NATIONAL QUALITY FORUM

Measure Submission and Evaluation Worksheet 5.0

This form contains the information submitted by measure developers/stewards, organized according to NQF's measure evaluation criteria and process. The evaluation criteria, evaluation guidance documents, and a blank online submission form are available on the submitting standards web page.

NQF #: 0205 NQF Project: Patient Safety Measures-Complications Project

(for Endorsement Maintenance Review)
Original Endorsement Date: Aug 05, 2009 Most Recent Endorsement Date: Aug 05, 2009 Last Updated Date: Apr 27, 2012

BRIEF MEASURE INFORMATION

De.1 Measure Title: Nursing Hours per Patient Day

Co.1.1 Measure Steward: American Nurses Association

De.2 Brief Description of Measure: NSC-13.1 (RN hours per patient day) – The number of productive hours worked by RNs with direct patient care responsibilities per patient day for each in-patient unit in a calendar month.

NSC-13.2 (Total nursing care hours per patient day) – The number of productive hours worked by nursing staff (RN, LPN/LVN, and UAP) with direct patient care responsibilities per patient day for each in-patient unit in a calendar month.

Measure focus is structure of care quality in acute care hospital units.

2a1.1 Numerator Statement: Total number of productive hours worked by nursing staff with direct patient care responsibilities for each hospital in-patient unit during the calendar month.

2a1.4 Denominator Statement: Denominator is the total number of patient days for each in-patient unit during the calendar month. Patient days must be from the same unit in which nursing care hours are reported.

2a1.8 Denominator Exclusions: Patient days from some non-reporting unit types, such as Emergency Department, peri-operative unit, and obstetrics, are excluded.

1.1 Measure Type: Structure
2a1. 25-26 Data Source: Management Data, Other
2a1.33 Level of Analysis: Clinician : Team

1.2-1.4 Is this measure paired with another measure? No

De.3 If included in a composite, please identify the composite measure (*title and NQF number if endorsed*):
N/A

STAFF NOTES (*issues or questions regarding any criteria*)

Comments on Conditions for Consideration:

Is the measure untested? Yes☐ No☐ If untested, explain how it meets criteria for consideration for time-limited endorsement:

1a. Specific national health goal/priority identified by DHHS or NPP addressed by the measure (*check De.5*):
5. Similar/related endorsed or submitted measures (*check 5.1*):
Other Criteria:

Staff Reviewer Name(s):

1. IMPACT, OPPORTUITY, EVIDENCE - IMPORTANCE TO MEASURE AND REPORT

Importance to Measure and Report is a threshold criterion that must be met in order to recommend a measure for endorsement. All three subcriteria must be met to pass this criterion. See guidance on evidence.
Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria. (evaluation criteria)

1a. High Impact: H☐ M☐ L☐ I ☐
(*The measure directly addresses a specific national health goal/priority identified by DHHS or NPP, or some other high impact aspect of healthcare.*)

De.4 Subject/Topic Areas *(Check all the areas that apply)*:
De.5 Cross Cutting Areas (*Check all the areas that apply)*: Infrastructure Supports, Infrastructure Supports : Workforce, Safety, Safety : Complications

1a.1 Demonstrated High Impact Aspect of Healthcare: Affects large numbers, A leading cause of morbidity/mortality, High resource use, Patient/societal consequences of poor quality

1a.2 If "Other," please describe:

1a.3 Summary of Evidence of High Impact *(Provide epidemiologic or resource use data)*:
With the increasing concerns about cost and quality of patient care over the past 2 decades, hospital nurse staffing has become a major focus in examining health care workforce relationships with patient outcomes. Nurses are the largest group of clinical providers of care in healthcare systems. The Institute of Medicine recently concluded, in its report, The Future of Nursing: Leading Changing, Advancing Health (2010), that nurses are vital in providing quality care to patients.

A large body of research has demonstrated that higher nurse staffing levels are significantly associated with better patient outcomes, including shorter length of stay and lower rates of mortality, failure to rescue, hospital acquired infections, falls, medication errors, and pressure ulcers (Blegen, Goode,Spetz, Vaughn, & Park, 2011; Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Lake & Cheung, 2006; Lang, Hodge, Olson, Romano, & Kravitz, 2004; Lankshear, Sheldon, & Maynard, 2005; Needleman et al., 2011; Stone et al., 2007; Unruh, 2008). The Agency for Healthcare Research and Quality (AHRQ) conducted a comprehensive and systematic review of the 97 observational studies on the relationship between nurse staffing and patient outcomes published between 1990 and 2006. This AHRQ's meta-analysis found a strong and consistent relationship between nurse staffing and specific patient outcomes (mortality and length of stay), particularly for patients in intensive care units and surgical units (Kane et al., 2007). For example, length of stay was shorter by 24% in intensive care units and by 31% in surgical units as 1 RN per patient day was increased. In addition, nurse staffing affects care costs. There was evidence that an additional RN hour per patient day or a 10% increase in the proportion of RNs decreased the odds of patients' pneumonia by 8.9% or 9.5%, respectively (Cho, 2003).

1a.4 Citations for Evidence of High Impact cited in 1a.3:
Blegen, M. A., Goode, C. J., Spetz, J., Vaughn, T., & Park, S. H. (2011). Nurse staffing effects on patient outcomes: safety-net and non-safety-net hospitals. Medical Care, 49(4), 406-414.

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.

Institute of Medicine. (2011). The future of nursing: Leading change, advancing health. Wahington, D.C.: National Academies Press.

Kane, R. L., Shamliyan, T. A., Mueller, C., Duval, S., & Wilt, T. J. (2007). The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. Medical Care, 45(12), 1195-1204.

Lake, E. T., & Cheung, R. B. (2006). Are Patient Falls and Pressure Ulcers Sensitive to Nurse Staffing? Western Journal of Nursing Research, 28(6), 654-677.

Lang, T. A., Hodge, M., Olson, V., Romano, P. S., & Kravitz, R. L. (2004). Nurse-patient ratios: a systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes. J Nurs Adm, 34(7-8), 326-337.

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

Needleman, J., Buerhaus, P., Pankratz, V. S., Leibson, C. L., Stevens, S. R., & Harris, M. (2011). Nurse staffing and inpatient hospital mortality. New England Journal of Medicine, 364(11), 1037-1045.

Stone, P. W., Mooney-Kane, C., Larson, E. L., Horan, T., Glance, L. G., Zwanziger, J., & Dick, A. W. (2007). Nurse working conditions and patient safety outcomes. Med Care, 45(6), 571-578.

Unruh, L. (2008). Nurse staffing and patient, nurse, and financial outcomes. The American Journal of Nursing, 108(1), 62-71.

1b. Opportunity for Improvement: H☐ M☐ L☐ I ☐
(*There is a demonstrated performance gap - variability or overall less than optimal performance*)

1b.1 Briefly explain the benefits (improvements in quality) envisioned by use of this measure:
Despite the consistent evidence that better nurse staffing contributes significantly to improved patient outcomes, there is considerable variations in nursing hours per patient day or nursing staff skill mix across and within different unit types. The patient care unit is operational level to deliver care to patients. Therefore, there is a major opportunity for quality improvement at the patient care level. We envision that nurse administrators/managers will monitor their nurse staffing and develop strategies to provide adequate nurse staffing on a unit by unit basis by comparing unit nurse staffing with regional, state, and national comparisons data of total nursing hours per patient day or RN hours per patient day.

1b.2 Summary of Data Demonstrating Performance Gap *(Variation or overall less than optimal performance across providers)*:
[*For Maintenance – Descriptive statistics for performance results for this measure - distribution of scores for measured entities by quartile/decile, mean, median, SD, min, max, etc.*]
The following are descriptive statistics of the total nursing hours per patient day and RN hours per patient day by unit type across all NDNQI participating hospitals that provided nurse staffing data for third quarter 2011.

1. Total nursing hours per patient day

Unit type: mean(SD), 25th percentile, median, 75th percentile

Adult Critical Care: 17.44(3.36), 15.26, 16.93, 19.02
Adult Step-Down: 10.83(2.48), 9.21, 10.44, 11.89
Adult Medical: 8.95(1.77), 7.87, 8.73, 9.77
Adult Surgical: 9.18(1.87), 8.06, 8.93, 9.87
Adult Medical-Surgical Combined: 9.07(1.90), 7.90, 8.82, 9.88
Adult Critical Care: 14.9(5.83), 10.88, 12.62, 16.93
Pediatric Critical Access: 20.46(4.30), 17.39, 20.10, 22.76
Pediatric Step-down: 13.28(2.50), 11.66, 13.38, 14.86
Pediatric Medical: 13.20(5.52), 10.03, 11.57, 14.90
Pediatric Surgical: 12.21(2.94), 10.38, 11.84, 13.69
Pediatric Medical-Surgical Combined: 13.11(5.01), 9.98, 11.64, 14.96
Well baby Nursery: 7.05(3.03), 5.42, 6.57, 7.66
Level I Neonatal Continuing Care: 10.44(4.76), 8.16, 8.26, 10.89
Level II Intermediate Care: 13.08(4.79), 9.79, 12.39, 15.33
Level III/IV Critical Care: 12.09(2.52), 10.40, 11.75, 13.26
Psychiatric Adult: 7.50(2.28), 6.06, 7.19, 8.55
Psychiatric Child/Adolescent: 10.66(3.98), 7.86, 10.22, 12.51
Psychiatric Geripsych: 9.16(2.35), 7.77, 8.81, 10.03
Psychiatric other: 6.99(2.40), 5.40, 6.86, 8.01
Adult rehabilitation: 8.51(2.00), 7.30, 8.21, 9.32
Pediatric Rehabilitation: 11.75(3.9), 7.39, 13.12, 14.47

2. RN hours per patient day

Unit type: mean (SD), 25th percentile, median, 75th percentile

Adult Critical Care: 15.68(3.05), 13.83, 15.11, 17.08
Adult Step-Down: 8.01(2.16), 6.60, 7.63, 9.06
Adult Medical: 6.03(1.51), 5.07, 5.85, 6.82
Adult Surgical: 6.34(1.51), 5.37, 6.15, 7.02
Adult Medical-Surgical Combined: 6.12(1.60), 5.12, 5.91, 6.83
Adult Critical Access: 11.22(6.16), 7.12, 9.34, 12.21
Pediatric Critical Care: 19.05(3.82), 16.39, 18.73, 21.22
Pediatric Step-down: 10.97(2.04), 9.66, 10.86, 12.12
Pediatric Medical: 10.61(4.61), 7.92, 8.96, 12.05
Pediatric Surgical: 9.34(2.33), 7.94, 8.90, 10.76
Pediatric Medical-Surgical Combined: 10.87(4.78), 7.98, 9.45, 12.34
Well baby Nursery: 6.20(2.67), 4.76, 5.97, 7.19
Level I Neonatal Continuing Care: 10.10(4.47), 8.16, 8.26, 10.78
Level II Intermediate Care: 12.64(4.72), 9.66, 11.64, 15.06
Level III/IV Critical Care: 11.64(2.51), 10.10, 10.17, 12.59
Psychiatric Adult: 4.26(1.58), 3.23, 4.04, 5.00
Psychiatric Child/Adolescent: 5.24(2.33), 3.87, 5.10, 5.98
Psychiatric Geripsych: 4.66(1.36), 3.83, 4.46, 5.45
Psychiatric other: 3.97(1.47), 3.01, 3.77, 4.81
Adult rehabilitation: 4.95(1.51), 3.99, 4.73, 5.68
Pediatric rehabilitation: 8.28(3.59), 4.00, 9.12, 10.60

There is a wide range of total nursing hours per patient day and RN hours per patient day between and within unit types. The mean number of both total and RN hours per patient day were lowest in psychiatric other units and highest in pediatric critical care units.

Citation for descriptive statistics:
National Database of Nursing Quality Indicators. (2011). 2011 Quarterly Report: Staffing and Outcome Indicators, National Summary Statistics. Kansas City, KS: Author

1b.3 Citations for Data on Performance Gap: [*For Maintenance – Description of the data or sample for measure results reported in 1b.2 including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included*]
The sample was all patient care units who submitted their nursing care hours and patient days data to NDNQI for the third quarter of 2011(July to September). The following are the number of units by unit type.

Unit type: number of units

Adult Critical Care: 2,321
Adult Step-Down:1,588
Adult Medical: 1,946
Adult Surgical: 1,400
Adult Medical-Surgical Combined: 2,496
Adult Critical Access: 26
Pediatric Critical Care: 186
Pediatric Step-down: 50
Pediatric Medical: 120
Pediatric Surgical: 44
Pediatric Medical-Surgical Combined: 457
Well baby Nursery: 37
Level I Neonatal Continuing Care: 5
Level II Intermediate Care: 133
Level III/IV Critical Care: 391

Psychiatric Adult: 568
Psychiatric Child/Adolescent: 133
Psychiatric Geripsych: 124
Psychiatric other: 122
Adult rehabilitation: 523
Pediatric rehabilitation: 9

Citation for descriptive statistics:
National Database of Nursing Quality Indicators. (2011). 2011 Quarterly Report: Staffing and Outcome Indicators, National Summary Statistics. Kansas City, KS: Author

1b.4 Summary of Data on Disparities by Population Group: [*For **Maintenance** –Descriptive statistics for performance results for this measure by population group*]
N/A

1b.5 Citations for Data on Disparities Cited in 1b.4: [*For **Maintenance** – Description of the data or sample for measure results reported in 1b.4 including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included*]
N/A

1c. Evidence (*Measure focus is a health outcome OR meets the criteria for quantity, quality, consistency of the body of evidence.*)
Is the measure focus a health outcome? Yes☐ No☐ If not a health outcome, rate the body of evidence.

Quantity: H☐ M☐ L☐ I☐ Quality: H☐ M☐ L☐ I☐ Consistency: H☐ M☐ L☐ I☐

Quantity	Quality	Consistency	Does the measure pass subcriterion1c?
M-H	M-H	M-H	Yes☐
L	M-H	M	Yes☐ IF additional research unlikely to change conclusion that benefits to patients outweigh harms: otherwise No☐
M-H	L	M-H	Yes☐ IF potential benefits to patients clearly outweigh potential harms: otherwise No☐
L-M-H	L-M-H	L	No ☐

Health outcome – rationale supports relationship to at least one healthcare structure, process, intervention, or service	Does the measure pass subcriterion1c? Yes☐ IF rationale supports relationship

1c.1 Structure-Process-Outcome Relationship *(Briefly state the measure focus, e.g., health outcome, intermediate clinical outcome, process, structure; then identify the appropriate links, e.g., structure-process-health outcome; process- health outcome; intermediate clinical outcome-health outcome)*:
The measure focus is structure, measuring the nursing hours per patient day (total nursing hours per patient day and RN hours per patient day) for each in-patient unit during a calendar month.

This structure measure is related to patient outcomes; higher nursing hours per patient day lead to better patient outcomes (e.g., shorter length of stay and lower rates of mortality, infection, falls, medication errors, and pressure ulcers).

1c.2-3 Type of Evidence *(Check all that apply)*:
Selected individual studies (rather than entire body of evidence)

1c.4 Directness of Evidence to the Specified Measure *(State the central topic, population, and outcomes addressed in the body of evidence and identify any differences from the measure focus and measure target population)*:
Note. There are 5 systematic reviews of studies on the relationship between nurse staffing and patient outcomes. However, these reviews included all nurse staffing studies that used other nurse staffing measures, such as nurse to patient ratio and RN full time equivalents (FTEs) per patient day. In addition, many studies published between 1990 and 2006 were repeatedly reviewed in these 5 systematic reviews. To provide evidence for the specified measure in the section 1c here, therefore, we selected individual

studies, rather systematic reviews of body of evidence.

All studies provide evidence that nursing hours per patient day (total nursing hours per patient day and/or RN hours per patient day) are related to patient outcomes in acute care hospitals. The patient outcomes included adverse events (falls, pressure ulcers, medication errors), mortality, failure to rescue, length of stay, complications (pneumonia, wound infection, urinary tract infection).

1c.5 Quantity of Studies in the Body of Evidence *(Total number of studies, not articles*): 7 studies (Note. As mentioned above, studies were included only if they examined the relationship between nurse staffing and patient outcomes using specifically the nursing hours per patient day measure).

1c.6 Quality of Body of Evidence (*Summarize the certainty or confidence in the estimates of benefits and harms to patients across studies in the body of evidence resulting from study factors. Please address: a) study design/flaws; b) directness/indirectness of the evidence to this measure (e.g., interventions, comparisons, outcomes assessed, population included in the evidence); and c) imprecision/wide confidence intervals due to few patients or events*): a) Most studies were large well-conducted studies of the effects of nurse staffing on a variety of patient outcomes. Two studies were conducted at the hospital level: 5 were conducted at the patient care unit level. All studies used cross-sectional data, not longitudinal data, which did not allow inferring causality of the relationships between nurse staffing and patient outcomes. Each of studies used a differing risk-adjustment approach. In these studies, control variables included were unit type (4 studies), patient acuity level (1), patient characteristics (1), and hospital characteristics (7).

b) The evidence is directly relevant to the focus of the measure (structure – nursing hours per patient day)

c) Sample sizes were large (872-5,388 units; 232-799 hospitals) in studies except for one study. The unit of analysis was different (hospital and patient care unit). Strategies to control for known differing case mix were different in each of studies.

1c.7 Consistency of Results across Studies *(Summarize the consistency of the magnitude and direction of the effect):* The relationships of nurse staffing (total nursing hours per patient day and RN hours per patient day) with various patient outcomes were not consistent. The results were as follows:

Falls

2 studies (Dunton et al., 2004, 2007) found a consistent direction in the relationship between total nursing hours per patient day and patient falls. Higher total nursing hours per patient day was related to lower fall rates.

1 study (Lake et al., 2010) found a significant and inverse relationship between RN hours per patient day and falls in intensive care units (IRR = 0.967).

2 studies (Blegen & Vaughn, 1998; Cho et al., 2003) found no significant relationship between total nursing hours per patient day and patient falls.

Pressure ulcers

2 studies (Cho et al., 2003; Dunton et al., 2007) found a positive relationship between total nursing hours per patient day and pressure ulcers.

1 study (Blegen et al., 2011) found an inverse relationship between total nursing hours per patient day and pressure ulcers in adult intensive care units. Higher total nursing hours per patient day was related to lower pressure ulcer rates.

