Nurse Staffing and Patient Outcomes in Inpatient Rehabilitation Settings

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KEY WORDS

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In rehabilitation nursing, the patient classification systems or acuity models and nurse-staffing ratios are not supported by empirical evidence. Moreover, there are no studies published characterizing nursing hours per patient day, proportion of RN staff, and impact of agency nurses in inpatient rehabilitation settings. The purpose of this prospective observational study was to describe rehabilitation nurse staffing patterns, to validate the impact of rehabilitation nursing on patient outcomes, and to test whether existing patient measures on severity and outcomes in rehabilitation could be used as a proxy for burden of care to predict rehabilitation nurse staffing ceilings and daily nurse staffing requirements. A total of 54 rehabilitation facilities in the United States, stratified by geography, were randomly selected to participate in the study.

The total nursing hours per patient day (HPPD) in rehabilitation were reported at 8.1 hours, with the proportion of registered nurse (RN) staff at 50%, and nominal use of agency nurses reported across sites. This staffing level exceeds levels reported in long-term care but falls short of acute care settings. Nurse staffing levels varied by geographic region, with significantly higher nursing HPPD in the West, a finding not previously reported in the literature. Freestanding rehabilitation sites reported a smaller proportion of RN staff and used significantly more agency nurse hours when compared to hospital-based rehabilitation facilities. The patient mix, defined by the distribution of rehabilitation impairment categories (RICs) on each unit, significantly affected nurse staffing levels. As the percentage of each RIC increased, there was a significant increase in the total nursing HPPD and RN HPPD, but not in the non-RN HPPD; however, the RIC did not significantly impact the proportion of RNs. Positive nurse managers' perception of non-RN staff competency in rehabilitation nursing practice was most predictive of improved patient outcomes, defined as FIM™ gain and discharge FIM™ score. A shorter length of stay (LOS) was predicted by three variables: a higher proportion of nurses certified in rehabilitation (certified rehabilitation registered nurse, or CRRN®), decrease in RN years of rehabilitation experience, or decrease in average daily census.

We examined the possibility of using the average admission relative weight (AARW), a patient severity measure, to predict nursing staff ceilings. As the facilities' AARW increased, there was a positive trend for increases in full-time employee equivalents (FTEE), overall nursing HPPD, and RN and non-RN HPPD, although these findings were not statistically significant. We also examined the possibility of using data from a commonly used patient outcome measure, the FIM™ instrument, as a proxy for the burden of care, to predict shift-by-shift nurse staffing needs. Night shift was the most highly correlated with average daily FIM™ score; for every 10-point increase in the rehabilitation unit's average FIM™ score, there is a corresponding 3.7% decrease in the average night shift hours per day. Practical issues associated with use of the FIM™ instrument were also considered. All sites found the daily administration of the FIM™ instrument to be moderately burdensome. There were regional differences in burden perceptions, with the South and the Midwest finding completing the daily FIM™ instrument slightly less burdensome than the Northeast and West. In addition to burden, the proportion of missing data averaged 9.4% for each study day for the daily FIM™ ratings. Further research is needed to examine the utility of AARW and the FIM™ instrument as potential nurse staffing tools in rehabilitation settings.

Specific Aims

Existing evidence does not support patient acuity models, patient classification systems, and nurse staffing ratios in rehabilitation nursing. Some rehabilitation units have adapted staffing tools originally created for either acute care or long-term care, although these tools lack specificity for rehabilitation practice. Another strategy has been to design a facility-specific tool, but these tools lack validity and reliability. Diverse staffing strategies have resulted in wide variation in staffing methodologies across inpatient rehabilitation settings. Specific nurse-patient ratios, proportion of RN staffing, and the impact of agency nurses have not been reported for rehabilitation. In addition to a lack of evidence-based nurse

Definition of Terms

- **Facility characteristics:** Location (region); facility type (freestanding versus unit-based); academic affiliation; size; nursing turnover; accreditation; percentage of CRRN certification; and number of admissions, transfers, and discharges.
- **Nurse characteristics:** RN and non-RN (LPN/LVN/NA) years of experience in general nursing and in rehabilitation nursing practice.
- **Staffing patterns:** Total HPPD (hours per patient day), RN and non-RN HPPD, proportion of RNs (percentage of RN and LPN/LVN/NA use), facility's use of agency staff (yes/no), and percentage of agency nurse use for RN and non-RN staff.
- **Nurse staffing patterns:**
  - Nursing **HPPD:** Total number of direct-patient-care nursing hours during study month divided by total midnight patient census during study month.
  - **RN HPPD:** Total number of direct patient care RN nursing hours during study month divided by total midnight patient census during study month.
  - **Non-RN HPPD:** Total number of direct-patient-care LPN/LVN/NA nursing hours during study month divided by total midnight patient census during study month.
  - **Staffing ceiling:** Total number of full-time and part-time RN and LPN/LVN/NA staff working during study month minus total number of full-time and part-time resignations during study month.
  - **Use of agency nursing staff:** A binomial variable, which indicated if a participating rehabilitation facility used any agency nursing staff during the study month.
  - **Percentage of agency staff use:** If a rehabilitation facility did indicate use of agency staff, the proportion of agency staff hours was divided by the total nursing staff hours during the study month.
- **FIM™ instrument:** A minimum data set consisting of 18 items (13 motor and 5 cognitive) that uses a 7-level scale to provide uniform measurement of the individual items. Higher values indicate greater functional independence.
- **FIM™ gain:** Total admission FIM™ rating minus total discharge FIM™ rating for each patient who was both admitted and discharged from the facility within the study period. Higher values indicate greater improvements in functional independence during hospitalization.
- **Case-mix adjusted FIM™ gain:** FIM™ gain (see above) case-mix adjusted using indirect standardization and CMGs. The CMG-adjusted FIM™ gain is calculated by subtracting the expected FIM™ gain for the CMG from the observed patient FIM™ gain. Negative values indicate a lower-than-expected FIM™ gain; positive values indicate a higher-than-expected FIM™ gain.
- **Case-mix groups (CMGs):** The CMG classification system categorizes patients with similar needs and resource utilization based on each patient's impairment group code (IGC), admission FIM™ motor rating, and, in some instances, admission FIM™ cognitive rating and age.
- **Rehabilitation impairment category (RIC):** The highest level of classification for the payment (case-mix group) categories. The RIC categorizes patients into 1 of 21 major categories based on the patient's primary reason for inpatient rehabilitation (i.e., the patient's IGC).
- **Admission relative weight (ARW):** Assesses the patient's relative severity utilizing only admission-level information. ARW also incorporates any comorbidities diagnosed throughout the stay. Previous iterations (pre-2006) were more reflective of patient impairment; ARW as of 2006 better reflects patient costs.
- **Length of stay (LOS):** Used to measure the duration of a single episode of hospitalization. Inpatient days are calculated by subtracting day of admission from day of discharge.
- **Discharge FIM™ Score:** The FIM™ assessment score for each patient within 3 days of hospital discharge. Higher values indicate greater functional independence at the time of discharge.

staffing methods in rehabilitation, the link between nurse staffing and patient outcomes in rehabilitation is largely unknown.

The purpose of this 2-year prospective observational study was to describe rehabilitation nurse staffing patterns, to validate the impact of rehabilitation nursing on patient outcomes, and to test whether existing patient measures on severity and outcomes in rehabilitation could be used as a proxy for burden of care to predict rehabilitation nurse staffing ceilings and daily nurse staffing requirements. The study had four key objectives: (1) describe current nurse staffing patterns in rehabilitation; (2) predict case-mix adjusted patient outcomes in rehabilitation based on nurse characteristics and staffing patterns, controlling for facility characteristics; (3) evaluate the utility of the AARW as a tool for predicting rehabilitation staffing ceiling levels; and (4) evaluate the utility of the FIM™ instrument for determining nurse staffing coverage on a shift-by-shift basis.

Although patient classification systems based on patient acuity drive nurse staffing models in acute care, the FIM™ score may be a stronger indicator for determining nurse staffing levels in rehabilitation. Given the widespread use of the FIM™ instrument, it seemed feasible to use this tool as a proxy for patient acuity in rehabilitation. Likewise, it seemed plausible to examine the possibility of using the AARW, a patient severity measure, to predict nursing staff ceilings. Testing these assumptions is a first step in developing a practical, evidence-based staffing methodology for rehabilitation nursing.

Background

The quality of healthcare in rehabilitation care settings may be compromised by external forces that have increased patient acuity, while simultaneously reducing the ratio of nursing staff to patients and the proportion of RN staffing (Lang, Hodge, Olsen, Romano, & Kravitz, 2004). These concerns have led to a growing interest in examining whether variations in nurse staffing levels and mix are associated with different patient outcomes in rehabilitation settings. The recent report published by the Institute of Medicine (IOM), *Keeping Patients Safe: Transforming the Work Environment of Nurses* (IOM, 2004), articulated the critical role of nurses in preventing complications and adverse events. Summarizing evidence on nurse staffing levels across the continuum of care, this report concluded the following:

- Long-term care: Moderate to strong evidence linking nurse staffing to patient outcomes, and moderate to strong evidence to establish minimum staffing levels
- Critical care: Emerging data linking critical-care nurse staffing to patient outcomes
- Acute care: Insufficient evidence to formulate a precise staffing formula, with growing evidence linking nurse staffing to patient outcomes in this setting

No studies have reported nurse staffing, patient outcomes, or minimum staffing levels in most specialty areas, including rehabilitation.

Several agencies have responded to the recent IOM report. The National Quality Forum (NQF) embraced the IOM's goals and further recognized that "increasing evidence demonstrates that the quality and stability of nursing personnel substantially influences patient outcomes and healthcare costs" (Kurtzman & Kizer, 2005). The Joint Commission on Accreditation of Healthcare Organizations (JCAHO, 2002) added requirements for staffing effectiveness standards that require organizations to evaluate staffing effectiveness based on clinical outcomes and human resource indicators. The Joint Commission's goal is to help hospitals evaluate their staffing effectiveness by using an evidenced-based approach to measure skill mix and number of nurses. This approach retrospectively evaluates nursing needs by comparing staffing mix to defined clinical outcomes.

The *Medicare Benefit Policy Manual* lists a condition for participation for admission to inpatient rehabilitation as being one in which "The patient requires the 24-hour availability of a registered nurse with specialized training or experience in rehabilitation" (Department of Health and Human Services, Centers for Medicare and Medicaid Services [CMS], 2007). The Commission on Accreditation of Rehabilitation Facilities (CARF) Medical Rehabilitation Standards Manual Section 3A, number 22 requires that "Twenty-four hours per day, seven days per week: (a) Rehabilitation nursing services are provided; and (b) There is patient coverage by registered nurses with rehabilitation experience" (Medical Rehabilitation Standards Manual, 2006, p. 106). Further research is needed in rehabilitation to address these standards. Given the dearth of evidence in rehabilitation, a brief review of the literature will follow that synthesizes the evidence about nurse staffing and patient outcomes in acute and long-term care. Lessons learned related to research methods for evaluating nurse staffing and patient outcomes will be summarized.

Evidence Linking Nurse Staffing and Patient Outcomes in Acute Care

A search of research studies linking nurse staffing to patient outcomes in acute care netted 25 studies conducted between 1994 and 2006, excluding single-facility studies. Of these, 88% used cross-sectional designs, and two studies used longitudinal designs. The studies include samples that ranged from 29 to 4,000 facilities and were conducted in the United States, England, and Canada. Of the studies reported,

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76% were case-mix adjusted, and most used standard approaches such as Medstat's disease-staging methods and Mediqual-based patient acuity system. Nurse staffing was generally characterized in acute care as nursing workforce (level and skill mix), RN hours per patient day (HPPD), proportion of RN staff, proportion of licensed nursing staff, and experience in nursing. Unfortunately, these measures were frequently aggregated facilitywide rather than unit-based. Patient outcome measures most frequently cited in acute care included pneumonia, urinary tract infections (UTIs), pressure ulcers, patient falls, infections, thrombosis, failure to rescue, patient satisfaction, and mortality. Key findings of these studies are summarized in **Table 1.**

In summary, a consistent pattern of results was reported in acute care, with richer (i.e., higher) RN staffing levels associated with lower failure-to-rescue rates, lower inpatient mortality rates, and shorter hospital stays. The pattern of findings is less consistent regarding the association between nursing workforce and complications or adverse events. It appears that in acute care there was a stronger relationship between nurse staffing and patient outcomes when the focus was on RNs or proportion of RNs rather than total nursing HPPD or LPN HPPD (Lankshear, Sheldon, & Maynard, 2005). The link between nurse staffing and patient outcomes may be curvilinear in acute care—that is, patient outcomes are worse for units staffed too high or too low (Blegen & Vaughn, 1998; Lankshear et al., 2005; Mark, Harless, McCue, & Xu, 2004).

