, self-care ability, adherence to treatment plans, and maintenance or improvement in functional status. Serious errors or complications often lead to poor clinical outcomes. So far, very few positive clinical outcomes have been studied by staffing-outcomes researchers, probably because of limited measures and data sources.

The sheer number of variables and myriad linkages depicted suggest why precise evidence-based formulas for deploying nursing staff to ensure safe, high-quality patient care are impossible based on the knowledge on hand. In fact, such prescriptions may never be possible. Certainly, evidence-based guidelines for allocating resources to ensure optimal outcomes in acute care and other health care settings cannot be offered until working environments, staffing (beyond head counts and skill mix), patient needs, processes, and outcomes of care can be measured with precision.

Research investigating links between hospital nurse staffing and patient outcomes began with studies examining patient mortality. Reviews now include research examining a broad range of outcomes, including specific adverse events other than mortality. Although many studies support a link between lower nurse staffing and higher rates of negative nurse-sensitive safety outcomes,[25–27] reviews of two decades of research revealed inconsistent results across studies.[25–30]

State of Science on the Relationship Between Nurse Staffing and Patient Outcomes

Before examining the state of the scientific literature on the relationship between nurse staffing and clinical outcomes, it is important to consider common challenges of research in this arena. Investigators face at least two fundamental problems when designing staffing-outcomes studies: first, finding suitable data sources and measures for staffing and patient outcomes, and

second, linking the two types of variables to reach valid conclusions. As noted earlier in this chapter, because of limitations in measures, data sources, and analytic methods, researchers generally ask a different question in their studies (Is there a correlation between staffing and patient care outcomes?) than the questions that are of primary concern to patients, clinicians, managers, and policymakers (What staffing levels are safe under a specific set of circumstances?).[31] Nonetheless, researchers in this field deserve a great deal of credit for making creative use of a variety of data sources not originally developed for research (or research on staffing and outcomes) to generate a great deal of evidence that has fueled discussion in the practice, management, and policy communities.

Data Sources, Measures, and Challenges

As clinical trials or controlled experiments are difficult if not impossible to conduct in this area, observational designs must be optimized as much as possible. When outcomes are compared across hospitals or other health care organizations as a whole or their clinical units or microsystems, frequently the research design that results from data linkages and analyses is cross-sectional and correlational in nature. Staffing levels and patient outcomes from approximately the same time are analyzed to determine whether a correlation exists between the two. As all students of research methods know, correlational designs are more limited than experiments for determining the extent to which causal links exist between staffing levels and outcomes. Factors other than nurse staffing can vary alongside staffing levels, so whether or not certain different staffing levels directly lead to better or worse outcomes cannot be determined with certainty from correlational designs. Such factors include other aspects of the environment in which care is provided (for example the availability of supplies, quality of physician care and/or other services and supports). Statistical methods can control for obvious factors that influence or are otherwise associated with staffing levels (such as hospital size, academic affiliation, or rural-urban location). Nonetheless, it is impossible to measure and account for all possible confounding variables (or competing explanations for findings) in the typical designs of these studies. Maximizing returns on correlational research designs involving staffing requires careful selection of variables and clearly articulating the theoretical and/or empirical bases for choosing them.

Tables 1 and 2 provide brief overviews of types of measures and the questions consumers of staffing outcomes research might consider in appraising individual studies. The discussion that follows is intended to emphasize a few fundamental points before turning to the findings in the literature itself.

Table 1. A Typology of Measures in the Staffing-Outcomes Literature

Variable	Sources of Data	Types
Staffing	• Records from health care facility operations (assignment sheets, scheduling grids) • Data submitted to regulatory bodies • Surveys of staff regarding staffing levels and/or workload	**Major types** • Staff/staffed hours divided by patient/service volume • Credentials/qualifications of nursing staff (higher or lower in relation to total): licensed vs. unlicensed; level of licensure; highest degree, professional certification; years of experience • Voluntary turnover • Use of contract or agency staff **Important distinctions** • Level of measurement within the organization (whole facility/department vs. unit) • Roles of staff measured (such as staff involved in "direct patient care" vs. all nursing staff) • Time frame (shift/day/week/month/quarter/year)
Outcome	• Patient records, discharge abstracts, incident reports, or other byproducts of care delivery (including reimbursement) • Prospective surveillance for specific events (such as falls and pressure ulcers) • Surveys of patients/families and providers	Occurrence of events suggestive of poor (or less commonly, high) quality of care or nurse work-related outcomes **Level of measurement** • Individual patients/nurses • Subunits (e.g., nursing units) of organizations • Entire facilities

Table 2. Major Methodological Considerations in This Literature

Design Feature	Questions to Ask
Measurement of staffing	Do the staffing measures reflect the type and "dose" of staff actually caring for the patients being studied? Were the staffing measures collected in a consistent manner (using common definitions) across the organizational units/time periods?
Measurement of outcomes	Were outcomes assessed in comparable ways across patients and across settings (units or institutions or time periods)? Do data sources allow a distinction between complicating conditions present when care was undertaken (which should be considered in the analyses in risk adjustment (below)) from conditions that appeared during care (that are potentially outcomes of nursing care during the hospitalization)? Were outcomes assessed completely/comprehensively for all patients? What evidence is there regarding the consistency of documentation for the outcomes in question in the data sources? Does the outcome in question have a plausible association with nursing practice, or is it primarily/entirely associated with factors outside the control of providers?
Risk adjustment	Have the authors conducted fair comparisons between rates of adverse events across hospitals units or time periods by considering potentially important differences in the patients treated across those settings and/or over time?