Failure to rescue

2 studies (Blegen et al., 2011; Needleman et al., 2002) found consistent relationships between nursing hours per patient day (total or RN hours per patient day) and failure to rescue. Higher nursing hours per patient day was related to lower rates of failure to rescue.

Mortality

1 study (Blegen et al., 2011) found that higher nursing staffing was related to lower rates of congestive heart failure mortality.

1 study (Needleman et al., 2002) found no significant relationship.

Length of stay

2 studies (Blegen et al., 2011; Needleman et al., 2002) found consistent relationships between nursing hours per patient day (total or RN hours per patient day) and length of stay (higher nursing staff was related to shorter length of stay).

This relationship was different for general units and intensive care units; no significant relationship was found in intensive care units (Blegen et al., 2011).

Urinary tract infection (UTI)

1 study (Needleman et al., 2002) found a significant and inverse relationship between RN hours per patient day and UTI among only medical patients (IRR = 0.99).

1 study (Cho et al., 2003) found no significant relationship between nurse staffing (both total and RN hours per patient day) and UTI.

Pneumonia

1 study (Cho et al., 2003) found no significant relationship between total nursing care hours per patient day and pneumonia.

1 study (Cho et al., 2003) found a significant and inverse relationship between RN hours per patient day and pneumonia (OR = 0.91); 1 study (Needleman et al., 2002) with no significant relationship among medical patients.

1c.8 Net Benefit *(Provide estimates of effect for benefit/outcome; identify harms addressed and estimates of effect; and net benefit - benefit over harms)*:
The results of the relationships of nursing staffing with a variety of patient outcomes were reported in 1c. 7.

There is inconsistent evidence to support the substantial effect of nursing hours per patient day on patient outcomes. In most studies where investigators found a significant relationship between nursing hours and patient outcomes, the results based on various estimates (e.g., incident rate ratios, adjusted odds ratios, or unstandardized regression coefficients) showed that the effect sizes of nursing hours per patient day on patient outcomes were small. Nevertheless, there was evidence that higher nurse staffing had strong effects on patient outcomes. For example, “An increase of 1 RN hour was associated with a decrease of 8.9% in the odds of pneumonia” (Cho et al., 2003). Overall, it concluded that higher nursing hours were related to better patient outcomes.

1c.9 Grading of Strength/Quality of the Body of Evidence. Has the body of evidence been graded? No

1c.10 If body of evidence graded, identify the entity that graded the evidence including balance of representation and any disclosures regarding bias: None

1c.11 System Used for Grading the Body of Evidence: Other

1c.12 If other, identify and describe the grading scale with definitions: Not graded

1c.13 Grade Assigned to the Body of Evidence: Not graded

1c.14 Summary of Controversy/Contradictory Evidence: N/A

1c.15 Citations for Evidence other than Guidelines*(Guidelines addressed below)*:
Blegen, M. A., & Vaughn, T. (1998). A multisite study of nurse staffing and patient occurrences. Nurs Econ, 16(4), 196-203.

Blegen, M. A., Goode, C. J., Spetz, J., Vaughn, T., & Park, S. H. (2011). Nurse staffing effects on patient outcomes: safety-net and non-safety-net hospitals. Medical care, 49(4), 406-414.

Needleman, J., Buerhaus, P., Pankratz, V. S., Leibson, C. L., Stevens, S. R., & Harris, M. (2011). Nurse staffing and inpatient hospital mortality. New England Journal of Medicine, 364(11), 1037-1045.

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.

Dunton, N., Gajewski, B., Taunton, R. L., & Moore, J. (2004). Nurse staffing and patient falls on acute care hospital units. Nurs Outlook, 52(1), 53-59.

Dunton, N., Gajewski, B., Klaus, S., & Pierson, B. (2007). The Relationships of Nursing Workforce Characteristics to Patient Outcomes. Online Journal of Issues in Nursing, 12(3) Manuscript 4. Retrieved from http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Volume122007/No3Sept07/Nursin

Lake, E. T., Shang, J., Klaus, S., & Dunton, N. E. (2010). Patient falls: Association with hospital Magnet status and nursing unit staffing. Res Nurs Health, 33(5), 413-425.

1c.16 Quote verbatim, the specific guideline recommendation *(Including guideline # and/or page #)*:
N/A

1c.17 Clinical Practice Guideline Citation: N/A

1c.18 National Guideline Clearinghouse or other URL: N/A

1c.19 Grading of Strength of Guideline Recommendation. Has the recommendation been graded? No

1c.20 If guideline recommendation graded, identify the entity that graded the evidence including balance of representation and any disclosures regarding bias:

1c.21 System Used for Grading the Strength of Guideline Recommendation: Other

1c.22 If other, identify and describe the grading scale with definitions: Not graded, does not apply

1c.23 Grade Assigned to the Recommendation: none

1c.24 Rationale for Using this Guideline Over Others: N/A

Based on the NQF descriptions for rating the evidence, what was the developer's assessment of the quantity, quality, and consistency of the body of evidence?
1c.25 Quantity: Moderate 1c.26 Quality: Moderate1c.27 Consistency: Moderate
1c.28 Attach evidence submission form:
1c.29 Attach appendix for supplemental materials:

Was the threshold criterion, *Importance to Measure and Report*, met?
(*1a & 1b must be rated moderate or high and 1c yes*) Yes☐ No☐
Provide rationale based on specific subcriteria:

For a new measure if the Committee votes NO, then STOP.
For a measure undergoing endorsement maintenance, if the Committee votes NO because of 1b. (no opportunity for improvement), it may be considered for continued endorsement and all criteria need to be evaluated.

2. RELIABILITY & VALIDITY - SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented. (evaluation criteria)
Measure testing must demonstrate adequate reliability and validity in order to be recommended for endorsement. Testing may be conducted for data elements and/or the computed measure score. Testing information and results should be entered in the appropriate field. Supplemental materials may be referenced or attached in item 2.1. See guidance on measure testing.

S.1 Measure Web Page *(In the future, NQF will require measure stewards to provide a URL link to a web page where current detailed specifications can be obtained*). Do you have a web page where current detailed specifications for this measure can be obtained? Yes

S.2 If yes, provide web page URL: https://www.nursingquality.org/

2a. RELIABILITY. Precise Specifications and Reliability Testing: H☐ M☐ L☐ I ☐

2a1. Precise Measure Specifications. (*The measure specifications precise and unambiguous.*)

2a1.1 Numerator Statement *(Brief, narrative description of the measure focus or what is being measured about the target population, e.g., cases from the target population with the target process, condition, event, or outcome)*:
Total number of productive hours worked by nursing staff with direct patient care responsibilities for each hospital in-patient unit during the calendar month.

2a1.2 Numerator Time Window *(The time period in which the target process, condition, event, or outcome is eligible for inclusion)*:
Nursing care hours for each in-patient unit are collected by the calendar month.

2a1.3 Numerator Details *(All information required to identify and calculate the cases from the target population with the target process, condition, event, or outcome such as definitions, codes with descriptors, and/or specific data collection items/responses*:
Nursing care hours are defined as the number of productive hours worked by nursing staff (registered nurse [RN], licensed vocational/practical nurse [LVN/LPN], and unlicensed assistive personnel [UAP]) assigned to the unit who have direct patient care responsibilities for greater than 50% of their shift.

Productive hours are actual direct patient care hours worked by nursing staff including overtime, not budgeted or scheduled hours. Vacation, sick time, orientation, education leave, or committee time are considered non-productive hours. However, orientation programs vary from hospital to hospital. Once orientees reach the point where they are considered part of the staffing matrix, their work hours are charged to the unit, and they would be replaced if they call in sick, then their hours are counted as productive.

Direct patient care responsibilities: Patient centered nursing activities by unit-based staff in the presence of the patient and activities that occur away from the patient that are patient related:

- Medication administration
- Nursing treatments
- Nursing rounds
- Admission, transfer, discharge activities
- Patient teaching
- Patient communication
- Coordination of patient care
- Documentation time
- Treatment planning
- Patient screening (e.g. risk) and assessment

Nursing staff included are either staff employed by the facility or temporary staff who are not employed by the facility (contracted/agency staff). Float staff—those are assigned to a unit other than their unit of employment on an as-needed basis—must be counted and reported in the unit's total nursing care hours where they provided direct patient care.

Included nursing staff:
Staff who are counted in the unit's staffing matrix, and
Are replaced if they call in sick, and
Work hours are charged to the unit's cost center.

Excluded nursing staff:
Persons whose primary responsibility is administrative in nature.
Specialty teams, patient educators, or case managers who are not assigned to a specific unit.
Unit secretaries or clerks, monitor technicians, and other with no direct patient care responsibilities (Therapy assistants, student nurses who are fulfilling educational requirements, sitters who either are not employed by the facility or who are employed by the facility, but are not providing typical UAP activities).

Unlicensed Assistive Personnel (UAPs): Individuals trained to function in an assistive role to nurses in the provision of patient care, as delegated by and under the supervision of the registered nurse. Typical activities performed by UAPs may include (but are not limited to): taking vital signs, bathing, feeding, dressing patients, assisting patients with transfers, ambulation, or toileting.

Included UAPs: nursing assistants, orderlies, patient care technicians/assistants, graduate nurses (not yet licensed) who have completed unit orientation.

Mental Health Technicians (MHT): For Psychiatric In-Patient Units ONLY
Individuals functioning in an assistive role, for which your facility requires course work or training that is different from UAP. They may be licensed or unlicensed. MHT hours are included in UAP hours when reporting, but their hours are collected separately from UAP hours if persons in this job position also meet the following criteria:

• They are engaged in direct care activities greater than 50% time, and
• Their position is staffed 24/7 and replaced when they call in sick, and
• Their hours are included in the nursing staff budget

Data Elements:
RN hours (Employee)
RN hours (Contract/Agency)
LPN/LVN hours (Employee)
LPN/LVN hours (Contract/Agency)
UAP hours (Employee)
UAP hours (Contract/Agency)
MHT hours (Employee)
MHT hours (Contract/Agency)
Year
Month
Type of Unit

2a1.4 Denominator Statement *(Brief, narrative description of the target population being measured)*:
Denominator is the total number of patient days for each in-patient unit during the calendar month. Patient days must be from the same unit in which nursing care hours are reported.

2a1.5 Target Population Category *(Check all the populations for which the measure is specified and tested if any)*: Adult/Elderly Care, Children's Health

2a1.6 Denominator Time Window *(The time period in which cases are eligible for inclusion)*:
Patient days for each in-patient unit are collected by the calendar month.

2a1.7 Denominator Details (*All information required to identify and calculate the target population/denominator such as definitions, codes with descriptors, and/or specific data collection items/responses)*:
Conceptually, a patient day is 24 hours, beginning the hour of admission. The operational definitions of patient days are described

in the section labeled Patient Day Reporting Methods.

The total number of patient days for each in-patient unit is collected by the calendar month using one of patient day reporting methods.

With the growth in the number of short stay in-patient units, included patients are in-patient and short stay patients (i.e., variously called short stay, observation, or same day surgery patients who receive care on a reporting in-patient unit for less than 24 hours).

Four (4) Patient Days reporting methods are as follows:

Method 1-Midnight Census
This is adequate for units that have all in-patient admissions. It is the least accurate method for units that have both in-patient and short stay patients. At the end of the month, sum the daily midnight census counts (the number of patients on the unit at midnight each day).

Method 2-Midnight Census + Patient Days from Actual Hours for Short Stay Patients
This is an accurate method for units that have both in-patients and short stay patients. The short stay "days" should be reported separately from midnight census and will be summed by NDNQI to obtain patient days. The total daily hours for short stay patients should be summed for the month and divided by 24.

Method 3-Midnight Census + Patient Days from Average Hours for Short Stay Patients
This method has been eliminated from the acceptable list of reporting methods and is no longer a reporting option starting the first quarter of 2012.

Method 4-Patient Days from Actual Hours
This is the most accurate method. An increasing number of facilities have accounting systems that track the actual time spent in the facility by each patient. Sum actual hours for all patients, whether in-patient or short stay, and divide by 24.

Method 5-Patient Days from Multiple Census Reports
Some facilities collect censuses multiple times per day (e.g., every 4 hours or each shift). This method has shown to be as accurate as Method 4. Patient days based on midnight and noon census have shown to be sufficient in adjusting for short stay patients. A sum of the daily average censuses can be calculated to determine patient days for the month on the unit.

For all patient day reporting methods, it is recommended that facilities consistently use the same method for a reporting unit over time. Each unit should report patient days using the method that most accurate for the nursing work load. For some hospitals in which the midnight census may be the only available measure of patient census, units with short stay patients should use either Method 2 or Method 4, if feasible.

Data Elements:
Month
Year
Patient Days Reporting method
Type of Unit
Patient days from Midnight census
Patient days from actual hours (depending on method selected)

2a1.8 Denominator Exclusions *(Brief narrative description of exclusions from the target population)*:
Patient days from some non-reporting unit types, such as Emergency Department, peri-operative unit, and obstetrics, are excluded.

2a1.9 Denominator Exclusion Details *(All information required to identify and calculate exclusions from the denominator such as definitions, codes with descriptors, and/or specific data collection items/responses)*:
Patient days must be from the same unit as the nursing care hours.

Data regarding nursing care hours in some units (e.g., Emergency Department, peri-operative unit, and obstetrics) have not been

collected. Patient days from these types of units are excluded.

2a1.10 Stratification Details/Variables *(All information required to stratify the measure results including the stratification variables, codes with descriptors, definitions, and/or specific data collection items/responses)*:
Stratification variables are patient population and unit type. Units are stratified by patient population first and then unit type based on acuity level, age, or type of service provided.

1. Patient population
1) Adult population: limited to units generally caring for patients over 16 years old.
2) Pediatric population: limited to units generally caring for patients under 18 years old.
3) Neonate population: limited to units caring for newborn infants.
4) Psychiatric population: units caring for patients with psychiatric disorders.
5) Rehabilitation population: limited to distinct acute rehabilitation units providing intensive therapy 5 days/week.

2. Unit types by population

1) Adult population

Critical Care
Highest level of care, includes all types of intensive care units. Optional specialty designations include: Burn, Cardiothoracic, Coronary Care, Medical, Neurology, Pulmonary, Surgical and Trauma.

Step-Down
Limited to units that provide care for patients requiring a lower level of care than critical care units and higher level of care than provided on medical/surgical units. Examples include progressive care or intermediate care units. Telemetry alone is not an indicator of acuity level.

Medical
Units that care for patients admitted to medical services, such as internal medicine, family practice, or cardiology. Optional specialty designations include: BMT (Bone Marrow Transplant), Cardiac, GI, Infectious Disease, Neurology, Oncology, Renal or Respiratory.

Surgical
Units that care for patients admitted to surgical services, such as general surgery, neurosurgery, or orthopedics. Optional specialty designations include: Bariatric, Cardiothoracic, Gynecology, Neurosurgery, Orthopedic, Plastic Surgery, Transplant or Trauma.

Medical-Surgical Combined
Units that care for patients admitted to either medical or surgical services. Optional specialty designations include: Cardiac, Neuro/Neurosurgery or Oncology.

Critical Access
A unit located in a Critical Access Hospital that cares for a combination of patients that may include critical care, medical-surgical, skilled nursing (swing bed) and/or obstetrics.

2) Pediatric population
Refer to Adult unit type descriptions for corresponding unit types.

Critical care
Step-Down
Medical
Surgical
Medical-Surgical Combined

3) Neonate population
The three unit types below (Level I, II, and III/IV) are based on the Guidelines for Perinatal Care, 5th Ed., which are used by state

certification programs. Level I, II, and III/IV neonatal units are the highest level of infant care provided, and are specified by sequential level of acuity.

Well-baby Nursery
Level I Continuing Care
Level II Intermediate Care
Level III/IV Critical Care

4) Psychiatric population

Adult
Units caring for adult patients with acute psychiatric disorders.

Child/Adolescent
Units caring for children and/or adolescents, predominantly ages 2-18 years old, with acute psychiatric disorders.

Geripsych
Units caring for elderly patients with acute psychiatric disorders.

Other (Behavioral Health, Specialty, Multiple Psychiatric Unit Types)

Behavioral Health
Units caring for individuals of any age with eating disorders or substance abuse (alcohol and drugs) diagnoses.

Specialty
Units caring for patients of any age with dual diagnoses (e.g., mental illness and mental retardation, or substance abuse and an additional mental illness diagnosis).

Multiple Psychiatric Unit Types
Units caring for patients that encompass 3 or more of the above unit types, but for which no one unit type comprises greater than 50% of the entire unit.

5) Rehabilitation population
Adult
Limited to units generally caring for rehab patients over 16 years old. Optional specialty designations include: Brain Injury/SCI, Cardiopulmonary, Neuro/Stroke and Orthopedic/Amputee Rehab units.

Pediatric
Limited to units generally caring for rehab patients under 18 years old.

2a1.11 Risk Adjustment Type *(Select type. Provide specifications for risk stratification in 2a1.10 and for statistical model in 2a1.13)*: Other 2a1.12 If "Other," please describe: Each unit is stratified by unit type (e.g., critical care, step down, medical), which is not identical to risk, but may be related.

2a1.13 Statistical Risk Model and Variables *(Name the statistical method - e.g., logistic regression and list all the risk factor variables. Note - risk model development should be addressed in 2b4.)*:
N/A

2a1.14-16 Detailed Risk Model Available at Web page URL (or attachment). Include coefficients, equations, codes with descriptors, definitions, and/or specific data collection items/responses. Attach documents only if they are not available on a webpage and keep attached file to 5 MB or less. NQF strongly prefers you make documents available at a Web page URL. Please supply login/password if needed:

2a1.17-18. Type of Score: Rate/proportion

2a1.19 Interpretation of Score *(Classifies interpretation of score according to whether better quality is associated with a higher score, a lower score, a score falling within a defined interval, or a passing score)*: Better quality = Higher score

2a1.20 Calculation Algorithm/Measure Logic*(Describe the calculation of the measure score as an ordered sequence of steps including identifying the target population; exclusions; cases meeting the target process, condition, event, or outcome; aggregating data; risk adjustment; etc.)*:
Eligible unit identified and selected; input patient days (including method) for each respective unit by month; input nursing care hours for each eligible staff category by month; then perform calculations to produce each of the quarter patient days and quarter nursing care hours by summing monthly values of the 3 months; then divide the quarterly nursing care hours by the quarterly patients days.