Evidence Linking Nurse Staffing and Patient Outcomes in Long-Term Care

A search of research studies linking nurse staffing to patient outcomes in long-term care netted 20 studies conducted between 1977 and 2006, excluding single-facility studies. Of the 20 studies, 55% were retrospective, relying on extant databases. The studies include samples that ranged from 2 to 14,000 facilities. Of the studies reported, 60% were case-mix adjusted, most using rehabilitation utilization groups (RUGs). Nurse staffing was generally characterized in long-term care as proportion of licensed nursing staff, nursing workforce (level and skill mix), RN HPPD, proportion of RN staff, and experience in nursing. Nursing turnover was a critical factor in long-term care facilities. Patient outcome measures most frequently cited in long-term care included nursing home discharge, mortality, and quality of care. Key findings of these studies are summarized in **Table 2.**

In summary, a consistent pattern of results was reported in long-term care, with richer RN staffing levels associated with higher likelihood of discharge to home, decreased adverse events, higher functional status, and lower mortality rates. Similar to the results of the research in acute care, in long-term care, there appeared to be consistent relationships among nurse staffing and patient outcomes, but the outcomes studied were tailored to this setting. In long-term care, higher proportion of RNs were associated with lowered mortality, and higher RN HPPD was associated with a shorter length of stay. Unique to long-term care, higher RN HPPD were significantly associated with improved activities of daily living (ADL), reduced urinary catheterization, improved nutrition, and reductions in pressure ulcers, UTIs, and rehospitalization. In addition to RN and licensed staffing, Horn, Buerhaus, Bergstrom, and Smout (2005) and Zimmerman and colleagues (2005) found significant relationships between lower CNA turnover and reduced mortality and between CNA staffing in incidence of pressure ulcers, providing empirical support for the importance of nonlicensed care in long-term care settings.

Methods

A prospective observational design was used to address five research questions: (1) How does nurse staffing vary by geographic region, type of rehabilitation facility, and specific patient rehabilitation impairments (i.e., RICs)? (2) What is the relationship among nurse staffing, nurse characteristics, and case-mix adjusted patient outcomes in rehabilitation settings, controlling for facility characteristics? (3) Does AARW predict overall nurse staff ceiling levels and nursing HPPD in rehabilitation? (4) Do daily FIM™ scores reveal the optimal assessment interval for determining nurse staffing requirements? (5) What is the perceived staff burden for completing the FIM™ instrument daily?

Although the majority of previously published studies relied on retrospective data, our use of prospective data collection enhanced the quality and specificity of the functional outcome data. Although many nurse staffing studies relied on data from only one facility or a limited geographical area, our random selection of sites was stratified by geographical region across the United States, thus strengthening generalizability. A unique aspect of our design was to avoid the bias in linking nurse staffing to negative patient outcomes (e.g., adverse events, deaths) rather than positive outcomes (Lang et al., 2004) by using functional independence as the primary outcome in this study, that is, a positive patient outcome sensitive to rehabilitation nursing practice. To compare nurse staffing levels across clinical settings with diverse patient mixes, data were case-mix adjusted using a rehabilitation-specific system, case-mix group

Table 1. Evidence Linking Nurse Staffing and Patient Outcomes in Acute Care Settings (1994–2006)

Patient Outcome Measure	Evidence Linking Patient Outcome to Nurse Staffing in Acute Care
Mortality	*Proportion of RN staff* • Higher proportion of RNs was associated with reduced mortality in acute care (Jarman et al., 1999; Mark, Harless, McCue, & Xu, 2004), as well as in unit caring for patients with myocardial infarction (MI; Person et al., 2004). • Richer skill mix of RNs was associated with lower 30-day mortality; specifically a 10% increase in number of RNs was associated with 0.5% point reduction in mortality in a Canadian sample, including acute MI, stroke, pneumonia, or septicemia (Tourangeau, Giovanetti, Tu, & Wood, 2002). *Overall nurse staffing (RN, LPN, NA)* • Higher ratios of nurses per bed were associated with lower mortality in acute care (Silber, Rosenbaum, & Ross, 1995), general or orthopedic surgery (Silber et al., 2000), as well as in acute surgical patients (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). • Higher ratios of nurses (RN, LPN, NA) per bed were not associated with lower 30-day mortality in Canadian sample of including acute MI, stroke, pneumonia, or septicemia (Tourangeau et al., 2002). *Non-RN staffing levels* • Higher proportion of LPNs was associated with reduced mortality in British acute care settings (Jarman et al., 1999). • Higher proportion of NAs was associated with reduced mortality in British acute care settings (Jarman et al., 1999). *Nursing education levels* • Higher proportion of nurses with a BS or higher in education was associated with reduced mortality in acute care (Aiken, Clarke, Cheung, Sloane, & Silber, 2003). *Hospital characteristics* • Magnet hospitals had reduced 30-day mortality rates (Aiken, Smith, & Lake, 1994). • The higher number of physicians, the lower inpatient mortality in England acute care settings (Jarman et al., 1999).
Failure to rescue*	*Overall nurse staffing (RN, LPN, NA)* • Higher ratios of nurses per bed were associated with reduction in failure to rescue in acute care (Silber et al., 1995), general, or orthopedic surgery (Silber et al., 2000), as well as in surgical patients (Aiken et al., 2003). *Proportion of RN staff* • Higher proportion of RNs and/or more RN HPPD were associated with a reduction in failure to rescue in medical patients (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). • Higher RN HPPD were associated with reduction in failure to rescue (Needleman et al., 2002). *Proportion of licensed nurses* • Higher proportion of licensed staff was associated with reduction in failure to rescue (Needleman et al., 2002). *Education of nurses* • A higher proportion of nurses with a BS or higher in education was associated with reduction in failure to rescue (Aiken et al., 2003).
Pneumonia	*Proportion of RN staff* • Higher proportion of RNs was associated with reduced rates of pneumonia (Cho, Ketefian, Barkauskas, & Smith, 2003; Knauf, Lichtig, Rison-McCoy, Singer, & Wozniak, 1997; Kovner, Jones, Zhan, Gergen, & Basu, 2002; Lichtig, Knauf, & Milholland, 1999; Mark et al., 2004; Needleman et al., 2002). *Proportion of licensed nurses* • Higher proportion of licensed nurses was associated with reduced rates of pneumonia (Needleman et al., 2002). *Hospital characteristics* • Higher resident/intern HPPD were associated with reduced rates of pneumonia (Kovner et al., 2002).

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* Failure to rescue is defined as death of patient with one of five life-threatening complications (pneumonia, shock/cardiac arrest, upper GI bleeding, sepsis, and deep vein thrombosis) for which early identification and prompt medical or nursing interventions can influence risk of death; (Heinz, 2004)

Table 1. Evidence Linking Nurse Staffing and Patient Outcomes in Acute Care Settings (1994–2006) *(continued)*

Patient Outcome Measure	Evidence Linking Patient Outcome to Nurse Staffing in Acute Care
Urinary tract infections (UTIs)	*Proportion of RN staff* • Higher proportion of RNs was associated with reduced rates of UTIs in acute care in general (Knauf et al., 1997; Lichtig et al., 1999; Mark et al., 2004); and on medical units (Needleman et al., 2002). However, this was not significant in another study (Cho et al., 2003). *Proportion of licensed nurses* • Higher proportion of licensed nurses was associated with reduced rates of UTI in acute care (Unruh, 2003) and on surgical units (Needleman et al., 2002). *RN HPPD* • Higher RN HPPD were associated with a reduction in UTIs in medical units (Needleman et al., 2002) and surgical units (Knauf et al., 1997; Lichtig et al., 1999; Needleman et al., 2002; Sovie & Jawad, 2001). However, this was not significant in another study (Cho et al., 2003). *Hospital characteristics* • Higher resident/intern HPPD were associated with reduced rates of UTIs (Kovner et al., 2002).
Wound infections	*Proportion of RN staff* • Higher proportion of RNs was associated with lower rates of postoperative infections (Knauf et al., 1997; Lichtig et al., 1999). However, this was not significant in another study (Cho et al., 2003). *Proportion of licensed nurses* • The higher the proportion of licensed nurses on the unit, the lower number of wound infections in acute care (McGillis-Hall et al., 2001). *RN HPPD* • Higher RN HPPD were associated with a reduction in postoperative infections (Knauf et al., 1997; Lichtig et al., 1999). However, this was not significant in another study (Cho et al., 2003). No relationship was found between nurse staffing and central line infections (Whitman, 2002). *Nursing experience* • The more experienced the nurses were, the lower the number of wound infections in acute care (McGillis-Hall et al., 2001).
Shock	*Proportion of RN staff and nursing HPPD* • Higher proportion of RNs and higher RN HPPD were associated with a reduction in shock in general medical units (Needleman et al., 2002).
Upper GI bleeding	*Proportion of RN staff and nursing HPPD* • Higher proportion of RNs and higher RN HPPD were associated with a reduction in upper GI bleeding (Needleman et al., 2002).
Atelectasis	*Proportion of licensed nursing staff* • Higher proportion of licensed staff was associated with lower incidences of atelectasis in acute care (Unruh, 2003).
Patient falls	*Proportion of RN staff* • Higher proportion of RNs was associated with lower incidences of falls in medical/surgical units and ICUs (Blegen & Vaughn, 1998). *Nursing HPPD* • Higher nursing HPPD were associated with lower fall rates in cardiac intermediate care (Whitman, 2002). • Higher RN HPPD were associated with lower fall rates in acute care; however, this diminished at the level of 6 HPPD (Sovie & Jawad, 2001). *Proportion of licensed nursing staff* • Higher proportion of licensed staff was associated with lower incidences of falls in acute care (Unruh, 2003).

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Table 1. Evidence Linking Nurse Staffing and Patient Outcomes in Acute Care Settings (1994–2006) *(continued)*

Patient Outcome Measure	Evidence Linking Patient Outcome to Nurse Staffing in Acute Care
Medication errors	*Proportion of RN staff* • Higher proportion of RNs was associated with fewer medication errors in medical/surgical units and ICUs. As the proportion of RNs increased from 50% to 85%, the rate of medical errors decreased, but the effect disappeared (Blegen & Vaughn, 1998). *Nursing experience* • The more experienced the nurses were, the lower the number of medication errors in acute care (McGillis-Hall et al., 2001). *Nursing HPPD* • Higher nursing HPPD were associated with lower medication errors in CCU and noncardiac intermediate units (Whitman, 2002).
Pressure ulcers	*Proportion of RN staff* • Higher proportion of RN staff was associated with reduced rates of pressure ulcers in acute care (Knauf et al., 1997; Lichtig et al., 1999; Mark et al., 2004). However, this was not significant in another study (Cho et al., 2003). *RN HPPD* • Higher RN HPPD were associated with lower rates of pressure ulcers (Knauf et al., 1997; Lichtig et al., 1999). However, this was not significant in another study (Cho et al., 2003). *Proportion of licensed nursing staff* • Higher proportion of licensed staff was associated with reduced rates of pressure ulcers in acute care (Unruh, 2003). • No relationship was found between staffing and pressure ulcers (Cho et al., 2003; Whitman, 2002).
Length of stay (LOS)	*Nursing HPPD* • Higher nursing HPPD were associated with reduced length of stay in acute care (Lang, Hodge, Olsen, Romano, & Kravitz, 2004). Each additional hour of nursing care per patient was associated with decrease in length of stay between 4.4% and 9.7% (Lang et al., 2004). *RN HPPD* • Higher RN HPPD were associated with reduced length of stay in acute care (Lang et al., 2004). • Higher RN HPPD were associated with 3%–12% decrease in LOS for medical but not surgical patients (Needleman et al., 2002).
Functional independence	*Proportion of licensed nurses* • Higher proportion of licensed nurses was associated with improved performance in activities of daily living and social functioning of patients—but it was not sustained at 6-week follow-up in acute care (McGillis-Hall et al., 2001).
Patient satisfaction	*RN HPPD* • Higher RN HPPD were associated with improved patient satisfaction with a minimum of 5–6 HPPD (Sovie & Jawad, 2001).