Design Feature	Questions to Ask
Data linkage	To what extent do staffing measures represent conditions at the times and places where nursing care affecting the outcomes and measured for this study is given? Are outcomes attributed to the locations of care where nursing services actually influence the outcome, or do they also reflect the place where detection of the outcome occurs?
Control for confounding factors	Have other aspects of the environments in which patients are cared for that might affect the outcomes been measured and analyzed? E.g., availability of equipment/supplies, quality of physician care, other types of facility personnel, hospital size, academic affiliation, rural-urban location
Statistical modeling	If the study examines an outcome that is rare in the patient population, has this been considered in any modeling? How is skewness of the data managed? If the subjects of the study are grouped or nested within larger organizational units (e.g., patients within nursing units within hospitals), has this been handled by the analytic strategy? Do at least some of the analyses presented depict the complexity of associations between the factors involved through some type of statistical modeling that evaluates impacts of variables simultaneously?

Staffing

Staffing levels can be reported or calculated for an entire health care organization or for an operational level within an organization (a specific unit, department, or division). Specific time frames (at the shift level and as a daily, weekly, or yearly average) must be identified to ensure common meaning among collectors of the data, those analyzing it, and individuals attempting to interpret results of analyses.

In many cases, staffing measures are calculated for entire hospitals over a 1-year period. It is fairly common to average (or aggregate) staffing across all shifts, for instance, or across all day shifts in a month, quarter, or year and sometimes also across all the units of hospitals. The resulting measures, while giving an imprecise idea of what specific conditions nurses and patients experienced at particular points, are general indicators of facilities' investments in staffing. However, staffing levels on different units reflect differences in patient populations and illness severity (the most striking of which are seen between general care and critical care units). Furthermore, in practice, staffing is managed on a unit-by-unit, day-by-day, and shift-by-shift basis, with budgeting obviously done on a longer time horizon. For these reasons, some researchers argue that at least some research should be conducted where staffing is measured on a shift-specific and unit-specific basis instead of on a yearly, hospitalwide basis. A distinct, but growing, group of studies examined staffing conditions in subunits or microsystems of organizations (such as nursing units within hospitals) over shorter periods of time (for example, monthly or quarterly).[17, 32–34]

In addition to three sources of staffing data, there are also two basic types of staffing measures or variables. The first type divides a volume of nurses or nursing services by a quantity of patient care services. Common examples include patient-to-nurse ratios, hours of nursing care delivered by various subtypes of personnel per patient day (HPPD), and full-time equivalent (FTE) positions worked in relation to average patient census (ADC) over a particular time period. Patient-to-nurse ratios, HPPD figures, or FTE:ADC measures have the potential to both

systematically overestimate or underestimate nurse workloads and the attention given to specific patients in relation to those patients' needs, conditions, and clinical trajectories across units or institutions or over time.[31]

The second major type of measure examines the credentials or qualifications of those staff members and expresses them as a proportion of staff with more versus less training (or vice-versa). Commonly, the composition of the nursing staff employed on a unit or in a hospital in terms of unlicensed personnel, practical or vocational nurses, and registered nurses (RNs) is calculated. The specific types of educational preparation held by RNs (baccalaureate degrees versus associate degrees and diplomas) have also begun to be studied. Additional staffing-related characteristics studied include years of experience and professional certification. The incidence of voluntary turnover and the extent to which contract or agency staff provide care have also been studied. As will be discussed, the majority of the evidence related to hospital nurse staffing focuses on RNs rather than other types of personnel.

For the most common measures, ratios and skill-mix, determining which staff members should be included in the calculations is important, given the diversity of staffing models in hospitals. Most researchers feel these statistics should reflect personnel who deliver direct care relevant to the patient outcomes studied. Whether or not to count charge nurses, nurse educators involved in bedside care, and nurses not assigned a patient load (but who nevertheless deliver important clinical services) can present problems, if not in principle, then in the reality of data that institutions actually collect. Outcomes research examining the use of advanced practice nurses in acute care—for instance, nurse practitioners and nurse anesthetists—to provide types of care traditionally delivered by medical staff and medical trainees has been done in a different tradition (analyzing the experiences of individual patients cared for by specific providers) and does not tend to focus on outcomes relevant to staff nurse practice; therefore these studies are not reviewed here. No studies were found that examined advanced practice nurse-to-patient ratios or skill mix in predicting acute care patient outcomes. There have been calls to examine advanced practice nurses supporting frontline nurses in resource roles (for instance, clinical nurse specialists who consult and assist in daily nursing care, staff development, and quality assurance) and their potential impact on patient outcomes. No empirical evidence of this type was found.