2a1.21-23 Calculation Algorithm/Measure Logic Diagram URL or attachment:
Attachment
Nursing_Hours_per_Patient_Day_Flowcharts.pdf

2a1.24 Sampling (Survey) Methodology. If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate):
N/A

2a1.25 Data Source *(Check all the sources for which the measure is specified and tested*). If other, please describe:
Management Data, Other

2a1.26 Data Source/Data Collection Instrument (*Identify the specific data source/data collection instrument, e.g. name of database, clinical registry, collection instrument, etc.*): Database: National Database of Nursing Quality Indicators(R) [NDNQI(R)]; Hospitals have NDNQI guidelines and Excel spreadsheets to guide data collection; data are provided to NDNQI via web based data entry or XML upload.

2a1.27-29 Data Source/data Collection Instrument Reference Web Page URL or Attachment: URL
https://www.nursingquality.org/
none needed - Reference on left-hand side of web page: "ANA´s NQF-Endorsed Measure Specifications"

2a1.30-32 Data Dictionary/Code Table Web Page URL or Attachment:
Attachment
Codebook_staffing.pdf

2a1.33 Level of Analysis (*Check the levels of analysis for which the measure is specified and tested)*: Clinician : Team

2a1.34-35 Care Setting *(Check all the settings for which the measure is specified and tested)*: Behavioral Health/Psychiatric : Inpatient, Hospital/Acute Care Facility, Post Acute/Long Term Care Facility : Inpatient Rehabilitation Facility

2a2. Reliability Testing. (*Reliability testing was conducted with appropriate method, scope, and adequate demonstration of reliability*.)

2a2.1 Data/Sample *(Description of the data or sample including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included)*:
Nursing care hours is the key data element because it is often used as the numerator to calculate nurse staffing, such as nursing hours per patient day and RN hours per patient day. The study presented in this section was designed by National Database Nursing Quality Indicators (NDNQI) to reevaluate the reliability of the nursing care hours (NCH) measure. In this study, the consistency of nursing care hours measure derived from two different data sources were assessed: the NDNQI and the California

Office for Statewide Health Planning and Development (OSHPD). The OSHPD database is one of few data sources containing unit-level nurse staffing data, and is publicly available.

The full study is provided in the attached supplemental materials.

Note that there were many challenges in linking the two databases, including different definition of hospital, different unit structure, and different data reporting interval. As a result, only critical care units were included in this study. Data on nursing care hours reported from each unit were combined into a single value of nursing care hours on the critical care unit type within a hospital.

A total of 48 hospitals in NDNQI and OSHPD were matched and comprised the final sample for this study. The majority of sample hospitals were non-teaching hospitals (62.5%) and non-magnet hospitals (79.2%). Large and teaching hospitals were over-represented in the sample. Sample hospitals with more than 200 beds (62.5%) and teaching hospitals (37.5%) were disproportionately represented compared with all California acute care hospitals (33.2% and 7.3%, respectively).

2a2.2 Analytic Method *(Describe method of reliability testing & rationale)*:
To determine the reliability of the nursing care hours measure, Intracalss correlations coefficients (ICCs) were calculated from a one-way random-effects ANOVA model.

2a2.3 Testing Results *(Reliability statistics, assessment of adequacy in the context of norms for the test conducted)*:
All the ICCs for nursing care hours by different types of nursing staff (RNs, LPNs, and UAPs) were above 0.7, ranging from 0.70 for LPN nursing hours to 0.95 for RN nursing hours. The results indicate that the nursing care hours measure from the NDNQI has substantial reliability.

2b. VALIDITY. Validity, Testing, including all Threats to Validity: H☐ M☐ L☐ I ☐

2b1.1 Describe how the measure specifications *(measure focus, target population, and exclusions)* are consistent with the evidence cited in support of the measure focus (*criterion 1c)* and identify any differences from the evidence:
The positive relationship between nurse staffing and quality of patient care has been well demonstrated in a large body of research. Higher total nursing care hours per patient day and RN hours per patient day, as structure measures, are significantly associated with better patient outcomes.

2b2. Validity Testing. (*Validity testing was conducted with appropriate method, scope, and adequate demonstration of validity.)*

2b2.1 Data/Sample *(Description of the data or sample including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included)*:
Based on the findings of systematic reviews that higher nurse staffing is significantly related to better patient outcomes (Kane et al., 2007; Lang et al., 2004; Unruh, 2008), we conducted our own studies to assess predictive validity of nursing hours per patient day measure.

Two studies are described here that provide support for the positive relationship of nurse staffing to patient falls. Study 1 was conducted by NDNQI staff and Study 2 used NDNQI data and included NDNQI staff as investigators.

Study 1:
Dunton, N., Gajewski, B., Klaus, S., & Pierson, B. (2007). The relationship of nursing workforce characteristics to patient outcomes. OJIN: The Online Journal of Issues in Nursing, 12(3), Manuscript 4. Retrieved from http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Volume122007/No3Sept07/NursingWorkforceCharacteristics.aspx

Study 2:
Lake, E. T., Shang, J., Klaus, S., & Dunton, N. E. (2010). Patient falls: Association with hospital Magnet status and nursing unit staffing. Research in Nursing & Health, 33, 413-425. http://www.ncbi.nlm.nih.gov/pubmed/20824686

Both of these publications are provided in the attached supplemental materials.

Study 1:

Data for the period from July 1, 2005, through June 30, 2006 were used for this study. The unit of analysis was the hospital unit; 1,610 critical care, step down, medical, surgical, combined medical-surgical, and rehabilitation units were included in the analysis.

Study 2:

This was a retrospective cross-sectional observational study using 2004 NDNQI data. These data were obtained in 2006. The sample contained 5,388 nursing units (intensive care, stepdown, medical, surgical, medical-surgical, and rehabilitation) in 636 hospitals. Data external to the NDNQI included hospital characteristics from the American Hospital Association (AHA) 2004 Annual Hospital Survey, the Medicare Case-Mix Index (CMI), and the hospital´s Magnet status.

2b2.2 Analytic Method *(Describe method of validity testing and rationale; if face validity, describe systematic assessment)*:
Study 1:

The mixed linear models, which account for the dependencies among units within the same hospital, were specified to test the relationships of hospital and unit structures to patient falls. Included hospital characteristics were staffed bed size, teaching status, and magnet status. Unit structures included in the model were total nursing care hours per patient day, RN hours per patient day, RN skill mix, unit RN education, unit RN experience, Average unit RN job enjoyment, and unit type.

Study 2:

In this study, the outcome variable, patient falls, was a count variable. Negative binomial regression analyses were conducted with generalized estimating equations (GEE adjust for repeated measures and the within-hospital clustering) to examine the association among nursing unit staffing , hospital Magnet status, and patient falls while controlling for other hospital and patient characteristics.

2b2.3 Testing Results *(Statistical results, assessment of adequacy in the context of norms for the test conducted; if face validity, describe results of systematic assessment)*:
Study 1:

The results indicated that total nursing care hours per patient day was significantly associated with patient falls. For every increase of one hour in total nursing hours per patient day, fall rates were 1.9% lower.

Study 2:

The results showed that RN hours per patient day was significantly and negatively related to falls in intensive care units (ICUs). An additional RN hour per patient day was associated with a 3% lower fall rate in ICUs. However, LPN and NA hours per patient day had positive relationship with falls. An additional LPN or NA hour was associated with a 2–4% higher fall rate in non-ICUs. These relationships varied by unit type (ICUs vs. non-ICUs).

POTENTIAL THREATS TO VALIDITY. (*All potential threats to validity were appropriately tested with adequate results.*)

2b3. Measure Exclusions. (*Exclusions were supported by the clinical evidence in 1c or appropriately tested with results demonstrating the need to specify them.*)

2b3.1 Data/Sample for analysis of exclusions *(Description of the data or sample including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included)*:
The measure is a patient care unit-level measure. Data regarding nursing care hours and patient days in some units (e.g., Emergency Department, peri-operative unit, and obstetrics) have not been collected by NDNQI. We are currently in the process of developing nurse staffing measure for these units.

2b3.2 Analytic Method (*Describe type of analysis and rationale for examining exclusions, including exclusion related to patient preference)*:
N/A

2b3.3 Results *(Provide statistical results for analysis of exclusions, e.g., frequency, variability, sensitivity analyses):*
N/A

2b4. Risk Adjustment Strategy. (*For outcome measures, adjustment for differences in case mix (severity) across measured entities was appropriately tested with adequate results.*)

2b4.1 Data/Sample *(Description of the data or sample including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included)*:
N/A

2b4.2 Analytic Method (*Describe methods and rationale for development and testing of risk model or risk stratification including selection of factors/variables)*:
Nurse staffing levels represent the conditions in which care occurs. At this time we do not have a statistical risk model for the nurse staffing measures.

We stratify our staffing data to account for various levels of patient acuity. Our main stratification is by unit type (e.g., adult or pediatric critical care, step down, medical, surgical, combined medical surgical, adult critical access, well baby nursery, level I neonatal continuing care, adult psychiatric, and adult rehabilitation in-patient). In addition to unit type, the stratifications can be done by facility bed size, teaching status, Magnet(R) Designation, Metropolitan status, census division, state, case mix index, and hospital type (e.g. pediatric, psychiatric).

2b4.3 Testing Results *(Statistical risk model: Provide quantitative assessment of relative contribution of model risk factors; risk model performance metrics including cross-validation discrimination and calibration statistics, calibration curve and risk decile plot, and assessment of adequacy in the context of norms for risk models. Risk stratification: Provide quantitative assessment of relationship of risk factors to the outcome and differences in outcomes among the strata)*:
We provide the results of descriptive statistics below: Mean, standard deviation (SD), median, and percentiles for total nursing hours per patient day by unit type across all NDNQI member hospitals who submitted staffing data in the third quarter 2011 (July to September)

Total nursing hours per patient day

Unit type: mean(SD), 25th percentile, median, 75th percentile

Adult Critical Care: 17.44(3.36), 15.26, 16.93, 19.02
Adult Step-Down: 10.83(2.48), 9.21, 10.44, 11.89
Adult Medical: 8.95(1.77), 7.87, 8.73, 9.77
Adult Surgical: 9.18(1.87), 8.06, 8.93, 9.87
Adult Medical-Surgical Combined: 9.07(1.90), 7.90, 8.82, 9.88
Adult Critical Access: 14.9(5.83), 10.88, 12.62, 16.93
Pediatric Critical Care: 20.46(4.30), 17.39, 20.10, 22.76
Pediatric Step-down: 13.28(2.50), 11.66, 13.38, 14.86
Pediatric Medical: 13.20(5.52), 10.03, 11.57, 14.90
Pediatric Surgical: 12.21(2.94), 10.38, 11.84, 13.69
Pediatric Medical-Surgical Combined: 13.11(5.01), 9.98, 11.64, 14.96
Well baby Nursery: 7.05(3.03), 5.42, 6.57, 7.66
Level I Neonatal Continuing Care: 10.44(4.76), 8.16, 8.26, 10.89
Level II Intermediate Care: 13.08(4.79), 9.79, 12.39, 15.33
Level III/IV Critical Care: 12.09(2.52), 10.40, 11.75, 13.26
Psychiatric Adult: 7.50(2.28), 6.06, 7.19, 8.55
Psychiatric Child/Adolescent: 10.66 (3.98), 7.86, 10.22, 12.51
Psychiatric Geripsych: 9.16(2.35), 7.77, 8.81, 10.03
Psychiatric other: 6.99(2.40), 5.40, 6.86, 8.01
Adult rehabilitation: 8.51(2.00), 7.30, 8.21, 9.32
Pediatric Rehabilitation: 11.75(3.9), 7.39, 13.12, 14.47

There is a wide range of total nursing hours per patient day across and within unit types. Variation across unit types was larger than variation within unit type. The mean number of total nursing hours per patient day were lowest in psychiatric other units and highest

in pediatric critical care units.

Citation for descriptive statistics:
National Database of Nursing Quality Indicators. (2011). 2011 Quarterly Report: Staffing and Outcome Indicators, National Summary Statistics. Kansas City, KS: Author

2b4.4 If outcome or resource use measure is not risk adjusted, provide rationale and analyses to justify lack of adjustment: In general, outcome measures are adjusted for risk. Risk adjustment for staffing measures is not advisable. Staffing measures themselves are served as a measure of acuity, reflecting the level of patients' need for care. Moreover, it is not possible to create risk or acuity-adjusted unit-level measures because acuity data are not available for patient care units yet.

Citation for rationale to justify lack of adjustment:
National Database of Nursing Quality Indicators. (2011). Method Development project, Final Report to the American Nurses Association, Kansas City, KS: Author.

The full report is provided in the attached supplemental materials.

2b5. Identification of Meaningful Differences in Performance. (*The performance measure scores were appropriately analyzed and discriminated meaningful differences in quality.*)

2b5.1 Data/Sample *(Describe the data or sample including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included)*:
Study1:
Note: This is same study that we conducted and was provided for validity evidence. It is also evidence of meaningful differences in performance.

Lake, E. T., Shang, J., Klaus, S., & Dunton, N. E. (2010). Patient falls: Association with hospital Magnet status and nursing unit staffing. Research in Nursing & Health, 33, 413-425. http://www.ncbi.nlm.nih.gov/pubmed/20824686

This study used 2004 NDNQI data. The final analytical sample contained 5,388 nursing units (intensive care, stepdown, medical, surgical, medical-surgical, and rehabilitation) in 636 hospitals.

Study 2:
Note. The results of descriptive statistics that was provided for the testing results of risk stratification are also provided as evidence of meaningful differences in performance here.

Citation for descriptive statistics:
National Database of Nursing Quality Indicators. (2011). 2011 Quarterly Report: Staffing and Outcome Indicators, National Summary Statistics. Kansas City, KS: Author

The sample was all 12,679 patient care units who submitted their nursing care hours and patient days data to NDNQI for the third quarter of 2011 (July to September). The unit types included were adult critical care, adult step-down, adult medical, adult surgical, adult medical-surgical combined, adult critical access, pediatric critical care, pediatric step-down, pediatric medical, pediatric surgical, pediatric medical-surgical combined, well baby nursery, level I neonatal continuing Care, level II intermediate care, level III/IV critical care, psychiatric adult, psychiatric child/adolescent, psychiatric geripsych, adult rehabilitation, and pediatric rehabilitation units.

2b5.2 Analytic Method *(Describe methods and rationale to identify statistically significant and practically/meaningfully differences in performance)*:
Study1:
Negative binomial regression analyses were conducted with generalized estimating equations (GEE adjust for repeated measures and the within-hospital clustering) to examine the association among nursing unit staffing , hospital Magnet status, and patient falls while controlling for other hospital and patient characteristics. In this study, nursing staff hours were separated into RN, LPN, and NA hours. In addition, the model tested with all combined units was also run for intensive care units (ICUs) and non-ICUs separately. Because ICUs are more likely to have sicker patients and higher nurse staffing, fundamental differences between ICUs

and non-ICUs may result in different patterns of relationships between nurse staffing and patient falls.

Study2:
Descriptive statistics were performed to summarize data on total nursing hours per patient day by unit type: Mean, standard deviation (SD), median, and percentiles.

2b5.3 Results *(Provide measure performance results/scores, e.g., distribution by quartile, mean, median, SD, etc.; identification of statistically significant and meaningfully differences in performance)*:
Study 1:
The results showed that nursing hours per patient day was significantly associated with patient falls. However, this relationship varied by unit type (ICUs vs. non-ICUs). Although RN hours per patient day was significantly and negatively related to falls in intensive care units (ICUs), no significant relationship was found in non-ICUs. An additional RN hour per patient day was associated with a 3% lower fall rate in ICUs. LPN and NA hours per patient day had positive relationship with falls. An additional LPN or NA hour was associated with a 2–4% higher fall rate in non-ICUs. Although this positive relationship was not expected, this study provides clinically meaningful information on how nursing staffing patterns affect patient safety by different unit types.

Study 2:
The results of descriptive statistics of total nursing hours per patient day by unit type were presented below. There was a wide range of total nursing hours per patient day between and within unit types. Variation across unit types was larger than variation within unit type. The mean number of total nursing hours per patient day were lowest in psychiatric other units and highest in pediatric critical care units. The results indicate meaningful differences in nurse staffing by different unit type.