(CMG), which classifies patients with similar needs and resource utilization based on each patient's impairment group code functional independence on admission, and age. Given that we included a large number of variables, appropriate adjustments were made to control for inflation of Type I error due to multiple comparisons. When multiple tests of significance were conducted, the Bonferroni adjustment was employed by dividing the nominal *p* value of .05 by the number of statistical tests conducted to identify the acceptable level of significance. When post hoc tests were conducted after significant analysis of variance results, the Ryan-Einot-Gabriel-Welsch Multiple Range Test was used. Also, linear mixed-regression model analysis was used for patient level outcome measures to adjust for patient nesting within facilities.

Sample

We randomly selected a representative sample of 54 units from a pool of 806 rehabilitation units participating in Uniform Data System for Medical Rehabilitation (UDSMR), stratified by geographical regions. After obtaining the sampling frame, a computer-generated list of random numbers (by region) was used to select the required number of rehabilitation facilities. If a facility refused to be a part of study, then the next center on the list was solicited. Of the 235 facilities contacted, 75% declined to participate in the study. The primary reason for refusing to participate was the need for nurses to collect daily FIM™ data on all patients over a 30-day period. Other reasons for refusal were demands of impending accreditation visits (Joint Commission or CARF), lack

Table 2. Evidence Linking Nurse Staffing and Patient Outcomes in Long-Term Care Settings (1977–2006)

Patient Outcome Measure	Evidence Linking Patient Outcome to Nurse Staffing in Long-Term Care
Activities of daily living (ADL)	*Licensed nurse staffing (RN and LPN)* • Licensed HPPD were associated with a lower patient dependency level at 1 and 3 years postadmission (Bliesmer, Kane, & Shannon, 1998). *Non-RN staffing* • Higher LPN ceiling levels were associated with improved ADL in NH residents (Cohen & Spector, 1996). *RN HPPD* • More RN HPPD in direct care were strongly associated with improved ADL (Horn, Buerhaus, Bergstrom, & Smout, 2005).
Urinary catheterization	*Proportion of RN staff* • Lower proportion of RN HPPD was associated with an increased use of urinary catheters and a decrease in toileting of NH residents (Zinn, 1993). *RN HPPD* • More RN HPPD in direct care were strongly associated with decreased use of urinary catheters (Horn et al., 2005).
Cognition	*Proportion of RN staff* • Higher RN staffing mix was associated with improved cognitive function (Weech-Maldonado, Meret-Hanke, Neff, & Mor, 2004).
Nutrition	*Proportion of RN staff* • Lower proportion of RN mix was associated with an increased use of tube feeding (Zinn, 1993). *RN HPPD* • More RN HPPD in direct-care time were associated with increased in the use of oral standard medical nutritional supplements (Horn et al., 2005). • More RN HPPD were associated with prevention of weight loss (Horn et al., 2005)
Pressure ulcers	*Proportion of RN staff* • Higher RN staffing mix was associated with a lower incidence of pressure ulcers (Weech-Maldonado et al., 2004). *Nursing HPPD* • Increased CNA, LPN, and RN HPPD were associated with a lower incidence of pressure ulcers (Horn et al., 2005).
Urinary tract infections (UTIs)	*RN HPPD* • More RN HPPD were associated with decreased rates of UTIs (Horn et al., 2005).
Functional status	*Overall nurse HPPD* • Increased nursing HPPD were associated with improved functional status (Spector & Takada, 1991). *RN turnover* • Lower RN turnover was associated with improved functional status (Spector & Takada, 1991). *Proportion of RN staff* • Higher RN staffing mix was associated with improved functional status (Linn, Gurel, & Linn, 1977).
Rehospitalization	*Overall nurse HPPD* • Higher nursing HPPD were associated with a decrease in 30-day hospital transfer rates (Ganz, Simmons, & Schnelle, 2005). *RN HPPD* • Higher RN HPPD were associated with reduced hospitalizations (Decker, 2006). • One hour of RN care per 100 residents was associated with a lower risk of hospitalization (Zimmerman et al., 2005). • Higher RN HPPD in direct care were strongly associated with decreased rates of hospitalization (Horn et al., 2005). *Licensed nurse HPPD* • Increased licensed nurse HPPD were associated with a lower risk of hospitalizations (Zimmerman et al., 2005).

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Table 2. Evidence Linking Nurse Staffing and Patient Outcomes in Long-Term Care Settings (1977–2006) *(continued)*

Patient Outcome Measure	Evidence Linking Patient Outcome to Nurse Staffing in Long-Term Care
Length of stay (LOS)	*RN HPPD* • Higher RN HPPD were associated with shorter LOS (Decker, 2006).
Discharge to home	*Licensed nurse HPPD* • A greater number of licensed HPPD were associated with discharge to home (Bliesmer et al., 1998). *Proportion of RNs* • Higher RN staffing mix was associated with discharge to home (Linn et al., 1977). *Nursing process* • Use of nursing process was significantly associated with probability of discharge to home (Braun, 1998).
Mortality	*Licensed nursing HPPD* • Higher licensed nursing HPPD were associated with decreased resident mortality (Bliesmer et al., 1998). • The likelihood of death decreased when RN and LPN hours per bed increased, although the odds of dying decreased more with RN levels (Decker, 2006). *Proportion of RNs* • Higher RN staffing mix was associated with decreased resident mortality (Cohen & Spector, 1996; Linn et al., 1977). *RN HPPD* • Higher RN HPPD were associated with decreased resident mortality (Braun, 1998). *Nursing turnover* • Lower CNA turnover was associated with decreased resident mortality (Zimmerman et al., 2005).

of defined process for research protocols, or recent turnover of nurse managers on the unit. In addition, 1% (3 facilities) were closed at the time of contact. We provided an educational incentive for sites to participate. After the site was enrolled, the sample included every inpatient and every direct-care nursing staff person (RN, LPN, NA) over a 30-day period.

Data Sources and Variables

Data were collected prospectively using surveys, logs, and an extant database. A daily log, consisting of 22 items, addressed staffing level (nursing HPPD), proportion of RN staff (total number of RN and nonprofessional nursing staff divided by total nursing hours), agency staff use (number sites using), and percentage of agency hours used. Census was determined by daily counts of patient admissions, transfers, and discharges, collected at midnight.

A monthly log, consisting of four items, addressed nursing resignations and active nursing personnel for the data collection month. The log also included a score for the perceived burden for nursing staff in completing the FIM™ instrument daily. The nurse managers were asked to rate the "Burden for Completing the FIM™ Instrument" daily on a scale from 1 to 5, with a score of 1 = "Least Heavy Burden" and 5 = "Heaviest Burden."

A baseline survey was completed by nurse managers to capture facility and nurse characteristics. Facility characteristics included academic affiliations and accreditations: Joint Commission and CARF. Nursing characteristics included percentage of RNs with rehabilitation certification (CRRN) and years experience in both general nursing as well as rehabilitation nursing for RNs and non-RNs. The nurse managers were asked to rate the nursing staff's experience on a scale of 1 to 5 where 1 = Novice, 2 = Advanced Beginner, 3 = Competent, 4 = Proficient, 5 = Expert. This scale reflects Benner's conceptualization of nursing experience from novice to expert, in which each rating reflects a greater complexity of functioning (Benner, 1984). Whereas beginner nurses are more rule driven, expert nurses practice from a more intuitive base and are able to identify complex patterns in patient status and the environment of care that are more likely to go undetected by novice nurses.

Nurses at participating sites were credentialed in UDSMR data collection and submission and rating of the FIM™ instrument to ensure data validity, which includes a written examination to test the raters' knowledge of the data elements, followed by a technical review of the facility's data to determine whether they fall within UDSMR guidelines for technical adequacy. Recredentialing is required every 2 years and includes retesting of all subscribing facilities. This database provided facility characteristics, including geographic region of the facility

(Northeast, South, Midwest, West), type of facility (freestanding or hospital-based), number of certified unit beds, and patient mix as denoted by the proportion of patient RICs on the unit. The RIC categorizes patients into 1 of 21 major categories based on the patient's primary reason for inpatient rehabilitation. Further, the UDSMR database provided patient characteristics including age, marital status, race/ethnicity, gender, discharge setting, type of payer, FIM™ ratings, CMG, and LOS, calculated as the number of days from admission to discharge. The admission relative weight (ARW) was an indicator of patient severity derived from admission-level data and comorbidities diagnosed throughout the patient stay.

Functional independence was measured using the FIM™ instrument, which consisted of 18 items: 13 assess motor function and 5 assess cognitive function. A 7-level scale was used to provide uniform measurement of the individual items. Higher values indicate greater functional independence. The validity of the FIM™ instrument is well established (Dodds, Martin, Stolov, & Deyo, 1993; Heinemann et al., 1997; Heinemann, Linacre, Wright, Hamilton, & Granger, 1993; Linacre, Heinemann, Wright, Granger, & Hamilton, 1994). FIM™ gain was computed as total admission FIM™ rating minus total discharge FIM™ rating for each patient who was both admitted and discharged from the facility within the study period. Negative values indicate a lower-than-expected FIM™ gain (lower level of functioning); positive values indicate a higher-than-expected FIM™ gain (improved functional status).

Patient severity was measured using the AARW, which accounts for the relative differences in resource use across the 87 CMGs. A CMG with a high relative weight indicates a greater resource need than one with a lower relative weight. Of the 87 CMGs, 82 of them—those used for typical patients—have one to four different relative weights each: one for each of three comorbidity tiers and one for no comorbidities. The five special CMGs used to classify atypical patients, each of which is unaffected by comorbidity status, have only one relative weight each. ARW calculations are based on admission data. The AARW is the aggregated mean of a set of cases (typically facility, region, or nation) based on the relative weight assigned to the admission CMGs. Therefore, adjustments related to early transfers and patient deaths are not reflected in this calculation. For each of the CMGs, CMS developed relative weighting factors to account for a patient's clinical characteristics and expected resource needs. Thus, the weighting factors account for the relative difference in resource use across all CMGs (RAND Corporation, 2006).

Although data collection extended over 24 months, which allowed us to stagger sites, the data collection period for each site was limited to 1 month. At the beginning of the study, a series of Web-based training sessions were conducted to ensure that site coordinators understood data collection instruments and procedures. The nurse manager was asked to complete the Baseline Survey, complete the Daily Log and transmit it to Tampa on a weekly basis, and at the end of the month, complete the Monthly Log. Deidentified patient outcomes and descriptive data for the study month were extracted from UDSMR and sent to the coordinating site. All patients and nursing staff on the unit on the first study day were included.

Human Subjects' Protection

Approval was obtained from the lead site and all 54 participating sites through locally established human subjects review committees. Data-sharing agreements were implemented as necessary. Patient level data were deidentified before transmission. Names, addresses, telephone numbers, unique identifiers, dates of admission, and discharge were removed. Nurse manager logs and surveys did not contain individual patient identifiers, and nurse variables were reported as unit-aggregated data. Codes were assigned to units, and the matching algorithm was kept in a locked file separate from the database. Because of these procedures, waiver of written informed consent was granted by the institutional review board (IRB) of the lead site.

Missing Data

Several steps were taken to reduce missing data including thorough training of data collectors, minimizing the burden of data collection, and conducting weekly reviews of daily logs with immediate follow-up to complete missing data. Despite these efforts, some data were lost. Nurse staffing data and facility characteristics collected directly from the rehabilitation sites had a less than 5% missing data rate, with the exception of the nurse manager rating of nursing staff rehabilitation experience, which had a 7.5% missing data rate. Patient data had a lower percentage of data missing < 1%, with the exception of the identification of a secondary payer (19% missing). The daily FIM™ measures, considered to be the most burdensome component of the data collection process, had 9.5% missing data.

Results

Facility characteristics: Participating sites ranged in size from 10 to 102 rehabilitation certified beds, with an average of 30 beds (SD = 19.68). The average daily census was 17.38 (SD = 11.43) and ranged from 3 to 56. Of the 54 sites, 45 (83%) were hospital-based, and

5 were freestanding. The majority of the sites had Joint Commission accreditation (91%), and slightly more than half (57%) were CARF accredited. A third (33%) of sites identified an academic affiliation (teaching facility).