Outcomes

Clearly, capturing data about patient outcomes prospectively (i.e., as care is delivered) is the best option for obtaining precise, comprehensive, consistently collected data. This approach is the most challenging because of practical, ethical, and financial considerations. However, researchers can sometimes capitalize on prospective data collections already in progress. For instance, hospital-associated pressure ulcer prevalence surveys and patient falls incidence are commonly collected as part of standard patient care quality and safety activities at the level of individual nursing units in many institutions.[18, 32] Many, but by no means all, studies in this area use secondary data not specifically intended for research purposes, such as patient medical records. Outcomes researchers often use condensed or abstracted versions of hospital patients' records in the form of discharge abstracts, which contain data extracted from health care records about clinical diagnoses, comorbidities, procedures, and the disposition of patients at discharge.[35] As there are concerns that the quality and reliability of clinical documentation varies widely,[35] one author suggested that only a form of electronic medical record that forces contemporaneous recording of assessment data and interventions will permit true performance measurement in

health care.[36] Wider application of information technology in health care settings, anticipated to facilitate care delivery and improve quality and safety, is also expected to provide richer, higher-quality data sources for strategic performance improvement that can be leveraged by outcomes researchers.

Patients are not all at equal risk of experiencing negative outcomes. Elderly, chronically ill, and physiologically unstable patients, as well as those undergoing lengthy or complex treatment, are at much greater risk of experiencing various types of adverse events in care. For instance, data on falls may be consistently collected for all hospitalized patients but may not be particularly meaningful for obstetrical patients. Accurately interpreting differences in rates across health care settings or over time requires understanding the baseline risks patients have for various negative outcomes that are beyond the control of the health care providers. Ultimately this understanding is incorporated into research and evaluation efforts through risk adjustment methods, usually in two phases: (1) carefully defining the patient populations at risk—the denominator in rates; and (2) gathering reliable and valid data about baseline risk factors and analyzing them. Without sound risk adjustment, any associations between staffing and outcomes may be spurious; what may appear to be favorable or unfavorable rates of outcomes in different institutions may no longer seem so once the complexity or frailty of the patients being treated is considered.[35]

The focus of this review is on staffing and safety outcomes. However, as was noted earlier, quality of care and clinical outcomes (and by extension, the larger domain of nursing-sensitive outcomes) include not only processes and outcomes related to avoiding negative health states, but also a broad category of positive impacts of sound nursing care. Knowledge about positive outcomes of care that are less likely to occur under low staffing conditions (or are more likely under higher levels) is extremely limited. The findings linking functional status, psychosocial adaptation to illness, and self-care capacities in acute care patients are at a very early stage[37] but eventually will become an important part of this literature and the business case for investments in nurse staffing and care environments.

Linkage

In staffing-outcomes studies, researchers must match information from data sources about the conditions under which patients were cared for with clinical outcomes data on a patient-by-patient basis or in the form of an event rate for an organization or organizational subunit during a specific period of time. Ideally, errors or omissions in care would be observed and accurately tracked to a particular unit on a particular shift for which staffing data were also available. Most, but not all, large-scale studies have been hospital-level analyses of staffing and outcomes on an annual basis and have used large public data sources.

Linkages of staffing with outcomes data involve both a temporal (time) component and a departmental or unit component. Many outcomes (endpoints) examined by staffing researchers are believed to reflect compounded errors and/or omissions over time across different departments of an institutions. These include some types of complications as well as patient deaths. Attribution of outcomes is complicated by the reality that patients are often exposed to more than one area of a hospital. For instance, they are sometimes initially treated in the emergency department, undergo surgery, and either experience postanesthesia care on a specialized unit or stay in an intensive care unit before receiving care on a general unit. If such a patient develops a pressure ulcer, at what point did low staffing and/or poor care lead to the

pressure ulcer? Unfortunately, in hospital-level datasets, it is impossible to pinpoint the times and locations of the errors or omissions most responsible for a clinical endpoint. In the end, if outcomes information is available only for the hospital as a whole (which is the case in discharge abstracts, for instance), data linkage can happen only at the hospital level, even if staffing data were available for each unit in a facility. Similarly, if staffing data are available only as yearly averages, linkage can be done only on an annual basis, even if outcomes data are available daily or weekly. Linkages can be done only at the broadest levels (on the least-detailed basis or at the highest level of the organization) available in a dataset. Many patient outcomes measures (such as potentially preventable mortality) may actually be more meaningful if studied at the hospital level, while others (such as falls) may be appropriately examined at the unit level.

One should recognize that common mismatches between the precision of staffing measures and the precision of outcome measures (i.e., the staffing across an entire year across all units in a hospital used as a predictor of outcomes for a patient treated for a short time in only a fraction of these units) compromise the likelihood that valid statistically significant associations will be found. This finding is particularly relevant when staffing statistics span a long time frame and therefore contain a great deal of noise—information about times other than the ones during which particular patients were being treated. High-quality staffing data, as well as patient assessment and intervention data—all of which are accurately date-stamped and available for many patients, units, and hospitals—will be necessary to overcome these linkage problems. Such advances may come in the next decades with increased automation of staffing functions and the evolution of the electronic medical record.

Recent prospective unit-level analyses, now possible with datasets developed and maintained by the NDNQI, CalNOC, and the military hospital systems, make it possible to overcome some of these issues. These databases, although not risk adjusted, stratify data by unit type and hospital size and have adopted standardized measures of nurse staffing and quality of care. The resulting datasets provide opportunities to study how variations in unit-level staffing characteristics over time can influence patient outcomes (for instance, pressure ulcers and falls, as discussed later). As data sources do not exist for all types of staffing and outcomes measures at all levels of hospital organization (nor will they ever), research at both the unit level and the hospital level will continue, and both types of studies have the potential to inform understanding of the staffing-outcomes relationship.