Total nursing hours per patient day

Unit type: mean(SD), 25th percentile, median, 75th percentile

Adult Critical Care: 17.44(3.36), 15.26, 16.93, 19.02
Adult Step-Down: 10.83(2.48), 9.21, 10.44, 11.89
Adult Medical: 8.95(1.77), 7.87, 8.73, 9.77
Adult Surgical: 9.18(1.87), 8.06, 8.93, 9.87
Adult Medical-Surgical Combined: 9.07(1.90), 7.90, 8.82, 9.88
Adult Critical Access: 14.9(5.83), 10.88, 12.62, 16.93
Pediatric Critical Care: 20.46(4.30), 17.39, 20.10, 22.76
Pediatric Step-down: 13.28(2.50), 11.66, 13.38, 14.86
Pediatric Medical: 13.20(5.52), 10.03, 11.57, 14.90
Pediatric Surgical: 12.21(2.94), 10.38, 11.84, 13.69
Pediatric Medical-Surgical Combined: 13.11(5.01), 9.98, 11.64, 14.96
Well baby Nursery: 7.05(3.03), 5.42, 6.57, 7.66
Level I Neonatal Continuing Care: 10.44(4.76), 8.16, 8.26, 10.89
Level II Intermediate Care: 13.08(4.79), 9.79, 12.39, 15.33
Level III/IV Critical Care: 12.09(2.52), 10.40, 11.75, 13.26
Psychiatric Adult: 7.50(2.28), 6.06, 7.19, 8.55
Psychiatric Child/Adolescent: 10.66 (3.98), 7.86, 10.22, 12.51
Psychiatric Geripsych: 9.16(2.35), 7.77, 8.81, 10.03
Psychiatric other: 6.99(2.40), 5.40, 6.86, 8.01
Adult rehabilitation: 8.51(2.00), 7.30, 8.21, 9.32
Pediatric Rehabilitation: 11.75(3.9), 7.39, 13.12, 14.47

2b6. Comparability of Multiple Data Sources/Methods. (*If specified for more than one data source, the various approaches result in comparable scores.*)

2b6.1 Data/Sample *(Describe the data or sample including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities included)*:
N/A

2b6.2 Analytic Method *(Describe methods and rationale for testing comparability of scores produced by the different data sources specified in the measure)*:
N/A

2b6.3 Testing Results *(Provide statistical results, e.g., correlation statistics, comparison of rankings; assessment of adequacy in the context of norms for the test conducted)*:
N/A

2c. Disparities in Care: H☐ M☐ L☐ I ☐ NA☐ (*If applicable, the measure specifications allow identification of disparities.*)

2c.1 If measure is stratified for disparities, provide stratified results *(Scores by stratified categories/cohorts)*: N/A

2c.2 If disparities have been reported/identified (e.g., in 1b), but measure is not specified to detect disparities, please explain:
N/A

2.1-2.3 Supplemental Testing Methodology Information:
Attachment
FinalScientifcSupplement.pdf

Steering Committee: Overall, was the criterion, *Scientific Acceptability of Measure Properties*, met?
(*Reliability and Validity must be rated moderate or high*) Yes☐ No☐
Provide rationale based on specific subcriteria:

If the Committee votes No, STOP

3. USABILITY

Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making. (evaluation criteria)

C.1 Intended Actual/Planned Use *(Check all the planned uses for which the measure is intended)*: Professional Certification or Recognition Program, Public Reporting, Quality Improvement (Internal to the specific organization), Quality Improvement with Benchmarking (external benchmarking to multiple organizations)

3.1 Current Use *(Check all that apply; for any that are checked, provide the specific program information in the following questions)*: Public Reporting, Professional Certification or Recognition Program, Quality Improvement with Benchmarking (external benchmarking to multiple organizations), Quality Improvement (Internal to the specific organization)

3a. Usefulness for Public Reporting: H☐ M☐ L☐ I ☐
(*The measure is meaningful, understandable and useful for public reporting.*)

3a.1. Use in Public Reporting - disclosure of performance results to the public at large *(If used in a public reporting program, provide name of program(s), locations, Web page URL(s)).* If not publicly reported in a national or community program, state the reason AND plans to achieve public reporting, potential reporting programs or commitments, and timeline, e.g., within 3 years of endorsement: [*For Maintenance – If not publicly reported, describe progress made toward achieving disclosure of performance results to the public at large and expected date for public reporting; provide rationale why continued endorsement should be considered.*]
1. Department of Banking, Insurance, Securities and Health Care Administration, VT

Vermont Hospital Report Card
http://www.bishca.state.vt.us/health-care/hospitals-health-care-practitioners/2011-hospital-report-card

Data on nursing care hours per patient day and percent of total nursing care hours provided by RNs for each Vermont hospital can be accessed directly through this link:
http://www.bishca.state.vt.us/health-care/hospitals-health-care-practitioners/2011-nurse-staffing

2. Colorado Hospital Association, CO

Colorado Hospital Report Card
http://www.cohospitalquality.org/corda/dashboards/COLORADO_REPORT_CARD_BY_MEASURE/main.dashxml

Data on nursing care hours per patient day can be accessed directly through this link:
http://www.cohospitalquality.org/corda/dashboards/COLORADO_REPORT_CARD_BY_MEASURE/main.dashxml#cordaDash=1037

Data on percent of total nursing care hours provided by RNs can be accessed directly through this link:
http://www.cohospitalquality.org/corda/dashboards/COLORADO_REPORT_CARD_BY_MEASURE/main.dashxml#cordaDash=1033

3. Norton Healthcare, KY

Norton Healthcare won the 2011 NQF Quality Healthcare Award for achievement in quality improvement. Norton Healthcare is one of the first healthcare organizations in the nation to publicly report its performance on hundreds of NQF-endorsed quality indicators.

Data on nursing care hours per patient day and nursing staff skill mix can be accessed directly through this link:
http://www.nortonhealthcare.com/NursingCare

4. Maine Quality Forum, ME

http://www.mqf-online.com/summary/intro.aspx

3a.2.Provide a rationale for why the measure performance results are meaningful, understandable, and useful for public reporting. If usefulness was demonstrated (e.g., focus group, cognitive testing), describe the data, method, and results: N/A

3.2 Use for other Accountability Functions (payment, certification, accreditation). If used in a public accountability program, provide name of program(s), locations, Web page URL(s): Nursing hours per patient day are used in credentialing programs such as the Magnet Recognition Program,
http://www.nursecredentialing.org/Magnet.aspx.

Magnet applicant hospitals are required to provide the actual to budgeted direct RN nursing care hours per patient day by unit for each of two 1-year periods immediately preceding the submission of written documentation.

3b. Usefulness for Quality Improvement: H☐ M☐ L☐ I ☐
(*The measure is meaningful, understandable and useful for quality improvement.*)

3b.1. Use in QI. If used in quality improvement program, provide name of program(s), locations, Web page URL(s):
[*For Maintenance – If not used for QI, indicate the reasons and describe progress toward using performance results for improvement*].
The nursing hours per patient day measure is one of quality indicators in the National Database of Nursing Quality Indicators (NDNQI). NDNQI's mission is to support hospitals' quality improvement efforts by providing national comparative data on nurse staffing by unit type, including total nursing hours per patient day and RN hours per patient day. Also, NDNQI provides comparative data on nursing-sensitive patient outcomes, such as patient falls and pressure ulcers. Currently there are over 1800 participating hospitals in NDNQI.

Website URL is www.nursingquality.org

3b.2. Provide rationale for why the measure performance results are meaningful, understandable, and useful for quality improvement. If usefulness was demonstrated *(e.g., QI initiative),* describe the data, method and results:

Participating NDNQI hospitals download quarterly reports electronically from the NDNQI website. Reports provide the most current eight quarters of data and a rolling average of those eight quarters with national comparisons at the unit level based on unit type as well as hospital characteristics, such as hospital bed size, and teaching status. For example, total nursing care hours per patient day are reported for each adult medical unit of a 100-199 bed facility, which can be compared with either the median for all medical units within that facility or the means for all medical units in the same size facilities nationwide. The significance of offering the reports at the unit level is that reports provide data regarding the specific site where the care occurs and provides a better comparison among like units. Nurse administrators and managers at participating facilities are also able to identify whether their performance improved after they intervened in an area needing improvement (e.g., poor patient outcomes on the units that had less than adequate staffing levels or the units in which staffing levels were getting worse).

In fall 2011, we conducted a survey of NDNQI site coordinators to collect information on nurse staffing data collection. All 1,529 site coordinators of member hospitals listed in the NDNQI database were invited to participate in this online survey. Of these, 811 visited the survey website and 441 completed the survey. In this survey, they were asked about usability of NDNQI quarterly staffing reports, and reported that the NDNQI staffing reports are very much (27%) or somewhat (61%) usable for decision-making on staffing. In addition, they felt that they were very much (37%) or somewhat (56%) successful in having adequate staffing to provide quality care to patients when they have used the NDNQI nurse staffing report for staffing plans.

The percent of site coordinators who reported the following users of NDNQI nurse staffing reports was: Chief Nursing Officer (89%), Nurse Managers (82%), Quality Improvement personal (54%), Staff nurses (28%), NDNQI site coordinators (89%), Chief Executive Officer (19%).

Here's how the site coordinators said their hospitals used NDNQI nurse staffing reports (nursing hours per patient day and nursing staff skill mix):

- 62% identified units with less than adequate staffing levels
- 46% set goals for improvement in staffing
- 55% developed annual or long-term strategic plans on staffing
- 45% monitored their quality improvement initiatives
- 27% have made decisions about staff adjustment (e.g., floating staff)

Further, a monograph published by the American Nurses Association demonstrates successful quality improvement initiatives using the NDNQI quality indicators data, including data on nursing hours per patient day data. One example of a quality improvement program is the Two-Tier fall reduction program at Memorial hospital, TN (Duncan et al., 2011, pp 63-67). In the third quarter of 2007, their fall rates were above the NDNQI mean of fall rates. To reduce injury fall rates, several strategies were implemented, such as a new risk assessment tool and new equipment. Nevertheless, their fall rates were above the NDNQI median for some units in the first quarter of 2008. They increased total nursing hours per patient day on 6 acute care units in July 2008. The most notable improvement was that three units achieved zero injury falls for four consecutive quarters (2Q08 to 1Q09). In addition to new bed alarms and sitter usage, improved nurse staffing was a key structural change that helps maintain the improvement.

Duncan, J., Montalvo, I., & Dunton, N. (2011). NDNQI Case Studies in Nursing Quality Improvement. Silver Spring, MD: American Nurses Association.

Overall, to what extent was the criterion, *Usability*, met? H☐ M☐ L☐ I ☐
Provide rationale based on specific subcriteria:

4. FEASIBILITY

Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement. (evaluation criteria)

4a. Data Generated as a Byproduct of Care Processes: H☐ M☐ L☐ I ☐

4a.1-2 How are the data elements needed to compute measure scores generated? *(Check all that apply).*
Data used in the measure are:
Other

generated from electronic payroll/accounting report or electronic staffing system

4b. Electronic Sources: H☐ M☐ L☐ I ☐

4b.1 Are the data elements needed for the measure as specified available electronically *(Elements that are needed to compute measure scores are in defined, computer-readable fields)*: ALL data elements are in a combination of electronic sources

4b.2 If ALL data elements are not from electronic sources, specify a credible, near-term path to electronic capture, OR provide a rationale for using other than electronic sources:

4c. Susceptibility to Inaccuracies, Errors, or Unintended Consequences: H☐ M☐ L☐ I ☐

4c.1 Identify susceptibility to inaccuracies, errors, or unintended consequences of the measurement identified during testing and/or operational use and strategies to prevent, minimize, or detect. If audited, provide results:
In fall 2011, the online site coordinator survey was conducted to evaluate current nursing care hours data collection procedures and the level of compliance with NDNQI standards on nursing care hours across all member hospitals.

According to NDNQI guidelines, all separate nursing care hours data by licensure levels (RNs, LPNs, and UAPs) as well as employment status (hospital employees and agency/contracts) must reported by the calendar month. Also, these nursing hours must be productive hours worked by nursing staff assigned to the unit who have direct patient care responsibilities. Consequently, collecting and submitting nursing care hours in compliance with the NDNQI definition was complex. Hospitals obtain nursing care hours data from several sources, such as electronic payroll/accounting report, electronic staffing system or electronic patient acuity systems. In some, their data were not clearly separated by licensure levels or employee/agency hours. Because of the differences in hospital information systems, some hospitals have challenges in reporting separate nursing care hours by the NDNQI definition of nursing care hours, which requires knowledge and efforts from all staff involved in the multi-step process for generating nursing care hours data.

To collect more accurate data on nursing care hours, the NDNQI implemented several strategies, including periodical site coordinator surveys, data cleaning tools, and training for site coordinators. Most importantly, NDNQI hospitals were strongly encouraged to review the data collection guidelines periodically. In addition to teleconferences with site coordinators for member hospitals, NDNQI provides new information to hospitals via newsletters and email so that they stay updated on the most recent changes to the NDNQI guidelines.

Overall, findings from the site coordinator survey indicate that there was a high degree of compliance with the NDNQI guidelines concerning types of providers whose hours are to be included as direct nursing care hours. Almost 61% of the respondents reported that they referred to NDNQI guidelines at least once a year and 33% used the guidelines once a quarter or more often. Very few respondents (5%) said that they never referred to the guideline. Nevertheless, there were some hospitals where two types of staff, unit secretaries (13%) or monitor technicians (11%), were still included in reporting nursing care hours. Moreover, some hospitals utilize bi-weekly pay periods. For these hospitals, NDNQI provides an example in the guidelines and has pay period conversion tables on the NDNQI website. A large majority of site coordinators (72%) reported data using the correct pay period conversion methods, whereas some site coordinators (17%) reported unaccepted methods to report data to NDNQI. More investigation into these two issues is necessary to discover whether the poor adherence to the definition is related to a lack of information or to limitations in the systems from which the data are extracted and to explore the impact of these.

Seventy-two percent of site coordinators reported that they checked whether data were accurate or not before submitting data to NDNQI, 24.5% reported that they did not have additional verification processes, such as the comparison between current values and values from earlier quarters, nurse manager review, and comparison with actual clock-hour records. NDNQI recently provided data summary reports and data error reports so that hospitals can verify their data during the data entry process. These data cleaning tools are relatively easy ways for hospitals to find suspicious data quickly. NDNQI hospitals are strongly encouraged to use these data cleaning tools before data are submitted to NDNQI. Findings from the recent site coordinator survey indicate that about 60% of site coordinators have used both data cleaning tools (data summary report and data error report) during the data entry process to report nursing care hours data to NDNQI. A large majority of site coordinators (85%) have used data error report to check data before data were submitted to NDNQI. They reported that this tool was very much (67.8%) or somewhat (32.2%) useful to detect erroneous data quickly during the data entry process.

During NDNQI's process of cleaning the quarterly nursing care hours data by NDNQI statistical analysts, in addition, hospitals are

asked to verify their nursing care hours when data appear to be erroneous. In the fourth quarter of 2011 (Sep, Nov, and Dec), a total of 12,609 units from member hospitals reported their nursing care hours data to NDNQI. Of these, data for the 706 units (5.59%) appeared to be inaccurate. Our statistical analysts contacted site coordinators who are responsible for data submission. Data for these 706 units were deleted or corrected based on their response.

4d. Data Collection Strategy/Implementation: H☐ M☐ L☐ I ☐

A.2 Please check if either of the following apply (*regarding proprietary measures*): Proprietary measure

4d.1 Describe what you have learned/modified as a result of testing and/or operational use of the measure regarding data collection, availability of data, missing data, timing and frequency of data collection, sampling, patient confidentiality, time and cost of data collection, other feasibility/implementation issues *(e.g., fees for use of proprietary measures)*:

NDNQI has learned/modified the nursing hours per patient day measure in a variety of ways.

First, the definition of nursing care hours has been clarified by providing clear description on float staff (hospital employees temporarily assigned to provide direct patient care for all or part of a shift on a unit other than their unit of employment) when reporting their nursing care hours in the NDNQI data collection guidelines.

New description on Float Staff:
"Float nurses can be classified in two groups when reporting NCH: 1) nurses who are assigned away from their home-based unit or 2) nurses who are assigned out of an internal registry (float pool). Floats are assigned on an as needed basis, such as to cover sick time of a unit-based employee. Float staff include RNs, LPN/LVNs and UAPs. Nursing care hours worked by float staff must be counted and reported in the unit's total hours where they provided direct care."

Second, the reporting methods for patient days, a denominator of the nursing care hours per patient day measure, have recently been clarified to better describe in the NDNQI data collection guidelines. In addition, one of options (Midnight census + patient days from average hours for short stay patients), is no longer a reporting option for reporting patient days as starting at the first quarter of 2012.

Third, we periodically provided teleconferences for site-coordinators to educate, update some changes in data collection guidelines, and address issues about the definition of NDNQI quality indicators (e.g., nursing care hours and patient days) and data collection procedures (changes on the data entry fields and the use of data summary report and data error report to verify data before reporting to NDNQI).

Lastly, NDNQI collects nursing care hours data through a secure NDNQI website. We provided data error messages to notify site coordinators that data on nursing care hours or patient days were not entered for all 3 months of a quarter, although it may or may not be an error.

Overall, to what extent was the criterion, *Feasibility*, met? H☐ M☐ L☐ I ☐
Provide rationale based on specific subcriteria:

OVERALL SUITABILITY FOR ENDORSEMENT

Does the measure meet all the NQF criteria for endorsement? Yes☐ No☐
Rationale:

If the Committee votes No, STOP.
If the Committee votes Yes, the final recommendation is contingent on comparison to related and competing measures.

5. COMPARISON TO RELATED AND COMPETING MEASURES

If a measure meets the above criteria and there are endorsed or new related measures (either the same measure focus or the same target population) or competing measures (both the same measure focus and the same target population), the measures are compared to address harmonization and/or selection of the best measure before a final recommendation is made.

5.1 If there are related measures *(either same measure focus or target population)* or competing measures *(both the same measure focus and same target population*), list the NQF # and title of all related and/or competing measures:

0190 : Nurse staffing hours - 4 parts
0204 : Skill mix (Registered Nurse [RN], Licensed Vocational/Practical Nurse [LVN/LPN], unlicensed assistive personnel [UAP], and contract)

5a. Harmonization

5a.1 If this measure has EITHER the same measure focus OR the same target population as NQF-endorsed measure(s): Are the measure specifications completely harmonized? Yes

5a.2 If the measure specifications are not completely harmonized, identify the differences, rationale, and impact on interpretability and data collection burden:

5b. Competing Measure(s)

5b.1 If this measure has both the same measure focus and the same target population as NQF-endorsed measure(s): Describe why this measure is superior to competing measures *(e.g., a more valid or efficient way to measure quality);* OR provide a rationale for the additive value of endorsing an additional measure. *(Provide analyses when possible)*:
Nurse staffing skill mix and nurse staffing hours - 4 parts are related, not competing measures. Nurse staffing skill mix is also a measure for which the American Nurses Association is the measure steward, and measures a different aspect of nurse staffing. The nurse staffing skill mix is the proportion of nursing hours provided by different types of nursing personnel (RNs, LPNs, and UAPs). There is no additional data collection burden. Therefore, nursing hours per patient day is not considered to be a competing measure with the other two measures (nurse staffing skill mix and nurse staffing hours - 4 parts).

