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AN INTEGRATED ANALYSIS OF NURSE STAFFING AND RELATED VARIABLES: EFFECTS ON PATIENT OUTCOMES

Leah L. Curtin, RN, ScD(h), FAAN

ABSTRACT

The objective of this article is to synthesize much of the research done on nurse staffing and patient outcomes; the impact of organizational characteristics on nurse staffing patterns, patient outcomes, and costs; and the impact of nurses' experience on patient outcomes. The author concludes research indicates that nurse staffing has a definite and measurable impact on patient outcomes, medical errors, length of stay, nurse turnover, and patient mortality. Moreover, the literature reports data that help determine what is, indeed, appropriate staffing. Ratios *are* important – a consensus seems to be emerging supporting a range of from 4 to 6 patients per nurse in most acute care hospital inpatient settings, with no more than one to two patients per nurse in areas of high patient acuity. However, ratios must be modified by the nurses' level of experience, the organization's characteristics, and the quality of clinical interaction between and among physicians, nurses, and administrators.

Key words:

Nurse staffing; skill mix; medical error; adverse events; quality of care; patient outcomes; nurse/patient ratios; inpatient mortality; clinical interaction; organizational characteristics

The parallel is astounding. In the late 1990s, modern nursing was under attack from the consulting firms that promoted radically 'restructured' care modalities to reduce the costs of patient care. For example, Byron Erwin, President at APM Consulting Firm, insisted that nurses were needed only to supervise cross-trained aides in the care of patients – and that there should be no nurse above the level of head nurse in any facility (Erwin, 1994). In fact, nursing has not been attacked so severely, and, as it turned out, unfairly, since members of the British Parliament blamed Nightingale for the increases in mortality *after* she took command of the hospital at Scutari (Small, 2002). It was, of course, Nightingale's own analysis that *proved* it had been the unsanitary conditions at Scutari that caused the deaths (Lipsey, 1993). The environment itself was toxic, quite literally infectious. Thus when Nightingale's sanitary reform was implemented, the mortality rate declined.

How to Best Measure Nurses' Contributions to Patient Outcomes

Nightingale was among the first to represent statistical data graphically (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). In the last decade, Nightingale's spiritual descendants also used statistical methods to demonstrate nurses' impact on the quality and safety of patient care. Thanks to the radical re-engineering of the late 90s, there was more than enough comparable data to study. As early as 1994 Aiken, Smith, and Lake found that mortality rates in Magnet Hospitals were 4.6 percent lower than in 'non-magnet' hospitals indicating, among other things, that certain characteristics in the environment of care affected the care itself. Four years later, Blegen, Goode and Reed's (1998) analysis of staffing in a large university hospital showed that the researcher must study *actual registered nurse (RN) hours of care per patient per day* to ascertain the impact that professional nursing care has on patient outcomes. Prior to this time, quality of nursing care studies tended to use financial data, usually hours of care per patient per day (HCPPD) based on the number of full time equivalents (FTEs) of all personnel in the nursing department, to measure quality outcomes. While correlations between adequate nurse staffing and positive patient outcomes were found (Lee, Chang, Pearson, Kahn, & Rubenstein, 1999), they were, by and large, weak correlations.

In 1994, the American Nurses' Association proposed a set of nurse-sensitive quality indicators to create the content for a nurse-specific report card for acute care (ANA, 1995). As a result, a number of articles related to nurse staffing and patient outcomes were published in a variety of journals in the late 1990s. Indeed, in each of these studies, nursing's impact on patient outcomes in acute care hospitals was demonstrated, but the correlations were weak (ANA, 1997; Kovner & Gergen, 1998; Lichtig, Knauf, & Milholland, 1999; Moore, Lynn, McMillan, & Evans 1999).