Research Evidence

Perhaps staffing and outcomes research has such importance and relevance for clinicians and educators as well as for managers and policymakers, staffing-outcomes research is a frequently reviewed area of literature. As was just detailed, a diversity of study designs, data sources, and operational definitions of the key variables is characteristic of this literature, which makes synthesis of results challenging. Many judgments must be made about which studies are comparable, which findings (if any) contribute significantly to a conclusion about what this literature says, and perhaps regarding how to transform similar measures collected differently so they can be read side by side. The review of evidence here builds on a series of recent systematic reviews with well-defined search criteria.[25, 27, 30, 38] At least one group of researchers conducted a formal meta-analysis that integrated the bulk of empirical findings in the hospital staffing literature and summarized effect sizes for specific staffing measures, outcomes, and clinical populations.[30] This review was the most up-to-date identified within this search.

Evidence Related to Acute Care Hospitals

Many researchers have identified higher levels of adverse patient events (mortality and complications, for instance) and negative nurse job outcomes (such as burnout) under poorer staffing conditions (specifically, thinner staffing coverage or fewer nurses per unit of patient care and, somewhat less commonly in these studies, lower skill mix/education level of staff). These findings have appeared in studies conducted using a variety of designs and examining hospital care in different geographical areas and over different time periods. On the whole, while some researchers have identified effects of 20 percent and greater reductions in negative outcomes associated with increased/improved (or the most generous) staffing, most studies in this literature show much smaller reductions in negative outcomes (under 10 percent and often much smaller ones) associated with the most favorable staffing conditions they observe.[30] Given the relative rarity of some outcomes, these are subtle enough changes in outcomes to require observing many thousands, if not hundreds of thousands, of patients to identify staffing effects on the reduction of negative patient outcomes. Again, because of the tremendous number of factors involved in staffing decisions and their effects on patient care, and limitations in assessing patient characteristics, the specific staffing thresholds applicable to managers' decisionmaking below which outcomes are demonstrably worse cannot be identified using this literature—a point emphasized in many reviews.[24, 26]

The evidence table summarizes four major systematic reviews of the literature, approaches, and conclusions regarding the state of the evidence for specific outcomes or outcome types. In these papers, reviewers identify specific measurement types and established criteria for study inclusion in terms of design and reporting and examined a relatively complete group of the studies one by one to provide an overview of the state of findings as an integrated whole.

The contrasts in the conclusions are interesting but are probably less important than the overall trend: research results point persuasively to a correlation of staffing with outcomes, but not all outcomes or datasets show such a connection. An additional important point is that nearly all studies connecting staffing parameters with outcomes have been conducted at the hospital (rather than the unit) level.

Recent results emerging from the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Working Conditions Program (2001–2005) offer some examples of recent unit-level studies of staffing and its impacts on outcomes. In a 2-year AHRQ Working Conditions and Patient Safety study built on the work of CalNOC, Donaldson and colleagues[17] engaged acute care hospitals using ANA nursing indicators for reporting staffing, patient safety, and quality indicators in a research, repository development, and benchmarking project. Data were drawn from 25 acute care, not-for-profit California hospital participants in the regional CalNOC. The sample included urban and rural hospitals with an average daily census from 100 to more than 400 patients. Most patients' principal diagnoses were medical (66 percent). The aims of the study were to test associations between daily nurse staffing on adult medical-surgical units and hospital-acquired pressure ulcers, patient falls, and other significant adverse events, if they were of sufficient volume to analyze. A prospective, descriptive, correlational design tested associations between patient outcome measures and daily unit-level nurse staffing, skill mix, hours of care (along with hours covered by supplemental agency staff), and workload. Falls were defined as "unplanned descents to the floor." RN hours of care were significantly associated with the two focal outcomes. Unit activity index and hospital complexity (measured by bed size) were also significant predictors of falls.

In another analysis, Donaldson and colleagues[39] traced daily, unit-level direct care nurse staffing in 77 units across 25 hospitals over a 2-month period using data on staffing effectiveness (the match between hours of care and hours provided). By law in California, each hospital unit uses an institutionally selected, acuity-based workload measurement system to determine required hours of care for each patient. For each patient-care unit, the ratio of actual to required hours of care, was expressed as both a mean ratio and as a percentage of days on which required hours exceeded actual hours over the 7 days prior to a pressure ulcer prevalence study. Using Spearman rank correlations, the percentage of patients with hospital-associated pressure ulcers was significantly associated with the mean actual/required hours ratio for the prior 7 days (r's = -0.25, 63 df, $P < 0.05$), and with the percent days with the actual/required ratio <100 percent for the prior 7 days (r's = 0.25, 63 df, $P < 0.05$). Larger actual/required ratios and actual/required ratios closer to 100 percent were associated with a lower percentage of patients with hospital-associated pressure ulcers. These analyses linked unit-level staffing and safety-related outcomes data, and measured for time periods at the unit level closely and logically connected (staffing measures relevant to conditions before the outcome occurred). The findings are intriguing and suggest that the impact on patients of "short" staffing appeared a number of days later, as one would expect given the pathophysiology of pressure ulcers (since it takes a number of days of unrelieved pressure on a vulnerable area for tissue damage to occur). Both researchers and research consumers need to reflect on the time frames involved in the evolution of various outcomes when assessing the validity of data linkages across time and units. For instance, in contrast to the lags between quality problems in care and evidence of their impact on outcomes such as infections and pressure ulcers, practice conditions will tend to have more immediately observable impacts on outcomes like falls with injury and most adverse drug reactions.