Nurse characteristics: Approximately 17% of the nurses were certified in rehabilitation (CRRN) (*SD* = 13.08), with the unit averages ranging from 0% to 43% of the RN staff. The average years of general nursing experience for RNs were 16.60 (*SD* = 4.50), and the average years in rehabilitation were 8.11 (*SD* = 2.87). For non-RN staff (LPN/LVN or NA), the average years of general nursing experience were 11.93 (*SD* = 5.85), and the average years in rehabilitation were 5.87 (*SD* = 3.02). On average, nurse managers rated the RN staff at the proficient level in both general nursing (mean = 3.8, *SD* = 0.55) and rehabilitation nursing (mean = 3.7, *SD* = 0.59), and the non-RN staff were rated at the competent level of performance in both general nursing (mean = 3.3, *SD* = 0.69) and rehabilitation nursing (mean = 3.12, *SD* = 0.76). Across all units, none of the nurse managers rated nursing staff as beginners in general nursing, but a small percentage (10%) rated their RNs and non-RN nursing staff as beginners in rehabilitation nursing.

Nurse staffing characteristics: On average, the total nursing HPPD were 8.11 (*SD* = 1.90), ranging from 5 to 14 **(Table 3)**. The average RN HPPD were 4.04 (*SD* = 1.44), and the non-RN HPPD were 4.07 (*SD* = 1.55). The proportion of RNs averaged 50% (*SD* = 14.22); 13% of sites were heavily skewed toward RN staff (>66% of nursing hours by RNs). Agency nurses were used at 22 sites, but their use was minimal; 13 used agency RNs, although 20 used non-RN agency staff. Of these sites, approximately 4.1% (*SD* = 4.57) of the total RN hours were agency, and 2.5% (*SD* = 3.66) of the total non-RN hours were agency.

Patient characteristics: A total of 3,150 patients were in the 54 sites during the data collection period. Every patient on the unit at any point during the month long data collection period was included. Of the 3,150 patients, 1,529 (48.53%) patients had their entire stay within the study period (both admission and discharge). The average patient age was 69 years (*SD* = 15.8) (see Table 3), ranging from 15 to 101. Slightly more than half (57%) of the patients were female, and 17% were minorities. The primary payer for 67% of patients was Medicare, and 37% did not have a secondary payer. For those patients with a secondary payer, 48% identified a commercial insurance carrier. The average LOS was 14.3 days (*SD* = 10.02). The patients who had their full stay during the study period had an average LOS of 9.7 days (*SD* = 5.11). The majority of the patients had a regular stay (80%), and 20% had either a short stay, early transfer, or died during their hospital stay. Most of the patients were discharged to home (75%).

Table 3. Descriptive Data: Nurse Staffing Levels, Characteristics (Facility, Nurse, and Patients), and Outcomes

Variable	Mean	*SD*	Range
Staffing level (*n* = 54)			
Overall nursing HPPD	8.11	1.90	5–14
RN HPPD	4.04	1.44	1–8
Non-RN staff (LPN/LVN/NA) HPPD	4.07	1.55	0.1–10
Staff mix (*n* = 54)			
Proportion of RNs	50%	14.22	19%–98%
Proportion of non-RN staff	50%	14.22	2%–81%
Percentage of Agency Staff (*n* = 22)			
Use of RNs	24%		
Use of non-RNs (LPN/LVNNA)	37%		
Nursing Experience (*n* = 54)			
Years of general nursing experience for RNs	16.60	4.50	7–27
Years of rehabilitation nursing experience for RNs	8.11	2.87	2–15
Years of general nursing experience for non-RNs	11.93	5.85	3–36
Years of rehabilitation nursing experience for non-RNs	5.87	3.02	2–16
Nursing Experience as Rated by Nurse Manager *			
RN experience in general nursing Practice	3.81	0.55	1–5
RN experience in rehabilitation	3.65	0.59	1–5
Non-RN experience in general nursing practice	3.34	0.69	1–5
Non-RN experience in rehabilitation	3.12	0.76	1–5
Patient Age (*n* = 3,150)	68.76	15.77	15–101
Outcome			
Length of stay (days) (*n* = 3,150)	14.34	10.02	1–106
Discharge FIM™ Score (*n* = 1,529)	91.47	20.94	18–125
FIM™ gain (*n* = 1,529)	20.17	13.03	–38–66

Note. Sample size of 54 is indicative of the 54 sites. A sample size of 3,150 is indicative of all the patients from these 54 sites; 1,529 are all the patients who had their full stay (admission and discharge) within the study period.
* 1 = Novice, 2 = Advanced Beginner, 3 = Competent, 4 = Proficient, 5 = Expert

Patient outcomes: The average admission FIM™ rating was 71 (*SD* = 17), and the average discharge FIM™ rating was 91 (*SD* = 21) (see Table 3). The mean FIM™ gain (discharge FIM™ rating – admission FIM™ rating) was 20.17 (*SD* = 13.03). Of the 21 possible RICs, six categories were identified by the research team of specific interest; stroke and lower extremity joint replacement accounted for the greatest proportions of the sample (25% and 20%, respectively), and the remaining RICs included brain injury (9%), spinal cord injury (6%), neurological (5%), amputation (3%), and other RICs (34%).

Research question 1: How does nurse staffing vary by geographic region, type of rehabilitation facility, and specific patient rehabilitation impairments?

The dependent variables in this research question were measures of nurse staffing, and the independent variables were geographic region, type of rehabilitation facility, and patient mix as defined by the RIC. Because the data were aggregated at the facility level, the unit of analysis was the facility. Analysis of variance (ANOVA) was used to investigate the relationship between the outcome measures and geographic region and type of rehabilitation facilities. Post hoc analysis was conducted for significant ANOVAs using the Ryan-Einot-Gabriel-Welsch Multiple Range Test to control for Type I error. Ordinary least-squares regression analysis was conducted to study the association of the independent variables in predicting patient mix. The Bonferroni adjustment was employed by dividing the nominal p value of .05 by 6 (the maximum number of omnibus statistical tests within group of analyses) to interpret p values of $p < .008$ as being significant.

Geographic region: The results of the ANOVA analyses for geographic region are shown in **Table 4.** After controlling for multiple tests of significance, significant mean differences were found for only one dependent variable (RN HPPD). Post hoc analysis found all regions (Northeast, Midwest, and South) had a significantly lower average unit RN HPPD when compared to the West ($p = .0001$). The proportion of RNs was not significantly different statistically across the geographic regions, although the West reported a higher percentage of RNs than other geographic areas. Neither number nor percentage of agency hours used was significantly related to the site's geographic region.

Type of rehabilitation facility: The results of the ANOVA analyses for type of facility region are shown in **Table 5.** Although not statistically significant, freestanding rehabilitation facilities had higher overall nursing HPPD when compared to hospital-based sites ($p = .90$), while relying more heavily on non-RN staff. The freestanding sites had slightly greater proportion of non-RN staff ($p = .0152$) compared to the unit-based facilities. Freestanding sites had a statistically significantly higher number ($p = .0009$) of agency hours use when compared with the unit-based sites.

Patient mix: Facilities typically had a heterogeneous mix of RIC cases, making it difficult to examine nurse staffing needs for each impairment group. The proportion of RIC cases (patient mix) in each unit significantly affected nurse staffing levels. As the percentage of each of the RIC categories increased, there

Table 4. Nurse Staffing Characteristic by Geographic Region (n = 54)

Nurse Staffing Characteristic	Northeast		Midwest		South		West	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Total nursing HPPD	7.68	1.70	8.15	2.06	7.40	0.91	9.63	2.15
RN HPPD*	3.66*	1.00	4.11	1.17	3.08	1.03	5.71	1.71
Non-RN HPPD	4.02	1.76	4.05	1.53	4.32	1.30	3.96	1.68
Staff mix	48.80	11.81	50.87	12.62	41.94	14.73	59.53	17.03
Number of agency hours used	94.00	205.0	66.06	228.6	30.60	79.98	35.33	37.43
Percentage of agency hours used	2.35	4.55	1.15	3.38	0.46	1.09	0.83	1.11

Note. Results are adjusted for multiple comparisons.
*Significant at alpha < 0.008

Table 5. Nurse Staffing Characteristic by Facility Type (n = 54)

Nurse Staffing Characteristic	Hospital-based		Freestanding	
	Mean	*SD*	Mean	*SD*
Total nursing HPPD	8.01	1.08	8.12	1.97
RN HPPD	2.86	0.86	4.16	1.43
Non-RN HPPD	5.15	0.87	3.96	1.57
Proportion of RNs	35.51	8.15	51.49	13.92
Number of agency hours used*	304.80	380.29	38.51	126.12
Percentage of agency hours used	4.62	5.51	1.01	2.86

Note. Results are adjusted for multiple comparisons; * Significant at alpha < 0.008

was a significant increase in the total nursing HPPD and RN HPPD, but not in the non-RN HPPD **(Table 6)**. There was a trend for more RN HPPD allocated for spinal cord injury (SCI) than any other RIC. There was also a trend toward more total nursing HPPD for stroke, brain injury, SCI, and neurological RICs, when compared with replacement lower extremity (LE) and amputation. The proportion of RNs and the use of agency nurses did not vary by RIC.

Research question 2: What is the relationship among nurse staffing, nurse characteristics, and case-mix adjusted patient outcomes in rehabilitation settings, controlling for facility characteristics?

The dependent variables were patient outcomes, including case-mix adjusted FIM™ gain, discharge FIM™ rating, and length of stay. The independent variables included nurse characteristics and staffing patterns. We were also concerned that facility characteristics might impact the relationship between the independent variable of interest and the outcome variables. Therefore, two potential facility characteristics—the patient mix (RIC) and the average daily census—were included in the analysis. A two-step analysis was used. First, a series of bivariate analyses (Pearson product moment correlation coefficients) were conducted between the dependent and independent variables. Variables found to be associated with the outcome measure through bivariate analysis were included in multivariable regression models. Second, mixed model regression analysis was used to investigate the relationships between the independent variables and case-mix adjusted patient outcomes, controlling for patient data being nested within facilities. Through an iterative process, independent variables found to be nonsignificant were eliminated to identify a parsimonious predictive model. Patients with immediate discharge (n = 304) were deleted from the analysis set, because their stay was not representative of a typical rehabilitation program. The rationale for deleting this group of patients was to eliminate those patients who were immediately discharged to another facility (e.g., rehabilitation facility, long-term care, acute care), because the time frame was too short to evaluate the impact of rehabilitation nurse staffing on patient outcomes. The Bonferroni adjustment was employed by dividing the nominal p value of .05 by 3 (the number of regression models interpreted) to interpret p values of $p < .02$ as being significant.

FIM™ Gain: Four variables were significantly correlated to the CMG-adjusted FIM™ gain based on the bivariate analysis: total nursing HPPD (p = .0019), use of agency staff ($p < .0001$), non-RN staff competency in rehabilitation as rated by the nurse managers ($p < .0001$), and patient mix ($p < .0035$). These variables were included in the initial multivariable mixed model. Facility characteristics (RIC and the average daily census) were also examined to determine whether we needed to control for these variables in the model; but in this case, neither was significant. Each variable was then deleted from the model in descending significance order. As each nonsignificant variable was removed, the model was reevaluated. **Table 7** shows the final parsimonious model, with one variable most predictive of FIM™ gain; the higher the nurse managers rating of non-RN staff competency in rehabilitation nursing practice, the higher the CMG-adjusted FIM™ gain (p = .0123).

Discharge FIM™ score: Five variables were significantly correlated to the CMG-adjusted Discharge FIM™ score based on the bivariate analysis: total nursing HPPD (p = .0442), percentage of RNs certified in rehabilitation nursing (CRRN) (p = .0496), percentage of non-RN staff (p = .0029), percentage of RN staff competency in rehabilitation nursing as rated by the nurse managers ($p < .001$), and patient mix ($p < .0338$). These variables were included in the initial multivariable mixed model. The same model-building process was followed as described earlier. **Table 8** shows the final parsimonious model for discharge FIM™ rating. The higher (more competent) the nurse managers rated their non-RN nursing staff, the higher the case-mix adjusted discharge FIM™ rating.