Several researchers also examined the impact of re-engineering on both the costs of care and patients' satisfaction with the care they received. For example, Seago (1999) demonstrated that utilizing lower paid nursing assistants to give patient care actually increased costs. Sovie and Jawad (2001) studied 28 university hospitals that had undergone restructuring and re-engineering and found that patient falls increased as nurse/patient ratios increased, while patient satisfaction with pain control decreased as nurse/patient ratios increased (Sovie & Jawad).

Florence Nightingale revolutionized the idea that social phenomena could be objectively measured...contemporary nurses have reached very similar conclusions.

In April of 2001, the Health Services Research Administration released an impressive study that was subsequently reported in the *New England Journal of Medicine*. The study, "Nurse Staffing and Patient Outcomes in Hospitals," was based on 1997 data from more than five million patient discharges from 799 hospitals in 11 states (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002; U.S. DHHS, 2001). This study found a strong and consistent relationship between nurse staffing and five outcomes in medical patients: urinary tract infection, pneumonia, shock, upper gastrointestinal bleeding, and length-of-stay. A higher number of registered nurses also was associated with a 3 percent to 12 percent reduction in the rates of adverse outcomes, while a higher staffing level for all types of nurses was associated with a decrease in adverse outcomes, ranging from 2 percent to 25 percent.

The Impact of Nurse Staffing on Mortality and Length of Stay

A study of the organizational characteristics of intensive care units related to outcomes following abdominal aortic surgery (Pronovost et al., 1999) included nurse/patient ratio as one of the characteristics. Although they did not find an association with inpatient mortality, they did find that high nurse patient ratios (1:3 or more) during the day were associated with a mean increase of 49 percent in the days patients spent in the ICU. They also found that a high nurse patient ratio (1:3 or more) during the evening was linked to an average increase of 20 percent in overall length of stay. A later study by the same team of researchers assessed the risk of complications following abdominal aortic surgery. *This study found that hospitals with fewer ICU nurses (defined as 1:3 or 1:4 nurse-patient ratio) had significantly more patient complications than did those with more ICU nurses (defined as 1:1 or 1:2 nurse-patient ratio).* As the authors' previous research had identified daily rounds by an ICU physician to be connected with risk of complication, this variable was also included. However, the results remained unchanged, suggesting that ICU nurse staffing has an independent effect on the risk of developing a complication following abdominal aortic surgery (O'Brien-Pallas et al., 2001; Pronovost et al.).

Another ICU study (Dimick, Swoboda, Pronovost, & Lipsett, 2001) supported Pronovost's original findings about ICU nurse staffing and its impact on patient outcomes, and added financial data to them. Dimick and colleagues collected data on 569 patients who were in the ICU after undergoing hepatic resection. A multivariate analysis showed that patients in units with fewer nurses (1 RN to 3 or more patients) were at increased risk for re-intubation, and incurred a 14 percent increase in hospital costs than those in better staffed ICUs (1 RN to 1 or 2 patients). Dimick and colleagues linked hospital discharge data to a prospective survey of organizational characteristics in the intensive care unit – an indicator that some environments are predictably therapeutic, while others are just as predictably toxic. That is to say, certain organizational characteristics have an impact for better (therapeutic) or worse (toxic) on patients and their care.

Characteristics of Organizations and Personnel Impacting Staffing and Patient Outcomes

Aiken and colleagues (Aiken, Sochalski, & Lake, 1997), whose interests in nursing care and its relationship to patient outcomes stemmed from their work in following magnet hospitals, demonstrated that nursing presence, whether measured as RN ratios or as RN hours relative to other nursing personnel hours, is significantly correlated to mortality. Aiken et al. found that hospitals that had a positive inpatient mortality outcomes also had distinct organizational characteristics.