Recent legislation in California that introduced mandated nurse-to-patient ratios at the unit level provides an interesting context for studying the association of staffing and outcomes. CalNOC has reported early comparisons of staffing and outcomes in 268 medical-surgical and step-down units in 68 California hospitals during two 6-month intervals (Q1 and Q2 of 2002 and Q1 and Q2 of 2004) before and after introduction of the ratios. Data were stratified by hospital size and unit type. On medical-surgical units, mean total RN hours per patient day increased by 20.8 percent, total nursing hours increased by 7.4 percent, the number of patients per licensed nurse decreased by 16.0 percent, and the portion of nonlicensed nursing hours decreased by 20.8 percent. However, there were no statistically significant changes in the rate of patient falls or pressure ulcers on these units.[40] These early data suggested that the introduction of mandated ratios may have led to changes in staffing metrics in California hospitals without yet attaining the goal of improving patient outcomes.

Summary and Comment

Researchers have generally found that lower staffing levels are associated with heightened risks of poor patient outcomes. Staffing levels, particularly those related to nurse workload, also appear related to occupational health issues (like back injuries and needlestick injuries) and psychological states and experiences (like burnout) that may represent precursors for nurse turnover from specific jobs as well as the profession.

Associations are not identified every time they are expected in this area of research. Other aspects of hospital working conditions beyond staffing, as well individual nurse and patient

characteristics, affect outcomes since negative outcomes are relatively uncommon even at the extremes of staffing and do not occur in every circumstance where staffing is low.

A critical mass of studies established that nurse staffing is one of a number of variables worthy of attention in safety practice and research. There is little question that staffing influences at least some patient outcomes under at least some circumstances. Future research will clarify more subtle issues, such as the preferred methods for measuring staffing and the precise mechanisms through which the staffing-outcomes relationship operates in practice.

Areas Where the Evidence Base Is Currently Limited

Nurse executives and frontline managers make decisions about numbers of staff to assign to the various areas of their facilities. They also establish models of care to be used in caring for patients in terms of the constellation of nursing staff and distribution of responsibilities among professional nurses and other types of nursing staff. Patients and their families want assurances that enough staff are on duty to ensure that care is safe and meets patients' needs. Policymakers want assurances that the nursing workforce in their jurisdictions is adequate; they also want to know whether or not regulatory intervention is necessary to ensure acceptable staffing levels and desirable patient outcomes. Staffing researchers are ultimately constrained by the limitations of their data in answering many questions of relevance to the real worlds of health care delivery and public policy. Investigators most commonly examined the correlations of complex patient outcomes with staffing measures derived at some distance from the delivery of care (perhaps aggregated over time). Researchers then asked whether measures of staffing and outcomes were statistically associated with each other. A clear distinction between direct conclusions from research findings and the opinions of particular authors or interest groups must be made.

It is impossible to specify parameters for staffing that will ensure safety based on current evidence without many qualifiers. The adequacy of staffing (the degree to which staffing covers patient needs) even for the same patients and nurses may change from hour to hour, particularly in acute care settings. Nurse-to-patient ratios and skill mixes in specific settings that are too low for safety still cannot be identified on the basis of the research literature, but decisions must be made on the basis of the judgments by frontline staff and their managers. On a related note, the specific nursing care processes that are more likely to be omitted or rendered less safe under different staffing conditions are not well understood, empirically speaking, and deserve further attention.

A number of other areas identified in the staffing literature are relatively underdeveloped. Most research on staffing has been conducted in acute care settings; however, not all clinical areas within acute care have been equally well studied. A number of observers remarked that for the most part, the state of evidence regarding staffing's impact on specialties outside of adult medical-surgical care is very limited. Data regarding settings for the care of children, childbearing families, and patients with mental health problems are currently very thin.[25] Difficulties in collecting reliable, valid outcomes indicators that are potentially sensitive to nursing care in these other settings is probably at least partly to blame.

The majority of nurses working in hospitals in the United States are, of course, registered nurses. Available evidence suggested that patients in hospitals that use more licensed practical nurses (LPNs) or vocational nurses may see worse outcomes.[30, 40] Indeed, at least one cost-benefit analysis of drawing on findings from one of the largest studies in the field[40] suggested that increasing the proportion of RNs (and decreasing the proportion of practical nurses) in the