Length of stay: Seven variables were statistically significantly correlated to the CMG-adjusted length of stay based on the bivariate analysis: total nursing HPPD (p = .05), use of agency nursing staff ($p < .0001$), percentage of agency staff use ($p < .0001$), percentage of RNs certified in rehabilitation (CRRN) ($p < .0001$), RN years of rehabilitation experience (p = .0029), non-RN years of rehabilitation experience (p = .0012), and patient mix (RIC) ($p < .0122$). In addition, one of the facility characteristics, average daily census, ($p < .0004$), was associated with the outcome variables. These variables were included in the initial multivariable mixed model. Each variable was then deleted from the model in descending significance order. As each nonsignificant variable was removed, the model was reevaluated. **Table 9** shows the final parsimonious model. As the percentage of RNs certified in rehabilitation nursing (CRRN) increased, the CMG-adjusted LOS decreased. Specifically, for every 6% increase in CRRNs on the unit, the average length of stay decreased by 1 day. Surprisingly, an increase in RN years of experience in rehabilitation nursing corresponded to a longer LOS. A higher patient census corresponded to a higher CMG-adjusted LOS.

Research question 3: Does average admission relative weight (AARW) predict overall nurse staff ceiling levels and nursing HPPD in rehabilitation?

Ordinary least-squares regression analysis was used to determine the effects of facility's AARW on

We were also concerned that facility characteristics might impact the relationship between the independent variable of interest and the outcome variables.

Table 6. Nurse Staffing Levels by RIC Distribution (*n* = 54)

	Total Nursing HPPD*			RN HPPD*			Non-RN HPPD		
Parameter	Est.	Standard Error	*p* Value	Est.	Standard Error	*p* Value	Est.	Standard Error	*p* Value
Intercept	–70	15.7	<.0001	–60	11.8	<.0001	–9.9	14.9	0.5122
Percentage of stroke cases	0.8	0.1	<.0001	0.6	0.1	<.0001	0.1	0.1	0.3253
Percentage of brain injury cases	0.8	0.2	<.0001	0.6	0.1	<.0001	0.2	0.2	0.2841
Percentage of spinal cord injury (SCI) cases	0.8	0.2	<.0001	0.7	0.1	<.0001	0.1	0.2	0.4739
Percentage of neurological cases	0.8	0.2	<.0001	0.6	0.1	<.0001	0.2	0.1	0.2073
Percentage of replacement lower extremity (LE) cases	0.7	0.2	<.0001	0.6	0.1	<.0001	0.1	0.1	0.4287
Percentage of amputation LE cases	0.6	0.2	0.0014	0.6	0.1	<.0001	0.0	0.2	0.9789
Percentage of all other cases	0.8	0.2	<.0001	0.6	0.1	<.0001	0.1	0.1	0.3278

Note. Results are adjusted for multiple comparisons;
*Significant at alpha < 0.008

Table 7. Parsimonious Model for Case-mix Adjusted FIM™ Gain (*n* = 1,529)

Effect	Estimate	Standard Error	Degrees of Freedom	*p* Value
Intercept	–1.7439	2.1675	37.6	0.4261
Non-RN staff competency in rehabilitation nursing*	1.8175	0.6940	41.1	0.0123

Note. Results are adjusted for multiple comparisons.
*Significant at alpha < 0.02

Table 8. Parsimonious Model for Case-Mix Adjusted Discharge FIM™ Score (*n* = 1,529)

Effect	Estimate	Standard Error	Degrees of Freedom	*p* Value
Intercept	–2.7228	2.2596	31.4	0.2372
Non-RN staff competency in rehabilitation nursing*	2.1979	0.7274	35	0.0047

Note. Results are adjusted for multiple comparisons.
*Significant at alpha < 0.02

nursing HPPD and staff ceiling levels (total number of full-time employees). For these analyses, the unit of analysis was the facility (n = 54). As the facility's AARW increased, there were no significant changes in the nurse staffing ceiling ($p < .0724$; **Table 10**), overall nursing HPPD ($p = .6579$; **Table 11**), RN HPPD ($p = .3406$; **Table 12**), or non-RN HPPD (0.1514; **Table 13**).

Research question 4: Do daily FIM™ scores reveal the optimal assessment interval for determining nurse staffing requirements?

We also examined the possibility of using data from a commonly used patient outcome measure, the FIM™ instrument, as a proxy for the burden of care, to predict shift-by-shift nurse staffing needs. Time series trend analysis was planned to determine the change in FIM™ score over time and the optimal interval to administer it; however, the average daily FIM™ ratings across all sites for each study day did not vary significantly over time **(Figure 1)**.

To evaluate the FIM™ instrument as a tool for determining shift-by-shift staffing, data were combined over the study period to yield total nursing HPPD by shift and an average daily FIM™ rating for each facility. Eight facilities reported structuring their nurses into 12-hour shifts. Data on 12-hour shifts

Table 9. Parsimonious Model for Case-Mix Adjusted LOS (*n* = 1,529)

Effect	Estimate	Standard Error	Degrees of Freedom	*p* Value
Intercept	–0.9320	0.6533	43.5	0.1608
Percentage of RNs certified in rehabilitation nursing (CRRN) on unit*	–0.06488	0.01428	43.2	<.0001
Years of RN experience in rehabilitation nursing*	0.1651	0.06385	43.5	0.0131
Average daily census*	0.08056	0.01575	38.6	<.0001

Note. Results are adjusted for multiple comparisons.
*Significant at alpha < 0.02

Table 10. Nurse Staffing Ceiling by Average Admission Relative Weight (AARW) (*n* = 54)

Parameter	Estimate	Standard Error	Pr > |t|
Intercept	0.97601917	18.19946254	0.9574
Nurse staffing ceiling	30.88448221	16.84369983	0.0724

were converted into an 8-hour shift framework by decreasing the day and night shift hours by 25% and combining them into an evening shift.

The average FIM™ score across all facilities was 77 (*SD* = 7.18). The nursing HPPD for the day shift averaged across the facilities was 1,439. The average shift hours per day was also calculated **(Table 14)** (total number of shift hours divided by number of days). Not surprisingly, day shift (mean = 53.67) had by far the greatest number of nursing hours when compared to afternoon (mean = 40.17) and night shifts (mean = 38.42).

Pearson product moment correlation coefficients were calculated to determine the association shift-by-shift daily nursing staffing and the average daily FIM™ score. The Bonferroni adjustment was calculated by dividing the nominal *p* value of .05 by 3 (the number of regression models interpreted) to interpret *p* values of $p < .02$ as being significant. As seen in **Table 15**, of the three shifts, the night shift is the most highly correlated with average daily FIM™ score ($p = .0043$). For every 10-unit increase of the average daily FIM™ score, there is a corresponding 3.9% daily decrease in the average night shift hours.

Research question 5: What is the perceived staff burden for completing the FIM™ instrument daily?

Nurse managers were asked to rate the level of burden experienced by the staff in administering the FIM™ instrument on every patient daily. The rating scale used was a Likert scale, where 1 represented the least burden and 5 represented the heaviest burden. On average, all sites found the daily administration of the FIM™ instrument to be moderately burdensome (mean = 3.4, *SD* = 1.17). There were no significant regional differences in burden perceptions ($p = .6251$), although the South and the Midwest found the daily administration of the FIM™ instrument slightly less burdensome than the Northeast and West **(Table 16)**.

Another indicator of burden of the daily administration of the FIM™ instrument was the proportion of missing data. An average 9.46% of the FIM™ items were missing for each study day across all the sites, ranging from 8.6% to 9.46%. Missing daily FIM™ data were defined as no FIM™ value for a patient on a study day.

Discussion

This is a critical time in nursing because regulatory and legislative solutions to the nursing shortage are being proposed in the absence of empirical data. This lack of data has been a major stumbling block that has contributed to the delays in implementing the mandated minimum nurse staffing levels in California. Evidenced-based staffing models are needed in all practice settings in nursing to satisfy Joint Commission requirements and to provide sound rationale for the new staffing effectiveness standards. This study provides data to help support staffing decisions specifically for rehabilitation settings.

Nurse Staffing Patterns in Rehabilitation

In this study, the total nursing HPPD in rehabilitation settings ranged from 5 to 14, with a mean of 8

Table 11. Total Nursing HPPD by Average Admission Relative Weight (AARW) (*n* = 54)

Parameter	Estimate	Standard Error	Pr > |t|
Intercept	7.438271284	1.53127688	<.0001
Total nursing HPPD	0.631253758	1.41720493	0.6579

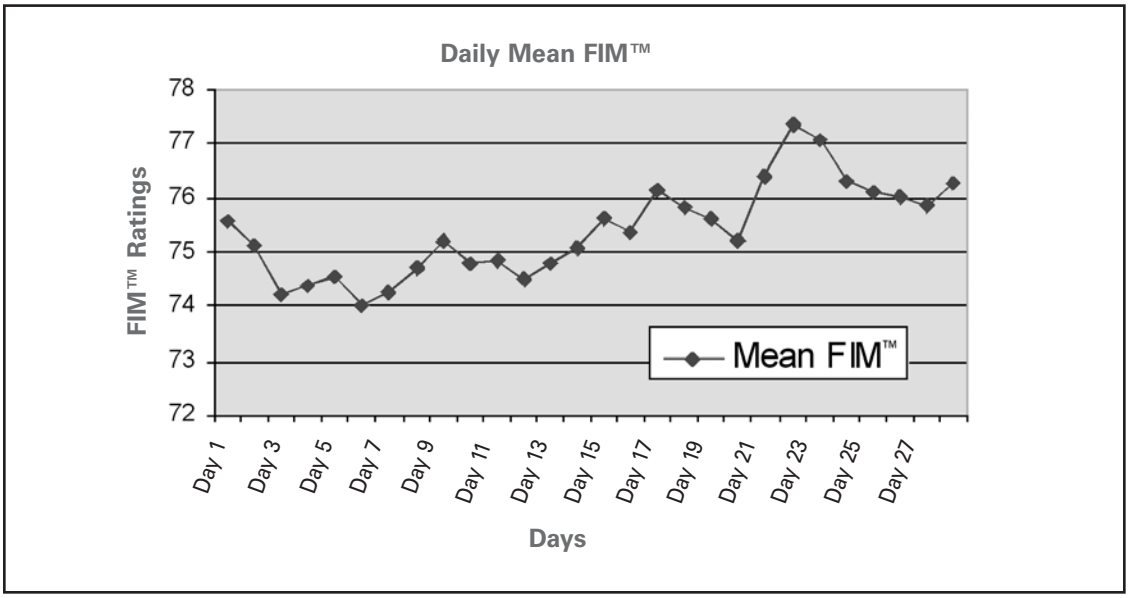
Table 12. RN HPPD by Average Admission Relative Weight (AARW) (*n* = 54)

Parameter	Estimate	Standard Error	Pr > |t|
Intercept	5.128218747	1.14633166	<.0001
RN HPPD	–1.020308018	1.06093608	0.3406

Table 13. Non-RN HPPD by Average Admission Relative Weight (AARW) (*n* = 54)

Parameter	Estimate	Standard Error	Pr > |t|
Intercept	2.310052537	1.22569251	0.0651
Non-RN HPPD	1.651561776	1.13438497	0.1514

Figure 1. Daily Mean FIM™ Ratings



hours. This is comparable to the mean HPPD reported in acute care, which ranged from 7 to 10 (Knauf, Lichtig, Rison-McCoy, Singer, & Wozniak, 1997; Lichtig, Knauf, & Milholland, 1999). Although rehabilitation settings reported a 50% proportion of RNs, the RN ratio in acute care is significantly higher; the mean RN HPPD was 6 to 8 in acute care (Aiken, Smith, & Lake, 1994), and it averaged 4.0 HPPD in rehabilitation. Neither Shukla (1983) nor Arndt and Crane (1998) found skill mix to be associated with amount of direct patient care. That is, increasing the number of RNs does not necessarily translate into higher RN direct care. Instead, it probably has a larger effect on quality of patient care than quantity of patient care (Lang et al., 2004). To better understand the variations reported in RN HPPD across sites, future studies should attempt to differentiate RN HPPD as to whether the hours were used for direct patient care, indirect patient care, or administrative duties.