They reported:

> A hospital organizational structure and orientation that devolve a level of authority to nurses that is consistent with their high level of responsibility should enhance the outcomes of patients. In settings where nurses' authority is consistent with their responsibility nurses would (1) exercise their professional judgement in a timely fashion, (2) exert control over the practice setting to focus resources as required for good patient care, and (3) establish good relations with physicians that facilitate exchange of important clinical information. Our theory predicts that organizational models, whatever their particular form, that result in greater nurse autonomy, more control by nurses of resources at the unit level, and better relations between nurses and physicians

will yield better patient outcomes." (Aiken, Sochalski, & Lake, 1997, p. NS 17).

The Impact of Clinical Interaction on Mortality

Aiken's conclusions are fortified by research conducted by researchers testing an ICU predictive tool (Knaus, Draper, Wagner, & Zimmerman, 1986). In 1986, one of the earliest studies associated with APACHE II, a severity adjustment and risk prediction system for critical care, identified collaboration as having an important positive impact on patient outcomes in intensive care units. In this study of thirteen hospitals (all of which had 1:1 staffing in their ICUs), physicians and nurses independently reported their perceived level of collaboration with each other. In hospitals where both the nurses and physicians agreed that their communication and collaboration were positive, a significant percent of patients lived even though the tool predicted that they would die (41 percent below predicted deaths). However, in hospitals where nurses and physicians reported that there was little communication and collaboration, a significant proportion (58 percent) of patients whom the tool predicted would live, actually died. The variation in mortality among the hospitals ranged from 41 percent below predicted to 58 percent higher than predicted, after adjustment for patient case mix and severity of illness. The environment of some hospitals clearly was therapeutic, and that of the others just as clearly was toxic.

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In recent years, a number of other studies have examined the connection that collaborative relationships between nurses and physicians have on patient outcomes. Many of these studies provide strong evidence that a collaborative approach to care has a positive impact on quality of care, resource utilization, and ICU costs (Malila & Von Reuden, 2002). Moreover, the "multidisciplinary" approach is often cited as having a positive and significant influence on such practices as weaning from mechanical ventilation (Young, Gooder, & Olterman, 1998), reducing ventilator-associated pneumonia rates, and decreasing readmissions to ICU (Kaye et al., 2000). These studies, among others, support Aiken and colleagues' (1994) assertion that hospitals which have lower mortality rates share certain distinct organizational characteristics; characteristics that help create a therapeutic environment for patients.

The APACHE III methodology first published in 1991 (Knaus et al.) formed the basis for additional studies of organizational factors affecting clinical outcomes. Shortell and colleagues (Shortell et al., 1994) examined data from 42 intensive care units in 40 hospitals, identifying those factors contributing to superior risk-adjusted outcomes. In these hospitals, there was again a wide variation in outcomes, ranging from 33 percent lower than predicted mortality to 26 percent higher than predicted mortality. Caregiver interaction (including communication, coordination, and problem solving/conflict management) did not have a significant relationship with mortality in this study; however, the level of clinician interaction was significantly related to shorter, risk-adjusted, length of stay. Again, it is reasonably clear that some hospitals provided a therapeutic environment that encouraged rapid recovery, while in others the environment was toxic so as to impede recovery.

The Impact of Nurse-Patient Ratios

In addition to their research on general hospitals, Aiken and her colleagues have investigated nursing organization and patient outcomes in specialized AIDS units (Aiken, Sloan, Lake, Sochalski, & Weber, 1999). They found that at 30 days post admission, mortality rates were 60 percent lower in magnet hospitals, and 40 percent lower in dedicated AIDS units than in conventional scattered bed units. It was concluded that the availability of specialized physician services and higher nurse patient ratios were the major factors in explaining the lower rates. Analyses suggested that an additional nurse per patient day reduced the odds of dying by one-half (Aiken, Sloan, Lake, Sochalski, & Weber). It seems to take very little to create a therapeutic environment: one extra nurse; fewer patients per nurse; and access to physician specialists make a life and death difference.