composition of hospital staffs may be a more cost-effective measure and could have a bigger impact on outcomes than increasing hours of nursing care per patient day.[41] Likewise, most reports in the literature dealing with unlicensed assistive personnel (UAPs) either failed to find associations with this type of staff or suggested worse outcomes in institutions with high levels of such personnel. There is no direct evidence that it is unsafe to employ LPNs in acute care settings,[42, 43] nor is there empirical support that the use of unlicensed personnel is intrinsically related to poor outcomes. Use of practical nurses and UAPs can be driven by any and all of the factors outlined in Figure 2. Nonetheless, anecdotal evidence suggests that inadequately trained and/or supervised personnel of all kinds at times provide unsafe care; that operational problems having related, but distinct, causes and consequences can lead to substituting other types of workers for RNs and to safety problems; and that the savings associated with using lesser-trained workers sometimes prove to be false economies. The models of care under which LPNs and unlicensed care providers are employed (i.e., the exact roles of non-RN personnel and degree of oversight provided by RNs) has not been considered in research. While RNs have the broadest scope of practice of frontline nursing workers, it is far from established that 100 percent RN staffing is effective in all situations. Future research needs to identify the circumstances under which LPNs and UAPs can be used safely. Until then (and even when it does), local labor market realities, experience, and judgment will need to be used by leaders to establish skill mix and to define the models of care under which RNs, LPNs, and UAPs work.

Early studies have offered early, tantalizing insights regarding a number of variables conceptually close to staffing. These findings include the educational preparation of RN staff in hospitals. Two recent studies[44, 45] found that mortality in surgical and medical patients was lower in hospitals where higher proportions of staff nurses held baccalaureate degrees. The AHRQ-sponsored studies of California hospitals discussed above also suggested that a higher percentage of nurses holding bachelor's and higher degrees was associated with lower fall rates. Additionally, in this latter work, units where higher percentages of RNs held specialty certification had lower proportions of restrained patients. Should these findings be borne out in future studies, there are important potential local and national policy implications. There is a clear need for more research. Similarly, while many feel experience and specialty training have logical associations with quality of care and patient safety, empirical data regarding their impact are very limited at present.

Yet another area where data related to patient outcomes are thin relates to the impact of specific types of work environments on nurse-sensitive outcomes, and in particular the impact of the Magnet hospital model, which has been argued to produce superior patient outcomes (and safer care).[46, 47] Such connections would make intuitive sense, since current Magnet criteria require adherence to many best practices in nursing management, including selection of a well-articulated staffing model driven by data. To our knowledge, there are no studies yet to directly support a connection between safety and specific managerial approaches or to link Magnet status with patient outcomes in the current era of certification. However, early findings with respect to questions around the outcomes of the program are expected in the coming years.

Evidence Related to Other Settings

There has been intense interest in identifying staffing-outcomes relationships in long-term care settings. RNs are, of course, in the minority among the nursing staff in long-term care, with unlicensed providers providing the bulk of physical care in these facilities. There are many

challenges in using existing documentation and databases to measure outcomes in long-term care facilities,[48] some of which are shared with outcomes measurement in acute care. Long-term care researchers face special issues, specifically with respect to data reliability and measure stability, skewedness of measures, and selection and ascertainment bias (where types of patients at high risk for poor outcomes or who are more closely observed are concentrated in certain nursing homes).[48]

Despite these problems, a critical mass of studies suggests that long-term care facilities with the lowest licensed and unlicensed staffing levels among their peers show disproportionately worse patient outcomes. A study sponsored by the Centers for Medicare and Medicaid Services (CMS) suggested that among short-stay patients, skilled nursing facilities with the lowest staffing levels were 30 percent more likely to fall in the worst 10 percent of facilities for transfers to acute care for acute heart failure, electrolyte imbalances, sepsis, respiratory infection, and urinary tract infection. Facilities with staffing below thresholds of 2.78 hours of aide time and 0.75 hours of RN time had greater probability of having the worst outcome rates for long-stay patients, including pressure ulcers, skin trauma, and weight loss.[49] Similar conclusions were reached in a secondary analysis of data from a pressure ulcers study. In 1,376 residents of 82 long-term care facilities, patients in facilities with more direct RN time (30–40 minutes per patient day and more) had fewer pressure ulcers, acute care hospitalizations, urinary tract infections, and urinary catheters, and less deterioration in ability to perform activities of daily living.[50] In a national sample of nursing homes from 45 States, those that met CMS guidelines for RN and unlicensed hours per patient-day had statistically lower rates of lawsuits after controlling for a multitude of structural, market, and patient factors.[51] Not all studies report such findings. Rantz and colleagues'[52] analysis of outcomes in 92 nursing homes found that staffing levels did not predict facilities' classification as having generally good, mediocre, or poor outcomes and found that on average, costs were somewhat higher in poor-outcome facilities. These researchers suggested that administrative practices other than staffing may play an important role in determining long-term care quality.

Home health is a growing sector in U.S. health care. Staffing models fall somewhere between acute care hospitals and long-term care in terms of the proportions of unlicensed personnel and practical nurses. Allocation of nursing time to patients presumably influences quality and thoroughness of nursing acts and assessments. There may be skill-mix issues as well. However, to date there have been no studies of home health agency staffing models, nurse workloads, or skill mix. OASIS (Outcomes Assessment and Information Set) data gathered by home health providers by mandate from the Medicare program, skillfully analyzed and interpreted, will offer opportunities to examine safety in home care in relation to staffing decisions.[53] Similar statements can be made about nurse staffing in most other ambulatory and community settings as well.

Summary of Current Best Practices

The general conclusion of these studies conducted in various settings is that differences in outcomes are often observed between situations or institutions where staffing is high and those where it is low. A critical mass of data suggests that staffing at the lower end of the continuum may place patients and nurses at heightened risk of poor outcomes. Therefore, it appears hazardous to patients and staff to staff at the lowest levels relative to peer units and health care organizations.