Table 14. Description of Number and Proportion of Nursing Hours per Shift for Each Facility (*n* = 54)

Variable	Mean	*SD*	Minimum	Maximum
Average daily FIM™ score	77.00	7.18	58.18	93.26
Total day shift hours	1439	948.42	366	4878
Total afternoon shift hours	1243	919.45	265	4603
Total night shift hours	1020	747.43	222	4021
Average day shift hours per day	51.41	33.87	13.07	174.21
Average afternoon shift hours per day	44.41	32.84	9.46	164.39
Average night shift hours per day	36.43	26.69	7.93	143.61

Table 15. Pearson Product Moment Correlation Coefficient (deleted outliers) (*n* = 54)

Shift-by-Shift Daily Nurse Staffing	r	*p* Value
Average day shift hours per day	–0.2953	0.0354
Average afternoon shift hours per day	–0.2282	0.1038
Average night shift hours per day*	–0.3859	0.0043

Note. Results are adjusted for multiple comparisons
*Significant at alpha < 0.02

Table 16. Nurse Manager Perceived Burden of Administering the FIM™ Instrument Daily, by Geographic Region

Region	*N*	Mean	*SD*
Northeast	17	3.47	1.07
Midwest	18	3.28	1.13
South	10	3.00	1.25
West	9	3.67	1.41

Although our study excluded nurse educators and nurse managers, we did not examine how much RN time was spent at the bedside.

Few nurse staffing studies have reported agency nurse use. The use of agency nurses to supplement nurse staffing in rehabilitation units was minimal, both in terms of the number of sites that employed agency nurses and in the extent to which they were used. The use of agency nurses did not vary across geographic regions. There were, however, significant geographic variations in overall nursing HPPD, with higher staffing levels reported in the West. In addition to overall higher levels of nursing HPPD, there were trends toward a higher proportion of RNs in the West, with the South reporting the lowest proportion of RN staffing.

Link Between Nurse Staffing and Patient Outcomes

Although the link between nurse staffing and patient outcomes has been a research priority since the 1980s, studies published to date have used diverse patient outcomes and nurse staffing measures for summarizing associations (Lankshear et al., 2005). Research has focused broadly on acute care settings and nursing homes, with no previously published study addressing acute rehabilitation.

Results of this study are a significant contribution to the literature because, to our knowledge, this is the first study to report on the relationship between nurse staffing and patient outcomes in rehabilitation. Results provide an understanding of the contribution of nursing to the recovery of patients in acute rehabilitation who have suffered strokes, brain injury, spinal cord injury, neurological impairments, and replacement and amputations of lower extremities. Although the results of our study are not completely comparable to studies in acute care due to the different outcomes measured, similarities were found for length of stay. Like Lang and colleagues (2004) and Needleman, Buerhaus, Mattke, Stewart, and Zelevinsky (2002), who found associations between total nursing HPPD and RN HPPD with length of stay, we found a significant relationship between hours of total nursing HPPD and length of stay. The cumulative evidence from these three studies demonstrates the importance of nurse staffing in reducing length of stay. These data suggest that more intensive nursing care facilitates patient recovery whether from acute care or acute rehabilitation and allows for timely discharge. Research that quantifies nurses' activities could be used to better understand the underlying mechanisms that would help to explain this relationship. Length of stay without positive postdischarge outcomes, of course, is not optimal, and research is needed to determine the nursing activities that prevent postdischarge complications and 30-day readmissions.

Results of this study demonstrate the importance of measuring outcomes that match the goals of the setting and patient population. Although failure to

rescue and mortality are appropriate outcomes for acute care, rehabilitation nursing focuses on restoration of patient functioning. Therefore, it makes sense that nurse staffing studies in rehabilitation should use patient function as a major dependent variable. Our study used the FIM™ instrument, the gold standard in rehabilitation functional outcomes, and we controlled for patient factors and admission FIM™ rating by using a case-mix adjusted FIM™ gain score. Also, non-RN nursing staff unit experience, as rated by managers, was a significant predictor of case-mix adjusted gain. Clearly, an adequate number of competent non-RN staff is important in achieving higher levels of patient functioning. Although RN staffing variables were not significant, non-RN nursing staff competency in rehabilitation was the most predictive variable in the multivariate analysis. Again, although our study does not identify the underlying mechanisms of this finding, it is reasonable to hypothesize that direct-care nursing staff to whom RNs can delegate important rehabilitation activities make a difference in the functional outcomes of patients.

Evidence from a review article of 43 studies in acute care suggests no support for specific minimum nurse-patient ratios in acute care, although nursing HPPD and skill mix appear to affect important patient outcomes (Lang et al., 2004). Patient acuity, skill mix, nurse competence, nursing process variables, technology sophistication, and institutional support also needs to be considered when making staffing decisions (Lang et al.). Evidence from our study begins to provide an evidence base for minimum nurse-patient ratios in rehabilitation that consider both RN and non-RN proportions, as well as expertise of non-RN staff and patient rehabilitation acuity.

Nursing Staff Competency and Patient Outcomes

Previous studies have focused on years of experience in general nursing and/or specialty nursing practice. Nurses in the Pennsylvania study had 10 years of nursing experience, although magnet hospital nurses had less experience, 7 and 5.6 years (Lake & Friese, 2006). Nurses in our study were more experienced, with averages of 16.6 years for RNs in nursing and 8.1 years experience in rehabilitation. Of all of the nurse staffing studies of acute and long-term care we reviewed, we found only one that reported a significant association between nursing experience and patient outcomes: McGillis-Hall and colleagues (2001) found that nurse experience was inversely related to medication errors and wound infections in acute care. We found that an increase in average years of RN experience in rehabilitation corresponded to a longer LOS. Although one would expect a decrease in LOS with increasing RN experience, perhaps more experienced RNs are more skilled in identifying rehabilitation potential and patient needs that translate into more rehabilitation time requirements to meet functional goals. Less experienced RNs, on the other hand, may influence earlier discharge because they may not recognize the potential for meeting functional goals that are critical to rehabilitation.

No studies we reviewed reported significant associations between non-RN experience and patient outcomes. By measuring nurse manager competency in nursing, we attempted to go beyond years of experience as an indicator of expertise or competency. Although our measure of competency was limited, our findings point to the important role that non-RN staff play in acute rehabilitation since competency in rehabilitation nursing of non-RNs as rated by nurse managers was the strongest predictor of both FIM™ gain and discharge gain. Non-RNs typically provide the bulk of hands-on patient care, such as assistance with ADL. The data suggest that they play a unique role in ensuring positive functional outcomes in acute rehabilitation. Therefore, education, training, and reinforcement of rehabilitation principles for non-RNs should be a priority for rehabilitation facilities to maximize functional outcomes, especially staff new to rehabilitation regardless of their experience in nonrehabilitation settings. Creative educational strategies, such as focused mentoring and reflection, could be used to develop non-RN competency from novice to more expert practice.

Nurse Certification in Rehabilitation and Patient Outcomes

Few studies have reported the link between specialty nurse certification and patient outcomes. In our study, approximately 17% of the RNs in the 54 participating sites were certified in rehabilitation nursing practice (CRRN®). We could not find any data to determine if this percentage of certified nurses was above or below the mean for other specialty nursing organizations. Specialty certification in nursing ensures core knowledge in a nursing specialty and demonstrates a high level of commitment to a specialty practice area. According to research conducted by the *American Journal of Nursing* (Cary, 2001), certified nurses reported that they experienced fewer adverse events and errors in patient care than before they were certified. These nurses reported feeling more confident in their ability to detect early signs and symptoms of complications and to initiate early and prompt interventions for such complications. According to the same study, certified nurses also reported more personal growth and job satisfaction.

We found an inverse relationship between the percentage of nurses certified in rehabilitation nursing

and LOS. Specifically, a 1% increase in CRRNs on the unit was associated with an approximated 6% decrease in LOS. This finding supports the "value added" in recruiting and retaining nurses with specialty certification, as well as supporting existing staff in efforts to obtain certification. Interestingly, the length of stay was not significantly different for nurses reporting more years experience in rehabilitation. This implies that there is some added benefit of certification beyond years of rehabilitation nursing experience.

Link Among Nurse Staffing, Nurse Characteristics, and CMG-Adjusted FIM™ Gain

FIM™ gain is a measure of the efficiency of rehabilitation care, demonstrating that the patient is making functional gains during the course of treatment. In the multivariate mixed model, the nurse manager's rating of non-RN staff competency in rehabilitation was most predictive of patient outcomes. Specifically, the higher the nurse managers' rating of non-RN staff (more competent), the higher the FIM™ gain.

Predictive Use of Admission Relative Weight (AARW) for Nurse Staffing

As the facility's AARW increased, so did the nurse staffing ceiling ($p < .0724$), overall nursing HPPD ($p = .6579$), RN HPPD ($p = .3406$), non-RN HPPD ($p = .1514$), and average daily census adjusted staff ceiling levels ($p = .0634$). These findings did not appear to be statistically significant; perhaps we were underpowered to detect such differences. Although empirical data were used to establish the Inpatient Rehabilitation Prospective Payment System (IRF PPS) including certain variables such as expected LOS, other items such as the list of comorbid conditions (which can increase the relative weight and corresponding length of stay for a patient) were more arbitrarily set. Thus, a patient could have multiple medical issues; however, if those conditions are not on the list of comorbid conditions from CMS, relative weight and corresponding length of stay would not be impacted to reflect the complexity.

Admission relative weight of a patient can be used as a proxy to the burden of care for that patient. Although our findings were not statistically significant, clinically speaking, we would expect that as the average admission relative weight of a patient increases, so would the nurse staffing levels. This is consistent with the philosophical framework of the FIM™ instrument and the IRF PPS.

Usefulness of Daily FIM™ Instrument as a Nurse Staffing Tool

To our knowledge, although the relationship between staffing and outcomes has been examined in acute and long-term care settings, no researchers have examined this relationship in rehabilitation. Gross, Faulkner, Goodrich, and Kain (2001) studied the use of the FIM™ instrument to predict the number of nursing hours required to care for stroke patients. The investigators concluded that the FIM™ instrument could be used as a component of a rehabilitation classification system, but it did not capture all of the necessary nursing activities.

To evaluate the FIM™ instrument as a tool for determining shift-by-shift staffing, data were combined over the study period to yield total nursing HPPD by shift and an average daily FIM™ rating for each facility. Night shift was the most highly correlated with Average Daily FIM™ score ($r = > -0.373$). For every 10-unit increase of the average daily FIM™ ratings, there was a corresponding 3% decrease in the average night shift hours per day.

Staff Burden for Completing Daily FIM™ Instrument

On average, all sites found the daily administration of the FIM™ instrument to be moderately burdensome. There were regional differences in burden perceptions, with the South and the Midwest finding the daily FIM™ instrument slightly less burdensome than the Northeast and West.

Another indicator of burden of the daily administration of the FIM™ instrument was the proportion of missing data. An average 9.46% of the FIM™ data were missing for each study day across all the sites, ranging from 8.6% to 9.46%. Missing daily FIM™ data were defined as no FIM™ value for a patient on the unit on a study day.

It is important to recognize that in rehabilitation, functional assessment is an integral part of patient assessment, whereas in acute care, the primary focus may rest solely on medical status. The FIM™ instrument uses the concept of burden of care as its framework. Thus, more functionally impaired patients present a greater burden to staff members providing care to them. Establishing nurse staffing levels based on patients' CMG (accounting for both acuity and functional status) would be ideal.

One of the limitations of the study included the average 9.46% of missing FIM™ data collected over the multiple sites. These missing data may be the result of rehabilitation facilities still trying to meet the demands of documenting for the IRF PPS. Although some rehabilitation facilities meet only the minimal requirements of the IRF PPS (collecting admission and discharge FIM™ ratings), the vast majority of rehabilitation facilities are now practicing daily documentation to support ratings placed on the IRF PAI (Patient Assessment Instrument). As clinical practice and documentation systems evolve in the era of the IRF PPS, we expect the perception of daily FIM™ ratings to become less burdensome.

Establishing nurse staffing levels based on patients' CMG would be ideal.