CONTACT INFORMATION

Co.1 Measure Steward (Intellectual Property Owner): American Nurses Association, 8515 Georgia Avenue, Suite 400, Silver Spring, Maryland, 20910

Co.2 Point of Contact: Isis, Montalvo, MBA, MS, RN, isis.montalvo@ana.org, 301-628-5047-

Co.3 Measure Developer if different from Measure Steward: American Nurses Association, 8515 Georgia Avenue, Suite 400, Silver Spring, Maryland, 20910

Co.4 Point of Contact: Isis, Montalvo, MBA, MS, RN, isis.montalvo@ana.org, 301-628-5047-

Co.5 Submitter: Isis, Montalvo, MBA, MS, RN, isis.montalvo@ana.org, 301-628-5047-, American Nurses Association

Co.6 Additional organizations that sponsored/participated in measure development:

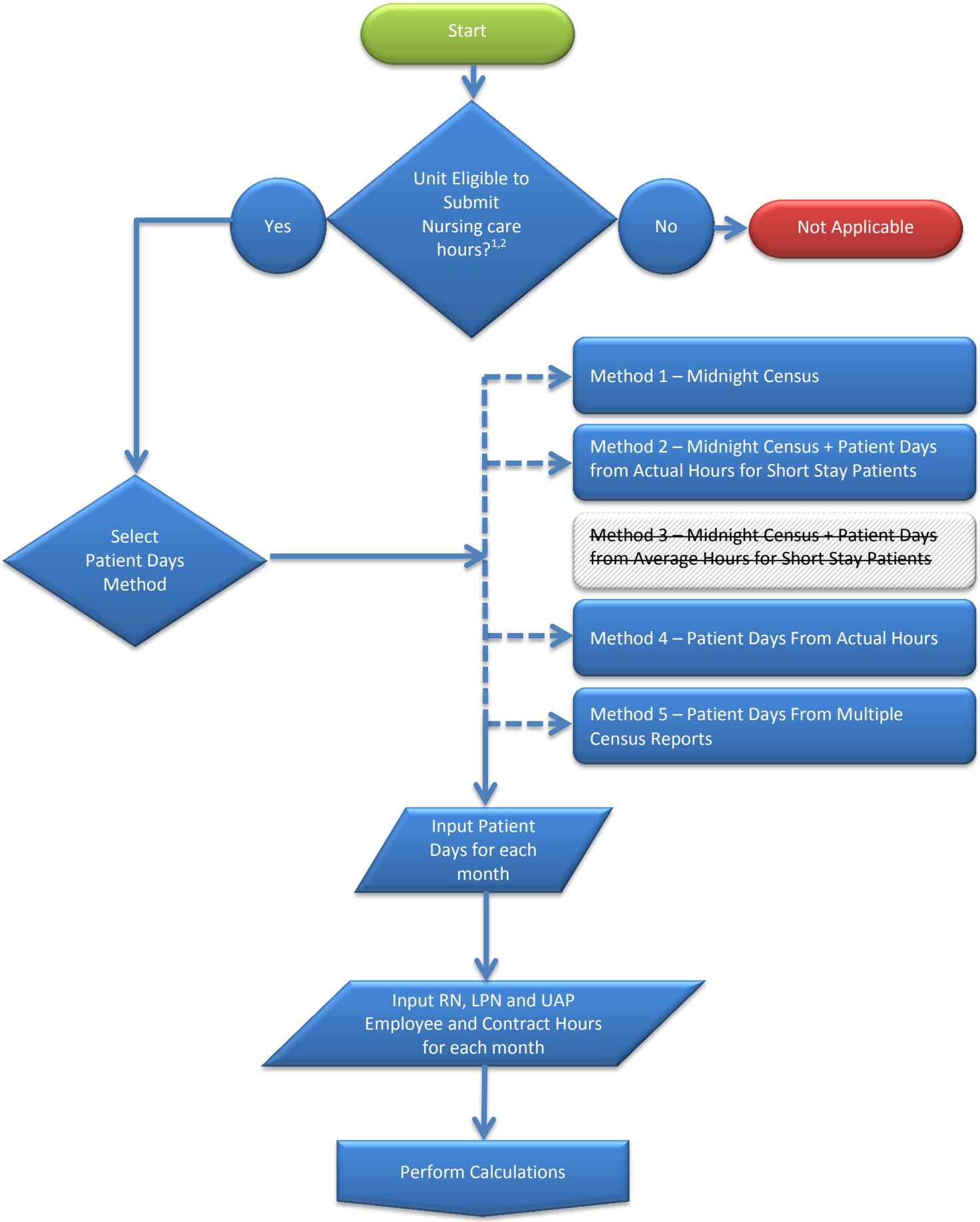
Co.7 Public Contact: Isis, Montalvo, MBA, MS, RN, isis.montalvo@ana.org, 301-628-5047-, American Nurses Association

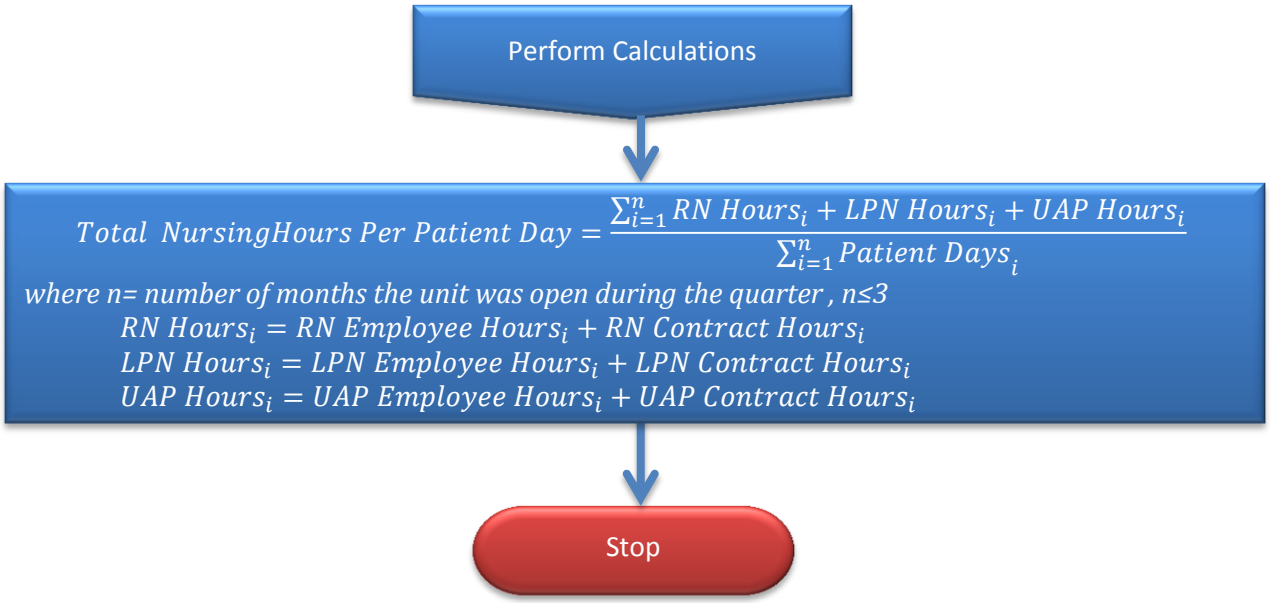
ADDITIONAL INFORMATION

Workgroup/Expert Panel involved in measure development
Ad.1 Provide a list of sponsoring organizations and workgroup/panel members' names and organizations. Describe the members' role in measure development.
The American Nurses Association sponsored the development of the nursing hours per patient day and nursing staff skill mix measures. The Lewin Group was hired by ANA to identify measures that likely were nurse-sensitive. An interview guide was developed and various institutions were selected based on their geographical location and organizational characteristics to provide a nation-wide sample that would include an academic medical center, private hospital, public hospital, urban hospitals, rural hospitals and hospital system. JCAHO,Catholic Health Association, AHA and AHCPR were also contacted to provide broader context. The interviews were conducted with nursing executives, quality specialists and other experts identified by each organization between August 1995 and October 1995. ANA's advisory committee was Rhonda Anderson RN, FAAN, Joanne Disch, PhD, RN FAAN, Gwendolyn Johnson, MA, RN,Clair B.Jordan, MSN, RN, Norma Lang, PhD, RN, FAAN, Pamela Mitchell, PhD, CNRN, FAAN, Margaret Sovie PhD, RN, FAAN, and Mary K.Walker, PhD, RN, FAAN.

Ad.2 If adapted, provide title of original measure, NQF # if endorsed, and measure steward. Briefly describe the reasons for adapting the original measure and any work with the original measure steward:
Measure Developer/Steward Updates and Ongoing Maintenance Ad.3 Year the measure was first released: 1998 Ad.4 Month and Year of most recent revision: 01, 2012 Ad.5 What is your frequency for review/update of this measure? annual updates, with every 3 year reendorsement Ad.6 When is the next scheduled review/update for this measure? 12, 2013
Ad.7 Copyright statement: Copyright 2011, American Nurses Association. All Rights Reserved.
Ad.8 Disclaimers:
Ad.9 Additional Information/Comments:
Date of Submission (*MM/DD/YY*): 04/27/2012

Total Nursing Care Hours per Patient Day Algorithm /Measure Logic Flowchart



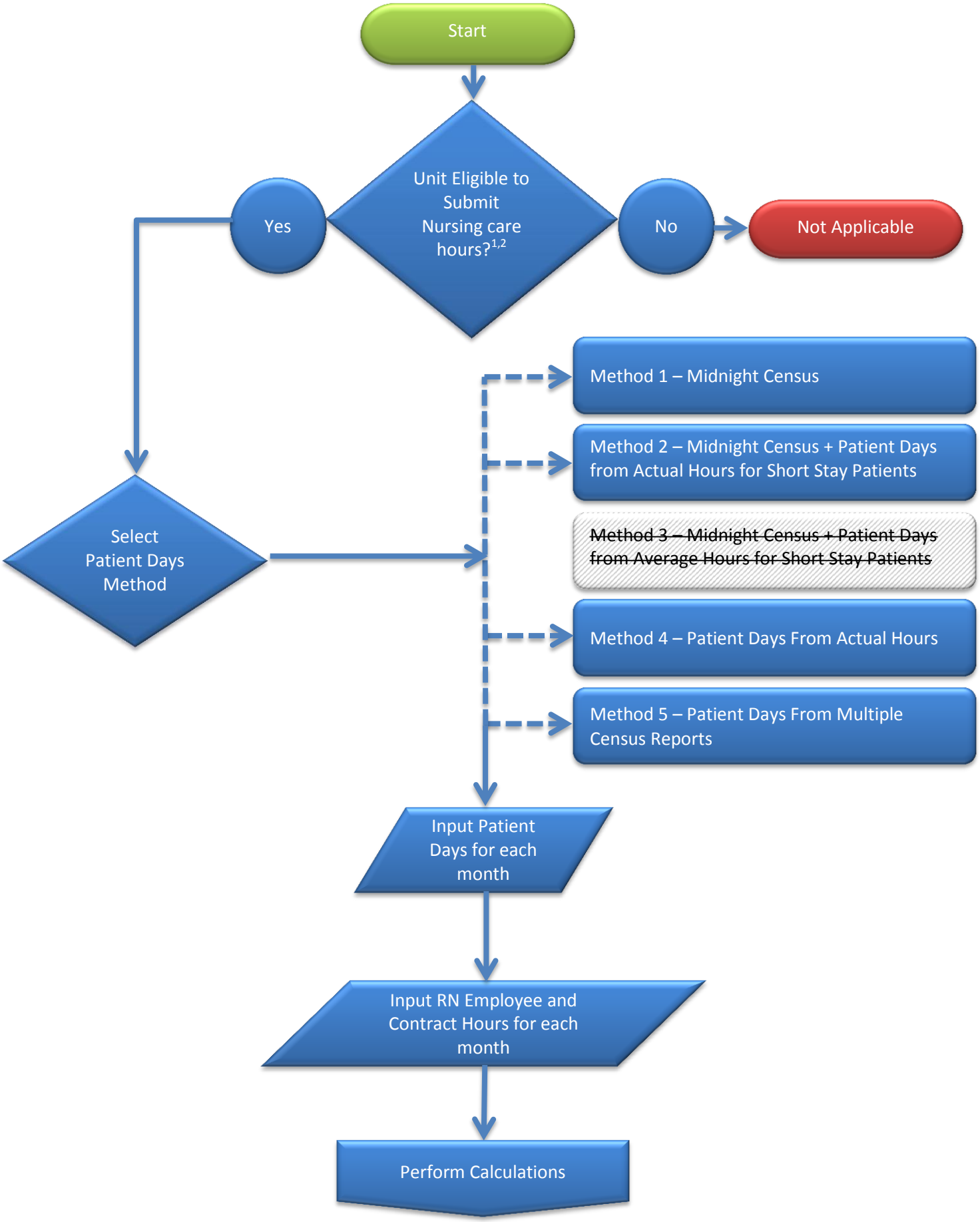


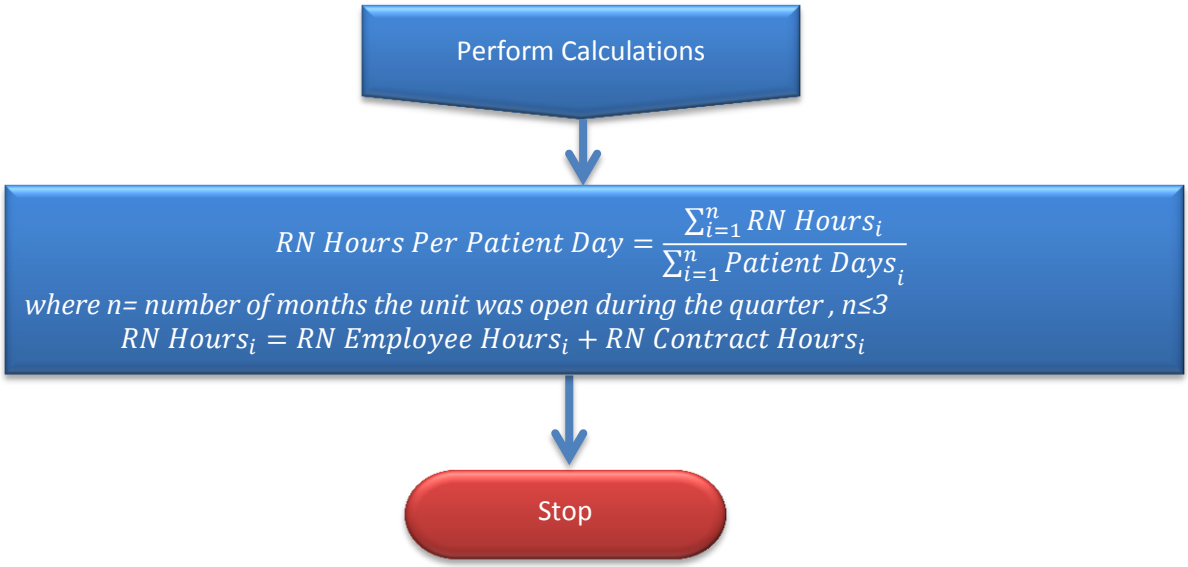
[1]Unit eligibility depends on NDNQI unit type designations. Eligible unit type designations are:

- Level III/IV Critical Care- Neonatal
- Level II Intermediate Care- Neonatal
- Level I Continuing Care- Neonatal
- Well Baby Nursery- Neonatal
- Critical Care- Pediatric
- Step Down- Pediatric
- Medical- Pediatric
- Surgical- Pediatric
- Med-Surg- Combined -pediatric
- Critical Care- Adult
- Step Down- Adult
- Medical- Adult
- Surgical- Adult
- Med-Surg Combined- Adult
- Critical Access - Adult
- Adult - Psychiatric
- Child/Adolescent- Psychiatric
- Geripsych-Psychiatric
- Other (Behavioral Health/Specialty/Multiple Unit Types) – Psychiatric
- Adult- Rehabilitation

[2]Unit must have been open (patients present) at least 1 month during reporting period.

RN Hours per Patient Day Algorithm / Measure Logic Flowchart





[1]Unit eligibility depends on NDNQI unit type designations. Eligible unit type designations are:

- Level III/IV Critical Care- Neonatal
- Level II Intermediate Care- Neonatal
- Level I Continuing Care- Neonatal
- Well Baby Nursery- Neonatal
- Critical Care- Pediatric
- Step Down- Pediatric
- Medical- Pediatric
- Surgical- Pediatric
- Med-Surg- Combined -pediatric
- Critical Care- Adult
- Step Down- Adult
- Medical- Adult
- Surgical- Adult
- Med-Surg Combined- Adult
- Critical Access - Adult
- Adult - Psychiatric
- Child/Adolescent- Psychiatric
- Geripsych-Psychiatric
- Other (Behavioral Health/Specialty/Multiple Unit Types) – Psychiatric
- Adult- Rehabilitation

[2]Unit must have been open (patients present) at least 1 month during reporting period.

Variable Name	Variable Name Label	Value
Hospid	hosptial identification number	
UnitID	unit identification number	
Uyear	year	
Umonth	month	
RHospHrs	RN employee hours	
RCntrHrs	RN contract/agency hours	
LHospHrs	LPN/LVN employee hours	
LCntrHrs	LPN/LVN contract/agency hours	
UHospHrs	UAP employee hours	
UCntrHrs	UAP contract/agency hours	
MHospHrs	mental health technician (MHT) employee hours	psych units only
MCntrHrs	mental health technician (MHT) contract hours	psych units only
PtDayID	Patient Day Reporting Method	1 = Method 1 2 = Method 2 4 = Method 4 5 = Method 5
PDMnCens	Patient Days from Midnight Census	continuous
PDActHrs	Patient Days from Actual Hours	continuous
PatientPopulationDesc	patient population description	1 = Neonatal inpatient 2 = Pediatric inpatient 3 = Adult inpatient 4 = Psychiatric 5 = Rehab inpatient 6 = Other
Xdesignationfid	Unit type	1 = Critical Care Adult 2 = Step Down Adult 3 = Medical Adult 4 = Surgical Adult 5 = Med-Surg Comb-Adult 19 = Critical Care-Pediatric 22 = Level III Neonatal Critical Care 23 = Level II Neonatal Intermediate Care

		24 = Level I Neonatal Contininug Care
		25 = Adolescent Pscyhiatric
		26 = Child Psychiatric
		27 = Geripsych
		31 = Adult Rehab
		34 = Perio-operative
		42 = Adult Psychiatric
		43 = Well Baby Nursery
		47 = Child/Adolescent Psychiatric
		48 = Behavioral Health
		49 = Specilaty Psychiatric
		50 = Multiple Psychiatric Unit Types
		56 = Step Down Pediatric
		57 = Medial Pediatric
		58 = Surgical Pediatric
		59 = Med-Surg Combo Pediatric
		60 = Bone Marrow Transplant
		61 = Critical Access Unit-Adult

Nursing Care Hours: Reliability Study

March 2012

Final Report

JiSun Choi, PhD, RN

Diane Boyle, PhD, RN

Nancy Dunton, PhD

Contents

Introduction

Since the American Nurses Association (ANA) established the National Database of Nursing Quality Indicators® (NDNQI®) in 1998 to facilitate the Patient Safety and Nursing Quality initiatives, the NDNQI has been serving as a data repository to provide unit-level bench-marking reports for member hospitals as well as unit-level data for research. Considering the important role of the NDNQI database, it is essential to collect reliable and valid data on quality indicators from NDNQI member hospitals, including nursing care hours, patient day, and patient falls. Accordingly, the NDNQI periodically evaluates these quality indicators to ensure continued support for reliability. In 2011, the reliability of Nursing Care Hours (NCH) measure was reevaluated. The specific aims of this current investigation were twofold:

Aim 1: To compare nursing care hours measure across two data sources: the NDNQI and the California Office for Statewide Health Planning and Development (OSHPD)

Aim 2: To identify issues related to NCH data collection procedures and to assess the compliance of data collection guideline on the NCH measure.