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Meanwhile, Needleman and colleagues, whose study found a correlation between nursing care and 5 variables, revisited their data, and both reinforced and clarified their initial conclusion about the relationship between poor patient outcomes and low nurse staffing in hospitals (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). The mean number of hours of nursing care per patient-day was 11.4, of which registered nurses provided 7.8 hours, licensed practical nurses 1.2 hours, and nurse aides 2.4 hours. Among medical patients, a higher proportion of hours of care per day provided by registered nurses and a greater absolute number of hours of care per day provided by registered nurses were associated with a shorter length of stay and lower rates of both urinary tract infections and upper gastrointestinal bleeding. A higher proportion of hours of care provided by registered nurses also was associated with lower rates of pneumonia, shock or cardiac arrest, and *"failure to rescue,"* which was defined as death from pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep venous thrombosis. Among surgical patients, a higher proportion of care provided by registered nurses was associated with lower rates of urinary tract infections, and *a greater number of hours of care per day provided by registered nurses were associated with lower rates of "failure to rescue.* A 2003 study by Unruh (2003) confirmed that it is, in fact, *RN hours of care* that impact the level of adverse events patients suffer, and not skill mix (the ratio of licensed versus unlicensed personnel). According to Unruh, licensed nurses' acuity-adjusted patient load increased from 1991 to 1997 and both licensed nurse and total nursing staff declined from 1994 to 1997. *There was a greater incidence of nearly all adverse events in hospitals with fewer licensed nurses* (Unruh).

As early as 1999, a review of articles addressing the link between a number of hospital characteristics and inpatient mortality rates identified a higher number of RN hours per patient day to be a major contributor to lower mortality rates. The authors (van Servellen & Schultz, 1999) suggested that the reason for this link was that hospitals that employ more RNs also have a high teaching status, and use advanced technology.

If the environment of care is toxic, nurses

However, Aiken and colleagues (Aiken et al., 2002) focused on the association between nurse patient ratios, mortality, and failure to rescue amongst 232,342 general, orthopaedic, and vascular surgery patients during and following their hospital discharge. Failure to rescue was defined as death

will leave, patients will suffer, and in the end, hospitals will lose the money they are trying to save.

within 30 days of admission among patients who experienced complications unrelated to pre-existing co-morbidities. Examples given were aspiration pneumonia and hypotension/shock. In the analysis of patient outcomes, demographic characteristics of patients; nature of hospital admission; co-morbidities; and hospital size, teaching status, and technology were controlled. Results demonstrated that the odds of patient mortality increased by 7 percent for every additional patient (over 4) in the average nurse's workload. The same increase in odds was evident with respect to the failure to rescue rate. After accounting for other important factors it was estimated that *an additional nurse per patient day cut the odds of dying by more than half.* Furthermore, it was found that the hospitals with the best staffing ratios also had a significantly shorter overall length of stay as well as fewer ICU days.

Turnover and its Relationship to Patient Outcomes

Numerous studies have documented the relationship between staffing load and nurse turnover, and a few actually investigated the impact of both staffing ratios or hours of care per patient per day and patient outcomes (Aiken et al., 2002; Cromer, 2003; Steinbrook, 2002; Sulmasy & McIlvane, 2002; Ulrich et al., 2002; Weinstein, 2002). One, at least, correlates all three, and includes cost data as well (Gelinas & Bohlen, 2002). The accumulated savings in reduced length of stay, fewer ICU days, and better staffing, which almost always is associated with higher retention rates, is by no means insignificant. In this 2001 Veterans' Hospital Administration (VHA) research analysis involving 235 hospitals, the authors confirmed that organizations with low turnover reported shorter patient lengths of stay overall. The study divided participating hospitals into three groups -- low, medium and high turnover -- and compared key performance indicators. Low turnover organizations had a turnover rate from 4 percent to 12 percent. High turnover organizations ranged from 21.6 percent to 43.8 percent. The low turnover group had a severity-adjusted length of stay that was 1.2 days less than the high turnover group. Of course, increased length of stay leads to increased costs. Gelinas and Bohlen concluded that:

- Organizations with high turnover rates had 36 percent higher costs per discharge than hospitals with turnover rates of 12 percent or less.
- Low turnover hospitals averaged 23 percent return on assets compared to a 17 percent return for high turnover ones.
- Low turnover organizations had lowered risk adjusted mortality scores as well as lower severity-adjusted length of stay compared to hospitals with 22 percent or higher turnover rates. (Gelinas & Bohlen 2002).