Limitations of cross-sectional observational designs that predominate in this literature have been reviewed extensively in the chapter. Prominent among these is that there is no guarantee that increasing staffing alone improves the process or outcomes of care. Nonetheless, it would appear wise to continue the widespread practice of adjusting staffing levels for setting, specialty, model of care, client needs, special circumstances, and trends in the frequency of outcomes potentially sensitive to nurse staffing.

Evidence-Based Practice Implications

A key implication arising from this review is that as much as possible, investigators should align their studies with emerging taxonomies and specifications of measures promulgated by authoritative sources (e.g., the Joint Commission). Continued proliferation of measures is slowing progress in this field. Standardized measurement will advance meta-analytic efforts and facilitate aggregation of data across studies. As hospitals and health systems are inundated with data-reporting demands, wise investigators will leverage ongoing measurement efforts by selecting core measures and common metrics already collected by hospitals. There is value for researchers to forge strategic partnerships with professional sponsors of public and private data repositories. Agencies and researchers alike will be served well by study designs that use already de-identified data and make minimal use of protected health information, particularly since the Health Insurance Portability and Accountability Act took effect in 2004.

Likewise, both researchers and clinical administrators must fully harness the potential of new health information systems to capture clinical data. High-quality data on clinical performance will drive both scientific understanding and organizations' strategic quests for excellence. Some authors suggested that competing on the analytics is a characteristic of high-performing organizations.[54]

Leaders at all levels in the health care system must decide how to apply the findings of this literature. It is impossible to read and discuss this area of research without considering whether regulation of nurse staffing is a valid application of the findings, especially in the current climate in health care. As mentioned earlier, there are no evidence-based minimum staffing ratios,[27, 55] although clinicians and managers set operating ratios every day, largely on the basis of their experience and, to a lesser extent, from extrapolations of researchers' findings. As in all aspects of health care management, empirical evidence needs to be interpreted in the context of local data and experience. Although unsatisfying to proponents and opponents of regulation, it bears mentioning that a like or dislike of minimum ratios is often based on one's values and opinions about the capacity and inclination of health care leaders to make responsible staffing decisions autonomously.

Even absent any specific legal mandates to do so, benchmarking staffing and outcomes against peers and attempting to avoid extremes of low staffing and high adverse events, keeping in mind important contextual factors when making comparisons, is undoubtedly the best administrative practice. Keeping in mind that there are many factors affecting the outcomes of care (see Figure 2), a range of efforts needs to be undertaken to increase the quality of clinical practice or reliability, defined by the Institute for Healthcare Improvement as "the number of actions that achieve the intended result divided by the number of actions taken during a target time period."[56]

Executives and managers make a host of decisions beyond those involving staffing that affect the clinical effectiveness of nursing staff. Thought leaders in the arena of patient safety practices

have identified a number of organizational strategies that may constitute better practice in managing the impact of nurse staffing on patient care quality and safety. For example, efforts to optimize clinical, throughput flow and reduce practice variability may reduce threats to staff and patients due to system and personnel overload.[57] Managing supply and demand in health care settings by smoothing peaks and valleys of patient flow,[58] as well as staffing levels, may be effective in modulating workflow extremes that cause staff distress and might pose risks to patients. Implementing systems that enable staff to standardize high-volume common practices (such as patient education, discharge planning, and risk assessments) may be expected to increase efficiency, while enabling staff to customize these highly effective interventions to the unique characteristics of the patient/family. Engaging staff in self-governance related to patient flow has also been cited as a promising best practice. Considered key to safe staffing, professional judgment as the gold standard establishes the threshold for safe patient care in a given clinical setting,[59] as nurses use a systematic decision matrix to determine if the staff on a particular unit can accept responsibility for additional patients. Informed by understanding of scientific conclusions linking staffing and patient outcomes in comparable settings, the self-governing and administrative teams of the future may use internally generated data to support decisions related to staffing adequacy and effectiveness.[60] Through systematic microsystem (unit) assessment, combined with concurrent measurement tracing structure, processes, and outcomes of care, it is possible to calibrate the expertise and dose of the nurse and individualize interventions to the unique characteristics and needs of the patient, optimizing patient care.[61]

As clinicians and administrators in clinical settings gain greater access to real-time data that enable them to explore links between structure, process, and outcomes, increasingly sophisticated tools such as virtual dashboards are promising.[18] Despite a tradition in nursing that has emphasized scientific inquiry as a fundamental source of evidence for practice, there is growing awareness that data that emerge from practice and practitioners (particularly when collected using systematic methods and with high-quality measures) may be a vital source of material for research in this and other areas of policy-relevant inquiry.[62]

Research Implications

There are a great many questions in this field that are still unanswered. There is a clear need to investigate processes of care that are specific to nursing that are associated with safer patient care as well as safer, more efficient interdisciplinary team functioning. Data issues (a lack of measures and of data sources) are a major barrier to work on care delivery. In a discussion of nursing workload measurement tools, the International Council of Nurses noted that "existing tools are unable to capture more than 40 percent of nursing work"[63] (p. 16). Future research must tackle the black box of nursing practice by acknowledging the complexity of nursing assessment, planning, intervention, and evaluation. Addressing variance in the quality of patient care performed by nurses is key to interpreting inconsistencies in the nurse staffing literature and perhaps at the heart of efforts to improve patient care outcomes. Ultimately, it is a priority for future research to explicate links between structure, process, and outcome in nursing practice and patient care.[64]

As indicated before, study of models of care using non-RN staff in acute care, of the impacts of high levels of staffing on health-promoting nursing interventions and nurse-sensitive outcomes, and of staffing and outcomes in understudied specialties in acute care and in nonacute care settings is vital. Ultimately, research in this area is on a track to assist in establishing

evidence-based management[54] that complements the profession's ongoing efforts in evidence-based practice.