To accomplish each of these aims, two separate studies were performed and will be presented later in this report.

Background

With the increasing concerns about cost and quality of patient care over the past 2 decades, hospital nurse staffing has become one of major foci in examining health care workforce relationships with patient outcomes. Various staffing measures have been used in studies where investigators examined such relationships. Two nurse staffing measures, nursing hours per patient day (NHPPD) and RN skill mix, were used most frequently (Unruh, Russo, Jiang, & Stocks, 2009). Both measures are endorsed by National Quality Forum (NQF, 2009). Nursing care hours is the key element of these nursing staffing measures. Few published studies were found in which investigators examined the reliability and validity of nursing care hours measures that may affect the estimates of nurse staffing in relation to patient outcomes. Therefore, it is important to establish the reliability and validity of nursing care hours measures.

Reliability Study of Nursing Care Hours by NDNQI

There have been variations in the operational definition of nursing care hours in the literature, including variation in labels, inclusion and exclusion criteria of nursing staff, included hours, and hospital or unit settings. Moreover, these variations are very likely linked to available databases used by researchers. Nursing care hours as defined by NDNQI (2010) is "the number of productive hours worked by nursing staff (RN, licensed vocational/practical nurse [LVN/LPN], and unlicensed assistive personnel [UAP]) assigned to the unit who have direct patient care responsibilities for greater than 50% of their shift." Productive hours refer to actual direct patient care hours worked by nursing staff, not budgeted or scheduled hours. This definition of nursing care hours is considered an acceptable standard as endorsed by NQF (2009). In 2007, the nursing care

hours indicator was the subject of reliability study as part of on-going efforts to improve the quality of NDNQI data. The study was conducted in 2 phases. In the first phase, NDNQI researchers evaluated the compliance of member hospitals with the NDNQI data collection guideline as a way to estimate the reliability of the indicator (Klaus, Dunton, Forbis, & Gajewski, 2008). Findings from phase 1 indicated that the majority of participating hospitals (70%) correctly identified the NDNQI definition of nursing care hours, including inclusion and exclusion criteria for types of care providers. Also, their compliance with NDNQI data collection guideline standards was quite high. Nevertheless, they found that there were some opportunities to improve hospital compliance and suggested several ways to do so. These included encouraging site coordinators to review the guidelines periodically, clarifying the guidelines on the inclusion of unit secretaries, monitor technicians, hours of sitters, and nurses during their orientation period.

In the phase 2, researchers estimated the reliability of the NDNQI NCH measures by calculating and comparing nursing care hours values from two separate raters (NDNQI staff and 11 hospitals; Klaus, Dunton, Forbis, Gajewski, Potter, & Leiker, 2008). Nursing care hours based on the NDNQI definition were calculated by the NDNQI staff using nursing clock hours files directly obtained from the hospitals' electronic sources, and then compared with those calculated by the hospitals. A scatter plot showed a high degree of agreement of nursing care hours from the NDNQI and the participating hospitals. The intraclass correlations (ICCs) for each hospital's nursing care hours were calculated, ranging from .84 to .99. The findings from this inter-rater reliability test provided evidence of the reliability for the NDNQI NCH measure. In the

next section, two separate studies will be described that were conducted for reevaluating the reliability of the NCH measure; first for Aim 1, then Aim 2.

Study for Aim 1

Aim 1: To compare nursing care hours measure across two data sources (the NDNQI and the OSHPD).

Data Sources

The study was designed to assess the consistency of the NCH measure derived from two different data sources (the NDNQI and the OSHPD). The brief overview of the NDNQI and the OSPHD databases is summarized in Table 1. The OSHPD database is one of few data sources containing unit-level nurse staffing data. While the NDNQI® is a proprietary repository of data from voluntary participating hospitals in the United States, the OSHPD database contains data from the mandatory annual final reports of all acute care hospitals licensed by the state of California and is publicly available. Although nursing care hours are defined as productive hours worked by nursing staff in the two databases, inclusion and exclusion criteria in reporting nursing care hours and data reporting interval were different (quarterly report for the NDNQI vs. yearly report for the OSHPD). Unit structure also is defined differently in two databases. While NDNQI classified units by patient population, unit type, and specialty; OSHPD unit types are classified by the cost centers related to nursing care services provided to in-patients on the unit. For example, the NDNQI classified all types of intensive care units caring for adult in-patients, including Burn and Coronary care, into the adult in-patient critical care unit. Each of cost centers classified by the OSHPD was as follows: Medical/Surgical intensive care, Coronary care, Burn care, pediatric intensive care, neonatal intensive care, and other intensive care.

Table 1 Overview of the NDNQI and the OSHPD Data sources

	NDNQI	OHSPD
Level of data	Unit-level	Unit-level
Availability	Proprietary	Public
Hospital	Voluntary. Participating hospitals in the United States licensed by a federal/state agency A hospital is defined to be contiguous configurations of buildings (e.g., "hospitals within a hospital" on separate, non-contiguous campuses are enrolled separately in NDNQI)	Mandatory. All acute care hospitals licensed by the state of California Some hospitals with multiple hospital locations are allowed to operate with a consolidated license and submit a consolidated report (e.g., Kaiser Foundation hospitals)
Data reporting interval	Quarterly report (monthly data in the calendar quarter)	Yearly report by the hospital's fiscal year (e.g., 35TH year [2009-10]: Report ended by June 30, 2009)
Unit structure	Classified by patient population, unit type, and specialty (e.g., Adult in-patient critical care unit [Highest level of acuity] - All types of intensive care units including burn, Medical, cardiothoracic, coronary care, Neurology, Pulmonary, Surgical or Trauma	Revenue-producing cost center related to nursing care services provided to in-patients on the nursing units within the hospital (e.g., Medical/Surgical intensive care, coronary care, burn care, other intensive care)
Definition of Nursing care hours	The number of productive hours worked by nursing staff assigned to the unit with direct patient care responsibility for greater than 50% of their shift * Excluded: vacation, sick time, orientation, education leave, or committee time	Productive hours: total hours actually worked by nursing staff * included: paid time attending meetings & educational activities at or away from the hospital * Excluded: vacation, sick time, on-call time, holidays or other paid time-off

Analytical Data File Construction

There were many challenges in linking the two databases. These included different definition of hospital, different unit structure, and different data reporting interval. First, 50 hospitals in NDNQI and OSHPD were matched based on Medicare provider number, address, and zip code. Of these, 2 hospitals were excluded because they did not have data for the same period of time in 2009. In addition, after a thorough review of the defined unit structure in the two databases (see the bottom of page 5), only critical care units were included for this study as the only unit type category that was consistent across the two databases. However, no detailed information on each reporting unit, such as the name of reporting units and unit bed size, was available. As a result, critical care unit-level data were aggregated at the hospital level. Based on the NDNQI definition of the critical care unit, data on nursing care hours reported from each unit associated with critical care in the OSHPD database were combined into a single value of nursing care hours on the critical care unit type. Included were medical/surgical intensive care, coronary care, burn care, and other intensive care. Finally, data from hospitals in the OSHPD database were reported by their fiscal years because hospitals have different accounting period beginning at different time during the year. Consequently, data reported from hospitals in the OSHPD were not for the same time period. Therefore, monthly nursing care hours data from the NDNQI were extracted for the same period of time in which each hospital in the OSHPD database reported nursing care hours to obtain comparable reference period for nursing care hours data for the sample critical care units included in the study. The NDNQI nursing care hours data were linked to data on nursing care hours in the OSHPD database at the hospital level.

Results

Sample characteristics

A total of 48 NDNQI hospitals comprised the final sample. Table 2 presents a comparison of the characteristics of the NDNQI sample with all California acute care hospitals. Information on Magnet status was not available in the OSHPD database. The majority of sample hospitals were non-teaching hospitals (62.5%) and Non-magnet hospitals (79.2%). Large and teaching hospitals were over-represented in the sample. Sample hospitals with more than 200 beds (62.5%) and teaching hospitals (37.5%) were disproportionately represented compared with all California acute care hospitals (33.2% and 7.3%, respectively).

Table 2 Characteristics of NDNQI Sample Hospitals Compared to All California Acute Care Hospitals

	NDNQI sample hospitals (*N* = 48)	California hospitals (*N* = 316)
Characteristics	%	%
Bed size		
< 100	8.3	34.2
100-199	29.2	32.6
200-299	25.0	15.5
300-399	20.8	9.8
400-499	12.5	3.8
500+	4.2	4.1
Teaching status		
Teaching hospital	37.5	7.3
Non-teaching hospital	62.5	92.7
Magnet status		
Magnet hospital	20.8	n/a
Non-Magnet hospital	79.2	

Note. Data sources: the NDNQI® for the sample hospitals and the OSHPD for the California hospitals. California hospitals refer to comparable and general acute care hospitals licensed by the state of California.

Descriptive statistics on nursing care hours

Descriptive statistics on nursing care hours by data source was presented in Table 3. For this report, average monthly nursing care hours for both NDNQI and OSHPD data were calculated as total nursing care hours in a year divided by 12. Also, separate nursing care hours by different types of nursing staff (RN hours, LPN/LVN hours, and UAP hours) were calculated. All separate nursing care hours based on the definition of the NDNQI were less than those derived from the OSHPD; however, no statistically significant differences were found between the two databases.

Reliability of nursing care hours measure

Intracalss correlations coefficients (ICCs) were calculated from a one-way random-effects ANOVA model to determine the reliability of the nursing care hours measure. As shown in Table 3, reliability coefficients for separate nursing care hours by types of nursing staff were presented with 95% confidence interval. The reliability coefficient above 0.6 is considered to be substantially reliable (Shrout, 1998). All the ICCs reported here were above 0.6, ranging from 0.70 for LPN nursing hours to 0.95 for RN nursing hours. The results indicate that the nursing care hours measure has substantial reliability.

Table 3 Average Monthly Nursing Care Hours by Data Source and Intraclass Correlations for Nursing Care Hours (N = 48)

	NDNQI	OSHPD	Reliability	
Types of nursing staff	M (*SE*)	M (*SE*)	ICC	95% CI
RN nursing hours	13397.8 (1709.7)	15099.1 (1834.5)	.95	.92, .97
LPN nursing hours	6.8 (4.2)	17.8 (7.7)	.70	.53, .82
UAP nursing hours	957.0 (244.2)	1391.5 (312.0)	.71	.53, .82

Study for Aim 2

Aim 2: To identify issues related to NCH data collection procedures and to assess the compliance of data collection guideline on the NCH measure.

Survey of Site Coordinator

For Aim 2, a survey of NDNQI site coordinators was conducted to collect information on compliance with the NDNQI guideline and data collection procedures. The short and voluntary survey was developed by using an online survey tool, Zoomerang. This online survey consisted of 42 items (Appendix A), asking questions about key elements of the NDNQI nursing care hours definition and data collection guideline, data collection-related issues identified by the NDNQI hospital liaisons and statistical analysts, and hospital demographics. The survey and study protocol were approved by the University of Kansas Medical Center Human Subjects Committee. The survey was administered for 4 weeks during October and November, 2011.

Sample

All 1,529 site coordinators of NDNQI member hospitals listed in the NDNQI database were invited to participate in the survey and sent an individual email with a unique link to the survey. Of these, 811 visited the online survey and 441 completed with a response rate of 28.8%. For this current survey, the response rate was low, likely due to a quarterly data submission deadline and the number of surveys sent to site coordinators in 2011. The majority of respondents (94%) were NDNQI site coordinators and they have been, on average, 3 years in this position. However, 25% reported that they have been in the position less than 1 year. Sample hospital characteristics and those of all

NDNQI hospitals are presented in Table 4. The hospital characteristics of the survey respondents are quite similar to those of all NDNQI hospitals in terms of the number of staffed bed and teaching status. Overall, however, large, teaching, and Magnet hospitals tend to be over-represented in this survey. Among the hospitals of survey respondents, the proportion of Magnet hospitals (29.8%) was higher than 22.6% of all NDNQI hospitals.

Table 4 Hospital characteristics

Characteristics	Sample hospitals (%)	All NDNQI hospitals (%)
Bed size		
< 100	19.0	25.9
100-199	26.7	29.5
200-299	22.5	19.6
300-399	12.4	11.2
400-499	6.2	6.5
500+	13.1	7.3
Teaching status		
Academic Medical Center	13.9	10.6
Teaching hospital	38.6	35.7
Non-teaching hospital	47.1	53.7
Magnet status		
Magnet hospital	29.8	22.6
Non-Magnet hospital	70.2	77.4

Note. Data sources: the NDNQI®

Results

In this section, results of the survey will be presented in 2 parts as categorized into current data collection procedures at the survey respondents' hospitals and the compliance with NDNQI data collection guideline on the nursing care hours measure.

Current data collection procedures

Table 5 shows descriptive information on the data preparation and generation procedures at the hospitals of the survey respondents (N = 441). About half of respondents (51.7%) reported that they used an electronic payroll/accounting report as their sole data source to obtain nursing care hours data. Some hospitals (15.2%) used an electronic staffing system only as their data source. Consistent with the findings of the 2007 reliability study (Klaus et al., 2008), 23.6 % of the respondent's hospitals reported that they obtained nursing care hours data from more than one source, such as both electronic payroll and electronic patient acuity systems.

While the majority of respondents (71%) received all separate data by licensure levels and agency/employee hours, the remainder reported that their data were not clearly separated by licensure levels or agency/employee hours. Results indicated that it may not easy for some hospitals to generate data that meet the NDNQI definition of nursing care hours. In addition, findings showed that various groups of staff were involved in the preparation of nursing care hours data to report to NDNQI. Almost a third of respondents (27.2%) reported that staff in several departments, including staff in finance/accounting, nursing management staff, nursing quality staff, and NDNQI site coordinator, work together to generate nursing care hours data. A third of respondents (32.2%) reported staff in finance/ accounting as the sole responsible person for generating nursing care

Table 5 Descriptive information on current data collection procedures of the respondent's hospitals

Sources or procedures of data collection	Response (%)
Source of data	
Electronic payroll/Accounting reports	51.7
Electronic Staffing system	15.2
Electronic Patient Acuity system	2.3
Paper time cards/sheets	2.3
More than one data source	23.6
Other (e.g., excel spread sheet developed)	5.0
Format of data received	
All separate data by licensure levels and agency/employee hours	71
Separate data by only licensure levels and combined agency and employee hours	9
Separate data only into licensed and unlicensed, with LPN hours included in RN hours	8
One aggregated valued of all nursing care hours	6
Other (e.g., No agency with separate data by licensure levels)	7
Responsible person for generating data	
Staff in Finance/Accounting	32.2
NDNQI Site Coordinator	11.7
Nursing management staff	12.2
Staff in Human Resources	3.6
Staff from different departments	27.2
Other (e.g., Nursing administrative support staff)	9.8
Responsible person for entering data	
Staff in Finance/Accounting	3.0
NDNQI Site Coordinator	64.4
Nursing management staff	3.9
Staff in Human Resources	0.2
Staff from different departments	9.5
Other (e.g., Nursing administrative support staff or nursing quality staff)	17.7
Days taken to generate and submit data	
1 day	45
2 days	25
3 days	13
4 days	4
5 days +	13
Data verification before submitting data	
Compared values to earlier quarters	27.2
Review and verified by nurse managers	4.5
Verified by accounting	7.3
Compared against actual clock-hour records	2.7
More than one verification method	28.1
No additional verification	24.5
Use of data cleaning tools	
Data summary report	1.8
Data error report	23.6
Both (data summary report and data error report)	59.2
Never use of both	12.5
Don't know about both	3.0

hours data, followed by nursing management staff (12.2%) and NDNQI site coordinator (11.6%). The majority of respondents (64.4%) reported that NDNQI site coordinator was solely responsible for entering data, with the remainder (17.7%), including nursing administrative support staff, secretary, or nursing quality staff. The majority of hospitals (70%) took a couple of days to generate and submit data to NDNQI. Some hospitals (13%) reported that they needed more than 5 days for the preparation of nursing care hours submitted to NDNQI.

With regard to data verification methods, site coordinators were asked to select all methods they used among the most feasible and valid method options. Although a majority of respondents reported that they verified data using one of the method options in the survey, 24.5% reported that they did not have additional verification processes before submitting data to NDNQI. Verification methods reported included the comparison between current values and values from earlier quarters, nurse manager review, and comparison with actual clock-hour records. The most common verification method was the comparison of nursing hours with those of earlier quarters as selected by 53% of respondents. Almost a third of respondents (28.1%) reported that they used several methods to check whether data were accurate or not. Among two data cleaning tools provided by NDNQI (data summary report and data error report), the majority of respondents (59.2%) reported that they have used both and 23.6% have used only the data error report. Few respondents (3.0%) reported that they did not know about both cleaning tools provided by NDNQI. Some respondents (12. 5%) reported that they never used both data cleaning tools.

Compliance with NDNQI data collection guideline on the nursing care hours

Almost 61% of the respondents reported that they referred to NDNQI guidelines at least once a year and 33% used the guidelines once a quarter or more often. Very few respondents (5%) said that they never referred to the guideline. Compared with results from the 2007 survey in which researchers found that 38% of respondents never referred to the guidelines (Klaus et al., 2008), findings from the current survey showed that the proportion of respondents who never updated on the most recent changes to the NDNQI guideline was significantly low.