Moreover, studies of root cause analysis of undesirable patient outcomes/sentinel events, conducted under the guidance of the Joint Commission on Accreditation of Healthcare Organizations, indicated that 24 percent of undesirable outcomes/sentinel events involved issues attributable to the nursing shortage, including fatigue and miscommunication (JCAHO, 2001). These sentinel events, along with those not reported, represent an enormous toll in human life -- and the potential for sizable malpractice awards.

The Impact of Nurses' Experience

U.S. nurses are not alone in studying the relationship between nurse staffing and patient outcomes. However, the Canadian researchers Tourangeau, Giovannetti, Tu, and Wood (2002) added another variable: experience! They investigated mortality rates amongst 46,941 patients discharged from 75 acute-care hospitals in Ontario, Canada. Performing a series of regression analyses they determined that:

- A 10 percent increase in the proportion of RNs across all hospital types was associated with five fewer patient deaths for every 1000 discharged patients.
- In urban community hospitals, each additional hospital mean year of nurse experience was associated with six fewer patient deaths for every 1000 discharged patients.
- In non-urban community hospitals, each additional hospital mean year of nurse experience on the clinical unit was associated with four fewer patient deaths for every 1000 discharged patients.
- The mean risk-adjusted 30-day mortality rate for all sample hospitals was 15 percent (150/1000 patients discharged).

The Effects of Nurses' Education on Patient Outcomes

In recent cross-sectional analyses (Aiken, Clarke, Cheung, Sloane, & Silber, 2003) of outcomes data for 232, 342 general, orthopedic, and vascular surgery patients discharged between April 1, 1998 and November 30, 1999, researchers linked educational level of staff nurses to patient mortality indices. The proportion of hospital RNs in this study holding a bachelor's degree or higher ranged from zero to 77 percent across the hospitals. The study adjusted for both patient characteristics and hospital structural characteristics (size, teaching status, level of technology), as well as for nurse staffing, nurse experience, and whether or not the patient's surgeon was board certified. A 10 percent increase in the proportion of nurses holding a bachelor's degree was associated with a 5 percent decrease in both the likelihood of patients dying within 30 days of admission, and the odds of failure to rescue (odds ratio, 0.95; 95 percent confidence interval, 0.91 - 0.99 in both cases).

Researchers Advice to Administrators

For those who would save money on staffing, the collective wisdom of all this research is succinctly summarized (O'Brien-Pallas, Thomson, Alksnis, & Bruce, 2001) as follows:

- Employ sufficient nursing staff to meet the needs of patients without the use of overtime or excessive capacity expectations that may affect nurse health and patient outcomes.
- The mix of full-time to part-time employees needs to increase (part-time staff should be used to cover unexpected or variable demands).
- Ensure strong, cohesive, and knowledgeable teams to provide continuity of patient care and to create supportive work environments for nurses.
- Reinvest in appropriately prepared managers and nurse clinical leadership.
- Examine the roles and activities of front-line nurses to determine ways to increase the time available for patient care.

General Conclusions

Just as Nightingale concluded that the high level of deaths in her base hospital in Scutari came from a contaminated environment (Small, 2002), and eventually published

"unpublished evidence of the public health disaster at Scutari" (Small , p. 141), today's nurse researchers have demonstrated clearly that the patient safety disaster of the 1990s came from a contaminated environment of an entirely different nature. Using uncharacteristically forceful language, the Institute of Medicine in *To Err Is Human: Building a Safer Health System*, reported that more people die from medical mistakes each year than from highway accidents, breast cancer, or AIDS (Kohn, Corrigan, & Donaldson, 2000).