Recommendations

Results from this study provide important information for understanding rehabilitation nursing, nurse staffing, and patient outcomes in rehabilitation; however, much more research is needed. Future studies will include the development and testing of an evidence-based staffing methodology specific to rehabilitation nursing. Several interesting trends emerged from this study, worthy of future research:

1. Rehabilitation seems to fall between acute care and long-term care in staffing demands. Although acute care has relied heavily on patient acuity for predicting nurse staffing needs, long-term care has relied more on patient dependency. The need to focus on both patient acuity and dependency makes staffing more complex in rehabilitation settings. Research is needed to examine the trend of rehabilitation RNs to assume more acute care functions in rehabilitation with more of the traditional rehabilitation efforts (including decreasing patient dependency) falling on non-RN nursing staff.
2. Because many of the benefits of rehabilitation nursing are likely to emerge over time, longitudinal studies are needed to examine patient outcomes postdischarge to determine whether patient outcomes were sustained over time, as well as to identify other critical nurse-sensitive outcomes that emerged over time. For example, one Canadian study found that the higher the proportion of RNs and LPNs on the unit, the higher the self-care level and social functioning of patients—but it was not sustained at 6-week follow-up (McGillis-Hall et al., 2001). Verran (1996) suggested that many of the effects of quality nursing care may not appear until after discharge, and this is particularly true in rehabilitation nursing. Future research is needed in this area.
3. A major conceptual problem is that nurse staffing processes are largely unknown. These staffing processes of care include scheduling staff; decisions related to use of agency nurses, floating, and overtime; accountability; continuity of care; collaboration; decision making; and education and development.
4. Another major conceptual problem is that rehabilitation nursing processes are not well-documented, and failures in these processes that lead to adverse outcomes are neither charted nor observed as part of routine practice. Research is needed to articulate the work processes of rehabilitation RNs (changing to include acuity as well as traditional rehabilitation nurse practices) and how these processes vary by skill mix, education, certification, and experience in both general nursing and rehabilitation. We need to elucidate the specific rehabilitation nurse actions that affect patient outcomes. Examples of rehabilitation nursing processes include care coordination, surveillance, therapeutic interventions, promotion of function, emotional support, patient education, documentation, and supervising nursing staff (IOM, 2004). The American Association of Colleges of Nursing (1998) identified the following core competencies for nurses: critical thinking, communication, assessment, and technical skills. Rehabilitation nursing practice embraces a holistic approach to medical, vocational, educational, environmental, and spiritual patient needs. The conceptual framework for rehabilitation is based on the World Health Organization (WHO) Model of Health, which uses the International Classification of Functioning, Disability, and Health. The focus of the WHO model is to promote full participation in life activities, including personal, vocational, and social pursuits. Rehabilitation nurses help individuals affected by chronic illness or physical disability to adapt to their disabilities, achieve their greatest potential, and work toward productive, independent lives. Rehabilitation nurses begin to work with individuals and their families soon after the onset of a disabling injury or chronic illness. They continue to provide support in the form of patient and family education and empower these individuals when they go home or return to work or school. The rehabilitation nurse often teaches patients and their caregivers how to access systems and resources. Rehabilitation nurses focus their practice on (1) managing complex medical issues, (2) collaborating with other specialists, (3) providing ongoing patient and caregiver education, (4) setting goals for maximal independence, and (5) establishing plans of care to maintain optimal wellness. Several nursing care delivery processes were deemed to be most affected by nursing shortages or perceived heavy workloads, including delayed response to pages or calls; communication problems; discharge delays; increased waiting times for surgery, tests, and procedures; and lack of time to maintain patient safety, detect complications early, and collaborate with the team (Buerhaus, Donelan, & Ulrich, 2005).

Future research needs to examine key rehabilitation nurse processes in addition to patterns of nurse staffing and patient outcomes.

5. Given the positive impact of rehabilitation nurse certification, efforts to build a business case for CRRN are needed. Inpatient rehabilitation facilities are in an era of financial constraint due to the tightening of the 75% Rule, which limits the types of patients IRFs can admit (CMS, 2006). As operating margins tighten, fewer dollars are allocated for nursing education and certification. This study shows that certified rehabilitation nurses can significantly decrease LOS. Because LOS is a key financial factor, there is an economic advantage to providing support to nurses interested in pursuing specialty certification in rehabilitation nursing.
6. Most nurse managers in rehabilitation indicated the need for total nursing HPPD. Arndt and Crane (1998) found that increasing the HPPD only slightly (e.g., by 6 minutes per patient) on a full 30-bed unit requires an additional 0.5 FTEE. Additional research is needed to address the resource implications of rehabilitation nurse staffing models, nurse staffing levels, and proportion of RNs that are optimal for patient care. Building a business case for nurse staffing focuses on
   a. Cost of increasing nurse staffing
   b. Cost avoidance for adverse outcomes (patient safety and quality)
   c. Cost avoidance for hospital days (reduced LOS)
   d. Avoided patient deaths
   e. Indirect savings associated with nurse recruitment or retention, reduction in liability costs, improved hospital reputation, or patient's increased ability to perform self-care have economic benefits but were not included in the model (Needleman et al., 2002).

In rehabilitation, it would be useful to know the associated costs and benefits of increasing RN HPPD, hiring more CRRNs, increasing the proportion of RN staff, and increasing total nursing HPPD. In a review article of 43 studies examining the link between nurse staffing and patient outcomes in acute care, nine studies addressed cost (Lang et al., 2004). All nine studies found better staffing was either budget neutral or cost saving. Eight of these studies were from one to two decades ago and may no longer be generalizable. The fiscal implications of rehabilitation staffing needs further study.

7. Rehabilitation facilities may give consideration to recruiting or hiring CRRN nurses because this has been associated with a shorter LOS. Maintaining an optimal level of skill mix to deliver care for the unique case mix of the facility is also suggested. Given that higher rating of non-RN staff by the nurse managers was correlated with a higher CMG-adjusted FIM™ gain, ensuring competency of non-RN staff is likewise important for optimal patient outcomes.

In summary, research is needed in several areas to better understand the relationship between rehabilitation nurse staffing and patient outcomes. Potential research questions include the following: (1) How has the delivery of nursing care in rehabilitation changed in response to caring for more acutely ill patients? (2) What is the relationship between inpatient nurse staffing patterns and postdischarge rehabilitation outcomes such as function, community participation, and quality of life? (3) What is the relationship between specific rehabilitation nursing processes and patient outcomes (immediate and long term)? and (4) What is the cost of increasing nurse staffing in rehabilitation relative to improvements in patient outcomes?

It would be useful to know the associated costs and benefits of increasing RN HPPD, hiring more CRRNs, increasing the proportion of RN staff, and increasing total nursing HPPD.

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References

Aiken, L., Clarke, S. P., Cheung, R. B., Sloane, D. M., & Silber, J. H. (2003). Educational levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association, 290*(12), 1617–1623.

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J., & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction, *The Journal of the American Medical Association, 228*(16), 1987–1993.

Aiken, L. H., Smith, H., & Lake, E. T. (1994). Lower Medicare mortality among a set of hospitals known for good nursing care. *Medical Care, 32*(8), 771–787.

American Association of Colleges of Nursing. (1998). *The Essentials of Baccalaureate Education for Professional Nursing Practice.* Washington, DC: American Association of Colleges of Nursing.

Arndt, M., & Crane, S. (1998). Influences on nursing care volume. *Journal of the Society for Health Systems, 5,* 38–49.

Benner, P. (1984). *From novice to expert: Excellence and power in clinical nursing practice.* Menlo Park, NJ: Addison-Wesley.

Blegen, M. A., & Vaughn, T. (1998). A multi-site study of nurse staffing and patient occurrence. *Nursing Economics, 16*(4), 196–203.

Bliesmer, M. M., Kane, R. L., & Shannon, I. (1998). The relationship between nursing staffing level and nursing home outcomes. *Journal of Aging and Health, 10*(3), 351–371.

Braun, B. (1998). The effect of nursing home quality on patient outcomes. *Journal of the American Geriatric Society, 39*(4), 329–338.

Buerhaus, P. I., Donelan, K., & Ulrich, B. T. (2005). Hospital RNs' and CNOs' perceptions of the impact of the nursing shortage on quality of care. *Nursing Economics, 2*(5), 214–221.

Cary, A. H. (2001). Certified registered nurses: Results of the study of the certified workforce: Findings show benefits and drawbacks of nursing certification. *American Journal of Nursing, 101*(1),44–52.

Cho, S. H., Ketefian, S., Barkauskas, V. H., & Smith, D. G. (2003). The effects of nurse staffing on adverse events, morbidity, mortality, and medical costs. *Nursing Research, 52*(2), 71–79.

Cohen, J., & Spector, W. (1996). The effect of Medicaid reimbursement on quality of care in nursing homes. *Journal of Health Economics, 15,* 23–28.

Commision on Accreditation of Rehabilitation Facilities (CARF). (2006). *Medical Rehabilitation Standards Manual.* Tucson: Author.

Decker, F. H. (2006). Nursing staff and the outcomes of nursing home stays, *Medical Care, 44*(9), 812–821.

Department of Health and Human Services, Centers for Medicare and Medicaid Services (CMS). (2007)**.** *Medicare Benefit Policy Manual.* Retrieved April 30, 2007, from http://www.cms.hhs.gov/manuals/Downloads/bp102c01.pdf.

Department of Health and Human Services, Centers for Medicare and Medicaid Services (CMS). (2006). CMS Manual System, Pub. 100–04 Medicare Claims Processing. Transmittal 221. November 3, 2006. Retrieved June 2, 2007, from http://www.cms.hhs.gov/Transmittals/downloads/R1104CP.pdf

Dodds, T. A., Martin, D. P., Stolov, W. C., & Deyo, R. A. (1993). A validation of the functional independence measurement and its performance among rehabilitation inpatients. *Archives of Physical Medicine and Rehabilitation, 74*(5), 531–536.

Ganz, D. A., Simmons, S. F., & Schnelle, J. F. (2005). Cost effectiveness of recommended nurse staffing levels for short-stay skilled nursing facility patients. *BMC Health Services Research, 5*(1), 35–43.

Gross, J. C., Faulkner, E. A., Goodrich, S. W., & Kain, M. E. (2001). A patient acuity and staffing tool for stroke rehabilitation inpatients based on the FIM™ instrument. *Rehabilitation Nursing, 26*(3), 108–113.

Heinemann, A. W., Kirk, P., Hastie, B. A., Semik, P., Hamilton, B. B., & Linacre, J. M. (1997). Relationships between disability measures and nursing effort during rehabilitation for patients with traumatic brain and spinal cord injury. *Archives of Physical Medicine and Rehabilitation, 78*(2), 143–149.

Heinemann, A. W., Linacre, J. M., Wright, B. D., Hamilton, B. B., & Granger, C. (1993). Relationships between impairment and physical disability as measured by the Functional Independence Measure. *Archives of Physical Medicine and Rehabilitation, 74*(6), 566–572.

Heinz, D. (2004). Hospital nurse staffing and patient outcomes: A review of current literature. *Dimension of Critical Care Nursing, 23*(1), 44–50.

Horn, S. D., Buerhaus, P., Bergstrom, N., & Smout, R. J. (2005). RN staffing time and outcomes of long-stay nursing home residents: Pressure ulcers and other adverse outcomes are less likely as RNs spend more time on direct patient care. *American Journal of Nursing, 105*(11), 58–70.

Institute of Medicine (IOM). (2004). *Keeping patients safe: Transforming the work of nurses.* Washington, DC: National Academies Press.

Jarman, B., Gault, S., Alves, B., Hider, A., Dolan, S., & Cook., A. (1999). Explaining differences in English hospital death rates using routinely collected data. *British Medical Journal, 318*(7197), 1515–1520.

Joint Commission on Accreditation of Healthcare Organizations (JCAHO). (2002). *Health care at the crossroads: Strategies for addressing the evolving nursing crisis.* Oakbrook Terrace, IL: JCAHO.

Knauf, R. A., Lichtig, L. K., Rison-McCoy, R., Singer, A. D., & Wozniak, L. M. (1997). *Implementing nursing's report card: A study of RN staffing, length of stay, and patient outcomes.* Washington, DC: American Nurses.

Kovner, C., Jones, C., Zhan, C., Gergen, P., & Basu, J. (2002). Nurse staffing and post surgical adverse events: An analysis of administrative data from a sample of U.S. hospitals. *HSR, 37,* 611–629.

Kurtzman, I. T., & Kizer, K. W. (2005). Evaluating the performance and contribution of nurses to achieve an environment of safety. *Nursing Administration Quarterly, 29*(1), 14–23.

Lake, E. T., & Friese, C. R. (2006). Variations in nursing practice environments. *Nursing Research, 55*(1), 1–9.

Lang, T. A., Hodge, M., Olsen, V., Romano, P. S., & Kravitz, R. L. (2004). A systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes. *JONA'S Healthcare Law, Ethics and Regulation 7/8,* 326–337.