Overall, findings showed that the respondent hospitals' compliance with NDNQI definition of nursing care hours were quite high in terms of the types of nursing staff included in reporting nursing care hours. However, the responses to the question on the types of care providers included in the monthly nursing care hours submitted to NDNQI reveal several types of providers defined by the NDNQI to be ineligible for reporting nursing care hours to NDNQI (Table 6).

Table 6 Ineligible staff when reporting nursing care hours to NDNQI

Provider type	Included (%)	Excluded (%)	N/A (%)
Nurse manager	10	85	5
Nursing staff educator	8	81	11
Advanced practice nurse	10	51	38
Unit secretary/clerk	**13**	81	6
Monitor technician	**11**	69	19
Student nurse	2	86	12
Specialized team (e.g., case manager)	3	77	20
Other (e.g., respiratory or physical therapists)	1	89	10

Consistent with results of the 2007 survey (Klaus et al., 2008), however, findings showed that there were some hospitals where two types of staff, unit secretary/clerk (13%) or monitor technician (11%), were still included in reporting nursing care hours. Also, some respondents reported that they included hours worked by nurse mangers (10%), nursing staff educators (8%), or advance practice nurses caring for patients across units (10%) as direct patient care hours. According to the NDNQI guidelines, these care providers should not be included in calculating nursing care hours.

According to NDNQI guidelines, nursing care hours data must be reported by the calendar month. However, some hospitals utilize bi-weekly pay periods. In this case, the hospitals should use an appropriate conversion method for pay periods as instructed by NDNQI. NDNQI provides an example in the guidelines and has pay period conversion tables on the NDNQI website. Methods used by the respondent's hospitals to report nursing care hours were presented in Table 7. The methods approved by NDNQI are showed in bold. The majority of hospitals (72%) reported nursing care hours using the correct methods. Findings showed that some hospitals (17%) still used unaccepted methods to report nursing care hours to NDNQI.

Table 7 Methods for reporting the calendar monthly nursing care hours

Methods	Response (%)
Sum of the daily nursing hours in the calendar month	50
Hours from 2-week pay periods divided using NDNQI guidelines	22
Hours from 2, 2-week pay periods in every month of the quarter	11
Hours from 2, 2-week pay periods in 2 months; 3, 2-week pay period in the 3rd month	1
All quarterly hours summed into a single month	5
Don't know	11

Finally, the respondents were asked about data collection issues identified by NDNQI analysts during the data cleaning process. These issues included nursing hours worked by sitter, newly hired staff during the orientation period, float staff, and estimated nursing hours. Table 8 shows the results of each of cases that are more likely to occur when reporting nursing care hours to NDNQI. Almost half of the respondents (48%) reported that they included sitters when reporting nursing care hours; 31% reported "always included" and 17% reported "sometimes included if they provided direct patient care." Although 23% of the respondent's hospitals used sitters, they did not include their hours because sitter hours were not included in the nursing unit budget. Compared with the results of the 2007 survey (Klaus et al., 2008), more sample hospitals for this study included sitter hours in nursing care hours reporting. In addition, almost half of the respondent's hospitals correctly included nursing hours worked by newly hired staff during their orientation period. Of the respondents who answered a question about nursing hours on the unit with zero census (N = 162), 24% of respondents said that they subtracted the exact nursing care hours during zero patient census period.

Table 8 Frequently identified issues in nursing care hours reporting

Case	Response (%)
Sitter hours	
Never included	45
Sometimes included	17
Always included	31
Don't know	6
Newly hired staff hours	
Once included in the staffing matrix and replaced when calling sick	45
When being capable of taking a full patient load	27
During all phases of orientation, regardless of patient assignment	10
When sharing the responsibility for a patient load with a preceptor	6
After a specified length of time	4
Don't know	7
Float staff hours	
Hours included in the unit that the nurse floated to	78
Clocks in and out on the home unit and the float hours are documented and charged to the receiving unit	10
Always charged to the home unit	2
Other	3
Don't know	7
Nursing hours on the unit with zero census	
Subtract the exact nursing hours during zero census times	9
Subtract an estimate of the nursing hours during zero census time	1
No method to track this	6
All nursing hours on the unit are counted	21
Other	5
N/A	57
***Type of estimating nursing hours (*n* = 42 [9.5%])**	
Estimate a portion of the working time by cross-trained staff	3.9
Estimate the work hours on a unit by teams of ancillary providers	0.5
Estimate direct care hours for charge nurses or nurse managers	4.1
Estimate the work hours for cross-trained staff and charge nurses	1.1

Note. *These are not correct because estimation is generally discouraged to report their nursing care hours to NDNQI.

Conclusions

The NDNQI nursing care hours indicator was reevaluated in 2 separate studies to ensure continued support for reliability. One study (Aim 1) was to assess the consistency of nursing care hours measure across two data sources (the NDNQI and the OSHPD). Although it appears that in the two databases that the overall definition of nursing care hours is the same in regard to productive hours worked by nursing staff, inclusion and exclusion criteria in reporting nursing care hours were different between NDNQI and OSHPD. The discrepancies in nursing care hours were found between the NDNQI and the OSHPD, although there were no statistically significant differences. All separate nursing care hours by different licensure status (RNs, LPNs/LVNs, and UAPs) based on the NDNQI were relatively less than those derived from the OSHPD. However, this comparison was not an ideal approach because it was conducted at the critical care unit type. Further investigation is needed to assess the consistency of nursing care hours at the unit level.

Despite the fact that there are some issues indicating lack of comparability in nursing care hours between two databases due to the different definitions of hospital, units, and nursing care hours, results of the study provide evidence of high reliability for the nursing care hours measure. In addition, there are some distinctions of data, which can affect the results of studies on the relationship between nursing staff and patient outcomes. It appears that the NDNQI nursing care hours measure has higher face validity because the operational definition of nursing care hours by NDNQI is specified to accurately capture the hours worked by nursing staff with direct patient care

responsibility. Moreover, this definition is considered an acceptable standard as endorsed by NQF (2009).

In Aim 2, the nursing care hours were reevaluated using a short and voluntary survey of NDNQI site coordinators in 2 parts: current data collection procedures and compliance with NDNQI guideline. The findings from the study clearly showed that collecting and submitting nursing care hours based on the NDNQI definition was complex. Some hospitals have challenges in reporting nursing care hours to NDNQI, which require knowledge and effort from all staff involved in a multi-step process for generating data. Considering the notably low response rate of the current study of NDNQI site coordinators, overall findings were similar to those from the previous study in 2007 (Klaus et al., 2008). Results of the current study indicated that the majority of the participating hospitals were highly compliant with the NDNQI data collection guideline for the nursing care hours indicator. Nevertheless, the issues identified in the 2007 report remain. These issues are associated with the inclusion of hours from several types of ineligible staff, including sitters, newly hired staff during orientation periods, unit secretaries, and monitor technicians. Also, the qualitative responses by the survey participants on suggestions to improve the NDNQI definition of nursing care hours referenced problems with including ineligible providers. There may be a need for continuing effort to improve data collection guidelines. These included: better definition of direct patient care hours, a chart to show who is to be included or to be excluded, and a clear definition of care providers (e.g., charge nurse, unit secretary, sitter, and monitor technician). Further investigation on these issues is needed to improve the compliance with the NDNQI data collection guideline. More importantly, a site coordinator for each

participating hospital plays an important role in collecting and reporting data to NDNQI so that a key strategy would be to provide periodical training opportunity for site coordinators to keep high compliance with the data collection guidelines.

References

Klaus, S., Dunton, N., Forbis, D., & Gajewski, B. (2008, January). Nursing care hour reliability study: Phase I report. Kansas City, KS: National Database of Nursing Quality Indicators™.

Klaus, S., Dunton, N., Forbis, D., Gajewski, B., Potter, C., & Leiker, K. (2008, August). Nursing care hour reliability study: Phase II report. Kansas City, KS: National Database of Nursing Quality Indicators™.

National Database of Nursing Quality Indicators. (2010). Guidelines for data collection on the American Nurses Association's National Quality Forum endorsed measures. Retrieved from https://www.nursingquality.org/

National Quality Forum. (2009). NQF-Endorsed® Standards. Retrieved from http://www.qualityforum.org/Measures_List.aspx#k=nursing%2520staff&e=0&st=&sd=&s=n&so=a&p=1&mt=&cs=&ss=

Shrout (1998). Measurement reliability and agreement in psychiatry. Statistical Methods in Medical Research, 7, 301-317.

Unruh, L., Russo, C. A., Jiang, H. J., & Stocks, C. (2009). Measuring up: Are nurse staffing measures adequate for health services research? Advances in Health Care Management, 8, 115-154.

Appendix A

Survey Instrument on Nursing Care Hours and Staff Skill Mix

zoomerang

nursing care hours and staff skill mix

Page 2 - Heading

Nursing care hours and staff skill mix study
Please click on the circle/square that best represents your answer. Your answers will be saved when you click the "Submit Survey" button at the end of the survey. If you are coordinating more than one hospital please answer the questions based on your experience with the hospital that has been in NDNQI the longest. If this is still more than one hospital that joined NDNQI, please pick the hospital with the smallest staffed bed size.

Page 2 - Question 1 - Rating Scale - Matrix

Who uses the NDNQI Quarterly nursing care hours and staff skill mix reports?

	Yes	No
CEO	☐ 1	☐ 2
CNO	☐ 1	☐ 2
Quality improvement office	☐ 1	☐ 2
NDNQI site coordinator/survey coordinator	☐ 1	☐ 2
Nurse managers (department or unit level)	☐ 1	☐ 2
Staff nurses	☐ 1	☐ 2

Page 2 - Question 2 - Rating Scale - One Answer (Horizontal)

How important are the NDNQI Quarterly staffing reports to your hospital's quality improvement efforts?

not at all important	somewhat important	very important
☐ 1	☐ 2	☐ 3

Page 3 - Question 3 - Rating Scale - Matrix

How important are the NDNQI Quarterly staffing reports for the following personnel?

	Not at all important	somewhat important	very important	n/a
CEO	☐ 1	☐ 2	☐ 3	☐ 4
CNO	☐ 1	☐ 2	☐ 3	☐ 4
Quality improvement office	☐ 1	☐ 2	☐ 3	☐ 4
NDNQI Site coordinators/Survey coordinator	☐ 1	☐ 2	☐ 3	☐ 4
Nurse managers (department or unit level)	☐ 1	☐ 2	☐ 3	☐ 4
Staff nurses	☐ 1	☐ 2	☐ 3	☐ 4

Page 3 - Question 4 - Choice - Multiple Answers (Bullets)

Have the NDNQI Quarterly staffing reports been used at your hospital to? (check all that apply)

- ❑ Identify units that have less than adequate staffing levels
- ❑ Identify units in which staffing levels are getting worse
- ❑ Set a goal for improvement in staffing
- ❑ Develop annual or long-term strategic plans on staffing
- ❑ Create a quality improvement strategy
- ❑ Monitor quality improvement initiatives
- ❑ Give quick feedback for staffing requests (e.g., traveling or agency staff)
- ❑ Make a decision about staff adjustment (e.g., floating staff)
- ❑ Other, please specify

.....

Page 3 - Question 5 - Rating Scale - One Answer (Horizontal)

When you have used the NDNQI Quarterly staffing reports for staffing plans, do you feel that you were successful in having adequate staffing to provide quality of care to patients?

not at all	somewhat	very much	n/a
□ 1	□ 2	□ 3	□ 4

Page 4 - Question 6 - Rating Scale - One Answer (Horizontal)

How usable are the NDNQI Quarterly staffing reports for decision-making on staffing?

not at all	somewhat	very much	n/a
□ 1	□ 2	□ 3	□ 4

Page 4 - Question 7 - Rating Scale - One Answer (Horizontal)

How timely are the NDNQI Quarterly staffing reports for decision-making on staffing?

not at all	somewhat	very much	n/a
□ 1	□ 2	□ 3	□ 4

Page 4 - Question 8 - Rating Scale - Matrix

How would you rate your level of confidence in..?

	very low	low	high	very high
The accuracy of the NDNQI Quarterly staffing reports	□ 1	□ 2	□ 3	□ 4
Understanding the NDNQI Quarterly staffing reports	□ 1	□ 2	□ 3	□ 4

Page 4 - Question 9 - Rating Scale - One Answer (Horizontal)

Do you think that staff at your hospital need more training on how to use the NDNQI Quarterly staffing reports?

not at all	somewhat	very much	don't know
☐ 1	☐ 2	☐ 3	☐ 4

Page 5 - Question 10 - Choice - Multiple Answers (Bullets)

What is the source of your nursing care hours and staff skill mix data? (check all that apply)

- ❑ Electronic Patient Acuity System
- ❑ Electronic Payroll/Accounting reports
- ❑ Electronic Staffing System report
- ❑ Paper time cards/sheets
- ❑ Other, please specify

.....

Page 5 - Question 11 - Choice - One Answer (Bullets)

Which best describes the format of your unit nursing care hours data when you receive it?

- ○ All nursing care hours aggregated into one value
- ○ Nursing care hours separated by licensure level but agency and employee hours are combined
- ○ Agency and employee hours are separate, as are the licensure levels of providers
- ○ Hours separated only into licensed and unlicensed, with LPN hours included in with the RN hours
- ○ Other, please specify

.....

Page 5 - Question 12 - Choice - Multiple Answers (Bullets)

Who are the persons who are responsible for generating nursing care hours data? (check all that apply)

- ❑ NDNQI site coordinator
- ❑ Staff in Finance/accounting
- ❑ Staff in Human Resources
- ❑ Nursing management staff (department or unit level)
- ❑ Other, please specify

.....

Page 5 - Question 13 - Choice - Multiple Answers (Bullets)

Who are the persons who are responsible for entering data to submit to the NDNQI? (check all that apply)

- ❑ NDNQI site coordinator
- ❑ Staff in Finance/accounting
- ❑ Staff in Human Resources
- ❑ Nursing management staff (department or unit level)
- ❑ Other, please specify

Page 5 - Question 14 - Rating Scale - Matrix

How many days are taken for generating and submitting staffing data?

	1 day	2 days	3 days	4 days	More than 5 days
Nursing care hours	□ 1	□ 2	□ 3	□ 4	□ 5
Patient days	□ 1	□ 2	□ 3	□ 4	□ 5

Page 6 - Question 15 - Choice - One Answer (Bullets)

What best describes the nursing care hours you submit for quarterly staffing?

- ❍ The hours for two, 2-week pay periods for every month (hours for 4 weeks total) of the quarter
- ❍ The hours for two, 2-week pay periods for two of the months, and 3 pay periods for the 3rd month
- ❍ The hours for a calendar month obtained from a sum of the daily nursing care hours
- ❍ The hours from 2-week pay periods, divided as instructed by NDNQI pay period tables
- ❍ The hours for the entire quarter are summed and entered into a single month
- ❍ I don't know how the hours are calculated

Page 6 - Question 16 - Choice - One Answer (Bullets)

Have you used the NDNQI pay period conversion tables to submit staffing data?

- ❍ Yes
- ❍ No
- ❍ Don't know

Page 6 - Question 17 - Rating Scale - One Answer (Horizontal)

If you have used the NDNQI pay period conversion tables, how useful is it for you to submit data to NDNQI?

not at all	somewhat	very much	n/a
□ 1	□ 2	□ 3	□ 4

Page 6 - Question 18 - Choice - Multiple Answers (Bullets)

Are data verified in the following manner before submitting nursing care hours? (check all that apply)

- ❑ Compared values to earlier quarters
- ❑ Reviewed and verified by nurse managers
- ❑ Verified by accounting
- ❑ Compared against actual clock-hour records
- ❑ No additional verification; entered as received
- ❑ Other, please specify

.....

Page 7 - Question 19 - Rating Scale - Matrix

Have you used the data cleaning tools NDNQI provided?

	Yes	No	Don't know
Data summary report	□ 1	□ 2	□ 3
Data error report	□ 1	□ 2	□ 3

Page 7 - Question 20 - Rating Scale - One Answer (Horizontal)

If you have used the data summary report, how useful is it for you to perform data cleaning?

not at all	somewhat	very much	n/a
□ 1	□ 2	□ 3	□ 4

Page 7 - Question 21 - Rating Scale - One Answer (Horizontal)

If you have used the data error report, how useful is it for you to perform data cleaning?

not at all	somewhat	very much	n/a
□ 1	□ 2	□ 3	□ 4

Page 7 - Question 22 - Rating Scale - One Answer (Horizontal)

How often do you have to do manual adjustments to the data before submitting to the NDNQI?

Never	Infrequent	Frequent	Very frequent
□ 1	□ 2	□ 3	□ 4

Page 7 - Question 23 - Rating Scale - One Answer (Horizontal)

How often do you have to do manual adjustments to the data after submitting to the NDNQI?

Never	Infrequent	Frequent	Very frequent
□ 1	□ 2	□ 3	□ 4

Page 8 - Question 24 - Choice - One Answer (Bullets)

How frequently do you refer to the NDNQI Data Collection Guideline Manual or on-line tutorial regarding the collection and submission of nursing care hours?

- ○ Never
- ○ Once a year or less
- ○ 2-3 times a year
- ○ Once a quarter
- ○ Several times each quarter

Page 8 - Question 25 - Rating Scale - Matrix

Which type of providers who work on the unit are included in the monthly nursing care hours submitted to NDNQI for a given unit?

	yes	**no**	**n/a**
Bedside RN staff nurses employed by the hospital	□ 1	□ 2	□ 3
Bedside RN staff nurses employed by an external agency	□ 1	□ 2	□ 3
Advanced practice RNs that assist in the care of patients across several units and whose hours are estimated for each unit	□ 1	□ 2	□ 3
The charge nurses	□ 1	□ 2	□ 3
The nurse manager	□ 1	□ 2	□ 3
The nursing staff educator	□ 1	□ 2	□ 3
Bedside LPN staff nurses employed by the hospital	□ 1	□ 2	□ 3
Bedside LPN staff nurses employed by an external agency	□ 1	□ 2	□ 3
Any direct nursing care provider that floats in from another unit	□ 1	□ 2	□ 3
The unit secretary/clerk	□ 1	□ 2	□ 3
The monitor technician	□ 1	□ 2	□ 3
Student nurses who are fulfilling educational requirements	□ 1	□ 2	□ 3
Specialized teams that perform specific services on an as needed basis and who either clock in and out of the unit for the time of service or whose time is estimated (e.g., case manager)	□ 1	□ 2	□ 3
Other providers such as a respiratory therapist, social workers, or physical therapists.	□ 1	□ 2	□ 3

Page 9 - Question 26 - Choice - One Answer (Bullets)

When do you count "sitters" in your nursing care hours?