For most of her ninety years, Nightingale pushed for reform of the British military health-care system and, with that, the profession of nursing started to gain the respect it deserved. With her analyses, Florence Nightingale revolutionized the idea that social phenomena could be objectively measured and subjected to mathematical analysis. Using many of the methods Nightingale pioneered, contemporary nurses have reached very similar conclusions.

Researchers are now providing the information that helps determine what is, indeed, appropriate staffing.

Patients do, indeed, benefit from appropriate staffing – and so do hospitals who improve their reputations and save money by avoiding costly errors and recidivism; decreasing turnover and capitalizing on experience and education; and reducing patients' length of stay. Moreover, researchers are now providing the information that helps determine what is, indeed, appropriate staffing. Ratios are important – a consensus seems to be emerging supporting a range of from 4 to 6 patients per nurse in most hospital inpatient settings, with no more than one to two patients per nurse in high acuity settings. However, ratios must be modified by the nurses' level of experience, the patients' characteristics (e.g., acuity level or debility), and the quality of clinical interaction between and among physicians, nurses and administrators. Only nurses can nurse, but administrators create the environment and circumstances within which care is given. If the environment of care is toxic, nurses will leave, patients will suffer, and in the end, hospitals will lose the money they are trying to save.

AUTHOR

Leah L. Curtin, RN, ScD(h), FAAN
curtncal@one.net

Leah L. Curtin, RN, ScD(h), FAAN, is a clinical professor of nursing at the University of Cincinnati College of Nursing and Health, editor and publisher of *The Journal of Clinical Systems Management*, and the Managing Partner in Metier Consultants. A frequent author and lecturer, Curtin was the editor-in-chief of *Nursing Management* from 1978 to 1998. In 1982, she was elected a Fellow of the American Academy of Nursing for her work in ethics, and in 1990 she was awarded an honorary doctorate from the State University of New York for the impact her editorials have had on the development of nursing and health care in the United States. In 2002 the Medical College of Ohio awarded her a second honorary doctorate for humanitarian services.

In 1996, Curtin was scholar-in-residence at Ballarat University in Victoria, Australia. She also was a visiting scholar at the University of Oklahoma, Brigham Young University, and the University of Eastern Kentucky. In 1998, Dr. Curtin visited Copenhagen where she testified before Denmark's Ministry of Health on the impact restructuring in U.S. hospitals

has had on the safety of patient care. In 2001, and again in 2002, she was a distinguished lecturer for the Hong Kong Hospital Authority, Hong Kong, China. She has been listed in *Who's Who in America* since 1991 and in *Who's Who in the World* since 1992. She is the author of more than 286 articles and 400 editorials as well as 8 books written for professionals.

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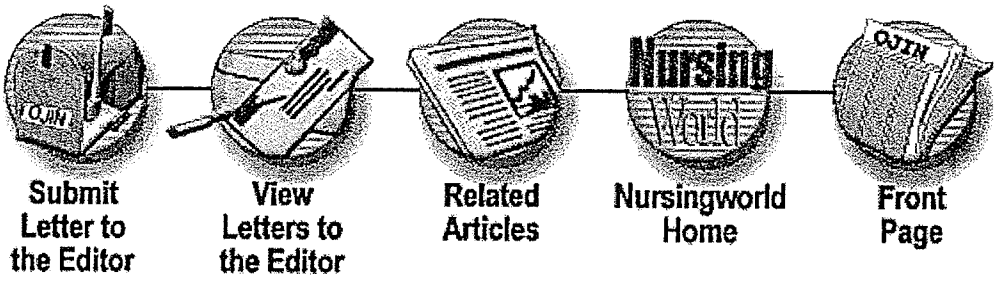

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