Lankshear, A. J., Sheldon, T. A., & Maynard, A. (2005). Nurse staffing and healthcare outcomes: A systematic review of international research evidence. *Advances in Nursing Science, 28*(2), 163–174.

Lichtig, L. K., Knauf, R. A., & Milholland, D. K. (1999). Some impacts of nursing on acute care outcomes. *JONA'S Healthcare Law, Ethics and Regulation, 29,* 25–33.

Linacre, J. M., Heinemann, A. W., Wright, B. D., Granger, C. V., & Hamilton, B. B. (1994). The structure and stability of the Functional Independence Measure (FIM™). *Archive of Physical Medical Rehabilitation, 75*(2), 127–132.

Linn, M., Gurel, L., & Linn, B. (1977). Patient outcome as a measure of quality of nursing home care. *American Journal of Public Health, 67,* 337–344.

Mark, B. A., Harless, D. W., McCue, M., & Xu, Y. (2004). A longitudinal examination of hospital registered nurse staffing and quality of care. *HSR, 39,* 279–301.
McGillis-Hall, L., Doran, D., Baker, G. R., Pink, G. H., Sidani, S., O'Brien-Pallas, L., et al. (2001). *The impact of nurse staffing mix models and organizational change strategies on patient, system, and nurse outcomes.* Toronto, Canada: University of Toronto. Retrieved January 31, 2007, from http://www.fhs.mcmaster.ca/nru/old%20nru/documents/web.McGillis%20Hall.pdf.
Needleman, J., Buerhaus, P., Mattke, S., Stewart, M., & Zelevinsky, K. (2002). Nurse-staffing levels and the quality of care in hospitals, *The New England Journal of Medicine, 356*(22), 1715–1722.
Person, S. D., Allison, J. J., Kiefe, C. I., Weaver, M. T., Williams, O. D., Centor, R. M., et al. (2004). Nurse staffing and mortality for Medicare patients with acute myocardial infarction. *Medical Care, 42*(1), 4–12.
RAND Corporation (2006). *Inpatient rehabilitation facility care use before and after implementation of the IRF prospective payment*. Santa Monica: Author
Shukla, R. K. (1983). All-RN model of nursing care delivery: A cost-benefit evaluation. *Inquiry, 20,* 173–184.
Silber, J. H., Kennedy, S. K., Even-Shoshan, O., Chen, W., Koziol, L. F., Showan, A. M., et al. (2000). Anesthesiologist direction and patient outcomes. *Anesthesiology, 93*(1), 152–163.
Silber, J. H., Rosenbaum, P., & Ross, R. (1995). Comparing the contributions of groups of predictors: Which outcomes vary with hospital rather than patient characteristics. *JASA Journal of the American Statistical Association, 90,* 7–18.
Sovie, M. D., & Jawad, A. F. (2001). Hospital restructuring and its impact on outcomes: Nursing staff regulations are premature. *Journal of Nursing Administration, 31,* 588–600.
Spector, W. D., & Takada, H. A. (1991). Characteristics of nursing homes that affect resident outcomes. *Journal of Aging and Health, 3*(4), 427–454.
Tourangeau, A. E., Giovanetti, P., Tu, J. V., & Wood, M. (2002). Nursing-related determinants of 30-day mortality for hospitalized patients. *Canadian Journal of Nursing Research, 33,* 71–88.
Unruh, L. (2003). Licensed nurse staffing and adverse events in hospitals. *Medical Care, 41,* 142–152.
Verran, J. A. (1996). Quality of care, organizational variables, and nurse staffing. In G. S. Wunderlich, F. A. Sloan, & C. K. Davis (Eds.), *Nursing staff in hospitals and nursing homes: Is it adequate?* (pp. 308–332). Washington, DC: National Academies Press.
Weech-Maldonado, R., Meret-Hanke, L., Neff, M. C., & Mor, V. (2004). Nurse staffing patterns and quality of care in nursing homes. *Health Care Manage Review, 29*(2), 107–116.
Whitman, G. R. (2002). The impact of staffing on patient outcomes across specialty units. *Journal of Nursing Administration, 32,* 633–639.
Zimmerman, S., Sloane, P. D., Eckert, J. K., Gruber-Baldini, A. L., Morgan, L. A., Hebel, J. R., et al. (2005). How good is assisted living? Findings and implications from an outcomes study. *Journal of Gerontology, 60B*(4), S195–S204.
Zinn, J. S. (1993). The influence of nurse wage differentials on nursing home staffing and resident care decisions. *The Gerontologist, 33,* 721–729.

Suggested Reading

Agency for Healthcare Research and Quality. (2004). Hospital nurse staffing and quality of care. *Research in Action, Issue 14* (AHRQ Publication No. 04–0029). Rockville, MD. Retrieved March 1, 2006, from www.ahrq.gov/research/nursestaffing/nursestaff.htm.
Aiken, L. H., Havens, D., & Sloane, D. (2000). The magnet nursing services recognition program: A comparison of two groups of magnet hospitals. *American Journal of Nursing, 100*(3), 26–36.
Akinci, F., & Krolikowski, D. (2005). Nurse staffing levels and quality of care in Northeastern Pennsylvania nursing homes. *Applied Nursing Research, 18,* 130–137.
Al-Hider, A. S., & Wan, T. T. (1991). Modeling organizational determinants of hospital mortality. *Health Services Research, 26*(3), 305–323.
American Nurses Association (ANA). (1997). *Implementing nursing's report card: A study of RN staffing, length of stay and patient outcomes.* Washington, DC: American Nurses.
American Nurses Association (ANA). (2002, March). *Nurse staffing and patient outcomes in the inpatient hospital setting: Executive summary.* Retrieved January1, 2007, from http://nursingworld.org/pressrel/2000/st0504.htm.
American Nurses Association. (2002, April). *Nursing's agenda for the future: A call to the nation.* Retrieved December 2, 2002, from http://www.nursingworld.org/naf/.
Blegen, M. A., Goode, C. J., & Reed, L. (1998). Nurse staffing and patient outcomes. *Nursing Research, 47,* 43–50.
Buerhaus, P. I., Donelan, K., DesRoches, C., Lamkin, L., & Mallory, G. (2001). State of the oncology nursing workforce: Problems and implications for strengthening the future. *Nursing Economics, 19,* 198–208.
Buerhaus, P. I., Staiger, D., & Auerbach, D. I. (2000). Why are shortages of hospital RNs concentrated in specialty care units? *Nursing Economics, 18*(3), 111–116.
Centers for Medicare and Medicaid Services. (2001). *Report to Congress: Appropriateness of minimum nurse staffing ratios in nursing homes—Phase II final report.* Washington, DC. Retrieved January 1, 2007, from http://www.cms.hhs.gov/CertificationandComplianc/12_NHs.asp.
Doran, D., Harrison, M. B., Laschinger, H. S., Hirdes, J. P., Rukholm, E., Sidani, S., et al. (2006). Nursing-sensitive outcomes data collection in acute care and long-term care settings. *Nursing Research, 55*(2S), S75–S81.
Dorr, D. A., Horn, S. D., & Smout, R. J. (2005). Cost analysis of nursing home registered nurse staffing times. *American Geriatrics Society, 53,* 840–845.
Gallagher, R. M., & Rowell, P. A. (2003). Claiming the future of nursing through nursing-sensitive quality indicators. *Nursing Administration Quarterly, 27*(4), 273–284.
Harrington, C., Zimmerman, D., Karon, S. L., Robinson, J., & Beutel, P. (2000). Nursing home staffing and its relationship to deficiencies. *Journal of Gerontology, 55B*(5), S278–S287.
Harrington, C., Woolhandler, S., Mulian, J., Carrillo, H., & Himmelstein, D. U. (2001). Does investor ownership of nursing homes compromise the quality of care? *American Journal of Public Health, 91*(9), 1452–1455.
Harts, A. J., Krakauer, H., Juhn, E. M., Young, M., Jacobsen, S. J., Gay, G. et al., (1989). Hospital characteristics and mortality rates. *The New England Journal of Medicine, 321,* 1720–1725.
Hurst, K. (2005). Relationships between patient dependency, nursing workload and quality. *International Journal of Nursing Studies, 42*(1), 75–84.
Kayser-Jones, J., Schell, E. S., Porter, C., Barbaccia, J. C., & Shaw, H. (1999). Factors contributing to dehydration in nursing homes: Inadequate staffing and lack of professional supervision. *American Geriatrics Society, 47,* 1187–1194.
Kayser-Jones, J. (1997). Inadequate staffing at mealtime: Implications for nursing and health policy. *Journal of Gerontological Nursing, 23*(8), 14–21.
Loeb, M. B., Cravens, S., McGeer, A. J., Simor, A. E., Bradley, S. F., Low, D. E., et al. (2003). Risk factors for resistance to antimicrobial agents among nursing home residents. *American Journal of Epidemiology, 157*(1), 40–47.
McClure, M. (1983). *Magnet hospital study.* Kansas City, MO: American Academy of Nursing.
McCue, M., Mark, B. A., & Harless, D. W. (2003). Nurse staffing, quality and financial performance. *Journal Health Care Finance, 29,* 54–76.
McGillis, H. L., Doran, D., & Pink, G. H. (2004). Nurse staffing models, nursing hours, and patient safety outcomes, *Journal of Nursing Administration, 34*(1), 41–45.
McGillis-Hall, L., Doran, D., Baker, G. R., Pink, G. H., Sidani, S., O'Brien-Pallas, L., et al. (2003). Nurse staffing models as predictors of patient outcomes. *Medical Care, 41*(9), 1096–1109.
Monroe, D. J. (1990). The influence of registered nursing staffing on the quality of nursing home care. *Research in Nursing and Health, 13*(4), 263–270.
National Quality Forum. (2004). *National Quality Forum endorses national voluntary consensus standards for nursing-sensitive performance measures and endorses two additional nursing home performance measures.* Retrieved February 3, 2004, from http://www.qualityforum.org.

Neatherlin, J. S., & Practer, L. (2003). Nursing time and work on an acute rehabilitation setting. *Rehabilitation Nursing, 28*(6), 186–190.

O'Brien-Pallas, L. Doran, D. I., Murray, M., Cockerill, R., Sidani, S., Laurie-Shaw, B., et al. (2002). Evaluation of a client care delivery model, part 2: Variability I client outcomes in community home nursing, *Nursing Economics, 20*(1), 13–21.

Rantz, M. J., Hicks, L., Grando, V., Petroski, G. F., Madsen, R. W., Mehr, D. R., et al. (2004). Nursing home quality, cost, staffing, and staff mix. *The Gerontologist, 44*(1), 24–38.

Rothberg, M. B., Abraham, I., Lindenauer, P. K., & Rose, D. N. (2005). Improving nurse-to-patient staffing ratios as a cost-effective safety intervention. *Medical Care, 43,* 785–791

Scott, J. G., Sochalski, J., & Aiken, L. (1999). Review of magnet hospital research: Findings and implications for professional nursing practice. *Journal of Nursing Administration, 29*(1), 9–19.

Scott, S. M., Forrest, W. H., & Brown, B. W. (Eds.). (1976). Hospital structure and postoperative mortality and morbidity. In S. M. Shortell & M. Brown (Eds.), *Organizational research in hospitals.* Chicago: Blue Cross Association.

Shortell, S. M., & Hughes, E. E. (1988). The effects of regulation, competition, and ownership on mortality rates among hospital inpatients. *The New England Journal of Medicine, 318,* 1100–1107.

Shortell, S. M., Zimmerman, J. E., Rousseau, D. M., Gillies, R. R., Wagner, D. P., Draper, E. A., et al. (1994). The performance of intensive care units: Does good management make a difference? *Medical Care, 32*(5), 508–525.

Stryker, R. N. (1977). *Rehabilitative aspects of acute and chronic nursing care* (2nd ed.). Philadelphia: Saunders.

Suter, W. N. (1987). Approaches to avoiding errors in data sets: A technical note. *Nursing Research, 36*(4), 262–263.

Yang, K. P. (2003). Relationships between nurse staffing and patient outcomes. *Journal of Nursing Research, 11*(3), 149–158.

Zhang, N. J., Unruh, L., Liu, R., & Wan, T. H. (2006). Minimum nurse staffing ratios for nursing homes. *Nursing Economics, 24* (2), 78–85.

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