Conclusion

From a research tradition in which nurse staffing factors were primarily background variables, the study of nurse staffing and patient outcomes has emerged as a legitimate and strategically crucial field of inquiry. However, despite significant growth in the number and sophistication of studies responding to public policy and provider demand for these findings, results have been inconsistent. This chapter highlights the methodologic challenges inherent in this area of inquiry and explicates how the diversity in measures and units of analyses confound literature synthesis. In the face of myriad pressures to adopt a position for or against mandated nurse-to-patient ratios, the state of the young science does not permit precision in prescribing safe ratios. In fact, it may be concluded that further research is crucial to tease out the nuances in the staffing-outcomes equation. It is essential to advancing the field that future studies replicate, extend, and refine the current body of knowledge, making explicit how characteristics of the workforce, now barely considered (for example, years of experience or professional certification), in addition to the "dose" of the nurse, are linked to processes of care that ultimately result in clinical outcomes (both desirable and adverse). Until then, selected better practices have been noted, with the potential to contribute to pragmatic efforts to improve patient care quality and safety in hospitals.

Search Strategy

The literature on nurse staffing and patient safety is rapidly evolving, very heterogeneous in terms of measures and methods, and equivocal in terms of many of its conclusions regarding specific measures. Our aim was to describe broad trends in this literature, and to this end, we based our work on four systematic, integrated reviews that contained detailed search criteria and clearly-articulated inclusion criteria and provided detailed syntheses of findings. Three of these four reviews were drawn from AHRQ publications, the most recent of which[30] included articles we had identified in our own searches of PubMed® and CINAHL® databases since 2002 and 2003 using the terms "nurse staffing," "safety," and "outcomes."

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Evidence Table. Major Integrative Reviews of the Staffing-Outcomes Literature

Study	Methods	Outcomes Associated With Staffing	Outcomes for Which Data Considered Limited or Mixed
Seago 2001[25]	16 studies dealing with staffing-safety outcomes relationships, 1990–2000 Grading of design and outcome measures	NPR: Length of stay Nosocomial infections (UTI, postoperative infections, pneumonia) Pressure ulcers	NPR: Mortality Unplanned readmissions Failure to rescue Skill mix: Negative patient outcomes
Hickam 2003[38]	26 studies examining nurse workload/staffing ratios and safety outcomes, 1980–2002 (22 published 1996 or later) Grading of design appropriateness and execution	Workload and skill mix: Nonfatal adverse events Workload: Medication errors	Mortality Recognition of errors Probability that errors will affect outcomes
Lang 2004[27]	43 studies examining effects of nurse staffing on patient, nurse, and hospital outcomes, 1980-2003, excluding studies of ICUs and long-term care facilities General comments on methods limitations for all studies; grading of effect sizes	Patient outcomes: Failure to rescue Mortality Shock in medical patients; gastrointestinal hemorrhage Nurse outcomes: Nurse needlestick injuries Burnout Institutional outcomes: Documentation quality Extended length of stay	Patient outcomes: Pneumonia UTIs Falls Nosocomial infections Medication errors Pressure ulcers Patient satisfaction Morbidity Adverse drug events Intravenous errors Cardiac arrests Patient injuries Nurse outcomes: Nurse job satisfaction Absenteeism Institutional outcomes: Assaults on psychiatric units Hospital financial outcomes

Study	Methods	Outcomes Associated With Staffing	Outcomes for Which Data Considered Limited or Mixed
Kane 2007[30]	94 studies examining associations of nurse-to-patient and hours per patient-day on patient outcomes in hospital practice from the United States and Canada, 1987-2005 Formal meta-analysis (calculation of pooled effect sizes across studies and subpopulations) incorporating evaluation of methodological quality	RN NPR: Hospital-related mortality Failure to rescue+ Medical complications Unplanned extubation* Pulmonary failure*+ Hospital-acquired pneumonia* Bloodstream infections+ Cardiopulmonary resuscitation*+ Extended length of stay * Evidence of a stronger effect or more consistent evidence in ICUs + Evidence of a stronger effect or more consistent evidence in surgical patients HPPD (all staff types) Mortality Shock Upper gastrointestinal bleeding Nosocomial infection Extended length of stay	RN HPPD: Limited support LPN and UAP NPR and HPPD: Trend toward association of worse outcomes with higher use/levels

NPR: Nurse-to-patient ratios
ICU: Intensive care unit
RN: Registered nurse
LPN: Licensed practical nurse
UAP: Unlicensed assistive personnel
HPPD: Hours of care per patient-day
UTI: Urinary tract infection