- ○ Never, we do not use sitters
- ○ Never, we use sitters, but do not include them in the nursing budget
- ○ Never, other reason
- ○ Sometimes, only if the sitter provides direct patient care and is paid by the hospital
- ○ Sometimes, other reason
- ○ Always, our sitters are already included in our staffing data because they are always unit-based direct care staff
- ○ Always, other reason
- ○ Don't know

Page 9 - Question 27 - Choice - One Answer (Bullets)

When a new direct nursing care provider is hired for a unit, at what point are her hours counted in the monthly nursing care hours reported to NDNQI?

- ○ When she is capable of taking a full patient load
- ○ When she shares the responsibility for a combined patient load with a preceptor
- ○ After a specified length of time
- ○ Once she is included in the staffing matrix and replaced when calling in sick
- ○ During all phases of orientation, regardless of patient assignment
- ○ Don't know

Page 9 - Question 28 - Choice - One Answer (Bullets)

When nurses "float" from their home units to other units, how are the float hours tracked?

- ○ Float hours are included in the unit that the nurse floated to (nurse clocks in on the receiving unit)
- ○ The nurse clocks in and out on her home unit and the float hours are documented external to the time/attendance system and charged to the receiving unit
- ○ Float hours are not tracked separately, they are always charged to the nurse's home unit
- ○ Don't know
- ○ Other, please specify

.....

Page 10 - Question 29 - Choice - One Answer (Bullets)

If your hospital requires minimum staffing during periods of low census, select the item below that best describes what you do.

- ○ Must always have at least 2 RNs in a unit if any patients are present
- ○ Must have a minimum of 1 RN in a unit if any patients are present, but provide an unlicensed staff or LPN for backup
- ○ Staff with 1 RN in a unit if any patients are present, with nurses from a nearby or

- ○ n/a
- ○ Other, please specify

Page 10 - Question 30 - Choice - One Answer (Bullets)

If your hospital assigns nurse staffing on units with zero census, do you subtract the nursing hours expended during the zero census period from the total nursing care hours before reporting to NDNQI?

- ○ Yes, we subtract the exact nursing care hours expended during zero census times
- ○ Yes, we subtract an estimate of the nursing care hours expended during zero census time
- ○ No, we don't have a method to track this
- ○ No, all nursing care hours on the unit are counted as part of the total unit staffing
- ○ n/a
- ○ Other, please specify

Page 10 - Question 31 - Choice - Multiple Answers (Bullets)

If you estimate any of the nursing care hours on a unit, select the estimates that apply (check all that apply).

- ❑ Estimate a portion of the working time for individuals who are cross-trained (e.g., unit secretary working part of the time as a nurse's aide)
- ❑ Estimate hours for advanced practice nurses that aren't assigned to a particular unit
- ❑ Estimate the work hours on a unit by teams of ancillary providers (e.g., wound care nurses)
- ❑ Estimate direct care hours for charge nurses/or assistant nurse managers that do administrative tasks part of the day and assist and assist with patient care for another part
- ❑ n/a
- ❑ Other, please specify

Page 10 - Question 32 - Rating Scale - Matrix

How difficult is if for you to submit staffing data to the NDNQI?

	very easy	easy	difficult	very difficult
Nursing care hours	□ 1	□ 2	□ 3	□ 4
Patient days	□ 1	□ 2	□ 3	□ 4

Page 11 - Question 33 - Choice - Multiple Answers (Bullets)

If you could improve staffing reports for NDNQI. Which approach would you take? (check all that apply)

- ❑ Provide an online training for site coordinators (and other NDNQI users)

- ❑ Provide more comprehensive guidance in the NDNQI data collection guidelines
- ❑ Revise the definition of nursing care hours
- ❑ Direct upload of electronic file
- ❑ Revise the format of staffing reports
- ❑ Other, please specify

Page 11 - Question 34 - Choice - One Answer (Bullets)

How would you improve the definition of nursing care hours?

- ○ I would not change anything, it just works fine
- ○ I would clarify the definition by modifying the wording (What wording would you use? or please specify any other suggestions)

Page 11 - Question 35 - Choice - One Answer (Bullets)

How would you improve the format of the staffing reports?

- ○ I would not change anything, it just works fine
- ○ I would provide staffing reports by using a different format (What format would you like to use? or please specify any other suggestions)

Page 12 - Question 36 - Open Ended - One Line

How many years has your hospital been a member of NDNQI?

Page 12 - Question 37 - Choice - Multiple Answers (Bullets)

What is your role for the NDNQI? (check all that apply)

- ❑ Site coordinator
- ❑ Survey coordinator
- ❑ Other

Page 12 - Question 38 - Open Ended - One Line

How many years have you been in your current position as a site coordinator or survey coordinator?

Page 12 - Question 39 - Yes or No

Is your hospital currently recognized as a Magnet Hospital by the American Nurses Credentialing Center?

- ○ Yes
- ○ No

Page 12 - Question 40 - Choice - One Answer (Bullets)

Which of the following best describes the teaching status of your hospital?

- ○ Our hospital is an academic medical center. We are the primary clinical training hospital for a School of Medicine
- ○ Our hospital is a teaching hospital, but not an academic medical center. We have medical residents, but are not the primary clinical site for a School of Medicine
- ○ Our hospital is a non-teaching hospital. We do not have medical residents

Page 13 - Question 41 - Choice - One Answer (Bullets)

Identify the number of staffed beds at your hospital.

- ○ 0-24
- ○ 25-49
- ○ 50-74
- ○ 75-99
- ○ 100-199
- ○ 200-299
- ○ 300-399
- ○ 400-499
- ○ 500 or more

Page 13 - Question 42 - Choice - One Answer (Bullets)

Your hospital is classified as a:

- ○ General Hospital
- ○ Critical Access Hospital
- ○ Qualified Swing Bed Hospital
- ○ Long Term Acute Care
- ○ Pediatric Hospital
- ○ Psychiatric Hospital
- ○ Rehabilitation Hospital
- ○ Specialty Hospital—Cardiac
- ○ Specialty Hospital—Oncology
- ○ Specialty Hospital—Orthopedic
- ○ Specialty Hospital—Women and Infant
- ○ Other Specialty Hospital—(not listed above)

Thank You Page

Thank you for participating in this survey. If you have any questions or comments concerning this study please call NDNQI at 913.588.1691. You may click on this text to go to our Home Page. <https://www.nursingquality.org/>

<https://www.nursingquality.org/>

The Online Journal of Issues in Nursing
A Scholarly Journal of the American Nurses Association

The Relationship of Nursing Workforce Characteristics to Patient Outcomes

Nancy Dunton, PhD
Byron Gajewski, PhD
Susan Klaus, PhD, RN
Belinda Pierson, MA

Abstract

Three reports from the Institute of Medicine found that errors in hospital care were more common than previously thought; that health care delivery should be reorganized to improve the quality of care; and that, operationally, nurses have a critical role in securing patient safety. Now the contribution of nursing to the reduction of adverse events must be established empirically, so that nursing-sensitive indicators can be incorporated in such health care-improvement strategies as public reporting of hospital quality and performance-based payment systems. This article reviews what is known from previous nursing outcomes research and identifies gaps in the current state of knowledge. It then describes the contribution to research that can be made through the National Database of Nursing Quality Indicators ™ (NDNQI®). Next it reports an NDNQI study that found three nursing workforce characteristics to be related significantly to patient outcomes: total nursing hours per patient day, percentage of hours supplied by RNs, and years of experience in nursing, and concludes with a discussion of the implications of these findings for both for nursing administrators and outcomes-based, quality-improvement initiatives.

Citation: Dunton, N., Gajewski, B., Klaus, S., Pierson, B., (September 30, 2007) "The Relationship of Nursing Workforce Characteristics to Patient Outcomes" *OJIN: The Online Journal of Issues in Nursing*. Vol. 12 No. 3, Manuscript 3.

DOI: 10.3912/OJIN.Vol12No03Man03

Key words: fall rate, health care quality, National Database of Nursing Quality Indicators, (NDNQI), nurse experience, nurse staffing, nursing hours, nursing outcomes, nursing-sensitive indicators, nursing workforce, outcome indicators, pay for performance, performance measures, pressure ulcer rate, skill mix, staffing ratios, value-based payment

The release of two reports from the National Institute of Medicine (1999, 2001) focused the nation's attention on the quality of hospital care and the problem of patient safety. These reports found that errors in hospital care were more common than the public had realized and recommended that health care delivery be reorganized to improve the quality of care. In response to the reports, federal and state governments, insurers, regulators, and health care providers are implementing health care-indicator initiatives to promote improvement in health care quality. Public reporting of quality indicators can help guide consumer choice among hospitals and assist businesses and insurers make purchasing and reimbursement decisions. However, most of the indicators included in public reporting initiatives reflect medical processes. Moreover, quality incentive programs for hospitals, generally known as pay-for-performance or value-based purchasing, are focused exclusively on physician-driven activities and medical outcomes (Centers for Medicare & Medicaid Services [CMS], 2007a). Under these programs, hospitals demonstrating good outcomes and efficient health care practices receive incentives, such as higher reimbursement rates, than hospitals with lesser performance. Recently, CMS announced that it will not provide reimbursement for care related to hospital-acquired complications (Centers for Medicare & Medicaid Services, 2007b).

A third report from the Institute of Medicine (2004) stated that, operationally, nurses

have a critical role in securing patient safety. With 2.4 million practicing registered nurses (RNs) in the United States, nursing is the largest of the health care professions. Although nurse staffing and indicators of nursing-sensitive outcomes (patient outcomes that vary in response to changes in nurse staffing) are included in some public reporting initiatives, nursing indicators represent a small proportion of the pool of quality indicators. They are absent altogether from value-based purchasing initiatives. Because nurses are the most prevalent care providers in hospitals, the promotion of health care quality through public reporting and value-based purchasing cannot be comprehensive unless nursing's contributions are incorporated.

Mandating nurse-to-patient staffing ratios is one alternative public policy approach to promoting nursing quality that has been considered by several states and adopted by at least one. The focus on staffing ratios for nursing is consistent with research literature that shows an influence of nursing hours of care on various patient outcomes. However, use of staffing ratios may be an insufficient policy response as to date, literature has been limited in terms of the number of nursing workforce characteristics or attributes available for the study of quality of care. There may be other workforce characteristics that are as influential in promoting quality of care as nurse staffing ratios.

This article reviews what is known from previous nursing outcomes research and identifies gaps in the current state of knowledge. It then describes the contribution to outcomes research that can be made through the extensive data on nursing workforce characteristics available in the National Database of Nursing Quality Indicators (NDNQI). Next it presents findings from a NDNQI study describing the relationship of nursing workforce characteristics to patient fall rates and the rate of hospital-acquired pressure ulcers. The article concludes with a discussion of implications from this study for both nurse administrators and health policy officials involved in outcomes-based, quality-improvement initiatives.

Review of Previous Nursing Outcomes Studies

This section will present the growing body of evidence that describes the relationship between hospital nursing workforce attributes, such as nurse staffing levels, and patient outcomes. Because many of these studies have had significant limitations in conceptual framework, design, and nursing workforce attributes, this section will also discuss the limitations of these studies.

Previous Studies Relating to Workforce Characteristics and Patient Outcomes

The Agency for Healthcare Research and Quality (AHRQ) recently published a comprehensive and systematic review of the literature on the relationship between workforce characteristics, such as nursing hours and ratios, and patient outcomes (Kane, Shamliyan, Mueller, Duvai, & Witt, 2007). The AHRQ review identified 97 observational studies published between 1990 and 2006 and included 94 of these reports in a meta-analysis. This meta-analysis found strong and consistent evidence that higher registered nurse (RN) hours were related to lower patient mortality rates, lower rates of failure to rescue, and lower rates of hospital-acquired pneumonia. There was evidence that higher, direct care RN hours was related to shorter lengths of stay. Higher total nursing hours also were found to result in lower hospital mortality and failure to rescue rates, and in shorter lengths of stay. Based on fewer studies, the review found evidence that the prevalence of baccalaureate-prepared RNs was related to lower hospital mortality rates, that higher RN job satisfaction and satisfaction with workplace autonomy were related to lower hospital mortality rates, and that higher rates of nurse turnover were related to higher rates of patient falls. The conclusion of the meta-analysis was that higher nurse staffing was associated with better patient outcomes, but that the association was not necessarily causal. Further, the associations varied by service line and unit type.

A recent study by Needleman, Buerhaus, Stewart, Zelevinsky, and Soeren (2006) demonstrated the business case, i.e. the cost effectiveness, for increasing the proportion of nursing hours supplied by RNs, without increasing total nursing hours. The cost of increasing RN's proportion of nursing hours was **less** than the **cost** that would have resulted from adverse events, such as failure to rescue, urinary tract infections, hospital-acquired pneumonia, upper gastrointestinal bleeding, shock, and cardiac arrest. More than 90 percent of the cost savings was associated with reduced length of stay.

Limitations of Previous Studies

Significant gaps remain in nursing outcomes research literature. These gaps need to be addressed to strengthen the case for including nursing quality indicators in public reporting and value-based purchasing initiatives and to provide guidance to nurse executives regarding staffing models. Work is needed in the specification of theoretical or conceptual models, including the analysis of unit-level, rather than hospital-level, data. A number of authors have also noted the need to examine additional work-related, structure measures. Finally appropriate data sets for the analysis are also needed. These limitations are addressed in the following sections.

Conceptual framework limitations. Nursing outcomes research typically is based on Donabedian's (1988, 1992) conceptual framework, or derivations thereof, in which the

structure of care influences the processes of care, and both in turn influence the outcomes of care. Because this framework supports many variations in actual model specification, many different organizational characteristics have been investigated. For example, different nursing workforce characteristics have been used as measures of the structure of hospital care; and the outcomes of a variety of different health conditions have been studied.

The Donabedian framework implies a hierarchical analysis model, in which patients are embedded in hospital units that have both structural characteristics and processes, and units are embedded within hospitals that have both structural characteristics and processes. Only a few studies, particularly studies published since the 1990s, had access to datasets that supported a hierarchical analysis. Failure to use a hierarchical model of analysis results in mis-estimation of the relationship between nursing workforce characteristics and patient outcomes. Harless & Mark (2006) demonstrated that relationships in many previous research studies may have been attenuated by having access only to hospital-level nurse staffing data and not unit level data.

It is important to note that some valuable studies have used the hospital service line (e.g., medical or surgical patients) as the unit of analysis (Needleman et al. 2001). In a different approach Whitman, Kim, Davidson, Wolf, and Wang (2002) have argued for the patient care unit, including unit specialty, as the unit of analysis because it is the operational level with the responsibility for care. A few authors have actually used the patient care unit as the unit of analysis (e.g., Blegen, Goode & Reed, 1998; Dunton, Gajewski, Taunton & Moore, 2004). Studies with data for service lines or unit types have demonstrated that specific aspects of the nursing workforce may be significant for some service lines or unit patient outcomes and not for others (e.g. Needleman et al., 2006).

Nursing workforce characteristic limitations. Although most previous research on the relationship between nursing workforce characteristics and patient outcomes has used nursing hours or patient-to-nurse ratios, a few studies have examined other characteristics, such as education, job satisfaction, or turnover. Work-related structure measures for which researchers have recommended further research include organizational factors, such as those affecting nursing processes (Mick & Mark, 2005), measures of hospital commitment to quality (Kane, et al., 2007), measures of longer-term organizational strategies and processes (Covaleski, 2005), and measures of hospital leadership (Bradley et al., 2006).

Data quality limitations. Additional measures of characteristics of the nursing workforce, such as measures of nursing processes, are needed, as are improvements in data quality, including larger sample size, reduced bias, and reduced measurement error. However, the nursing workforce should simultaneously be characterized in terms of supply (hours); knowledge, expertise, and experience; job satisfaction; and fitness (fatigue). Theoretically based measures of nursing processes, such as assessment, surveillance and monitoring, nursing interventions, communication with other health care providers, and patient education, should also be included in analyses.

The data available for nursing outcomes research have generally come from three types of sources. First, analysts have used large national data sets, such as hospital discharge abstracts or Medicaid costs reports, and matched those with nurse staffing data from selected states. Generally, such data sets are limited to information for the largest states and do not have data at the unit level. As a consequence, measures of the nursing workforce cannot distinguish between nurses in direct patient care or those involved in administrative or outpatient activities. While these data sets have information on a large number of patient outcomes, the nursing workforce indicators are quite limited. Second, analysts have obtained data from individual states or subsets of hospital surveys, administrative data, or hospital primary data collections. The California Nursing Outcomes Coalition Database and the Veterans Administration Nursing Outcomes Database are good examples of datasets that have unit-level information on both a variety of nursing workforce characteristic and patient outcomes for a subset of the nation's hospitals. Third, some analysts have collected data from convenience samples of a small number of hospitals to which they have access. It is questionable whether findings from these convenience-sample studies can be generalized to larger populations.

Finally, most studies are based on cross-sectional data sets. These data sets do not allow the analyst to study trends or estimate lagged effects. Understanding these trends or lagged effects could contribute to a causal understanding of the relationship between nursing indicators and patient outcomes.

In summary, advancing our knowledge of the relationship between nursing workforce attributes and patient outcomes will come from the use of data sets which support hierarchical analyses; additional attributes of the nursing workforce; unit-level data; and large, representative, longitudinal data sets.

NDNQI as a Data Resource for Nursing Outcomes Research

The American Nurses Association (ANA) established the National Database of Nursing Quality Indicators (NDNQI) in 1998 with the twin goals of (a) providing acute care

hospitals with comparative information on nursing indicators that could be used in quality improvement projects, and (b) developing a database that could be used to examine the relationship between aspects of the nursing workforce and nursing-sensitive patient outcomes (National Database of Nursing Quality Indicators, n.d.). The NDNQI was developed in a way that addresses many of the limitations encountered by researchers working with other data sets as described above. The NDNQI will support hierarchical models of multiple nursing workforce indicators and patient outcomes. It is a large, longitudinal database, with unit-level data and national, although not representative, coverage. The next section will discuss strengths, limitations, and data collection methods of the NDNQI.

Strengths of NDNQI

NDNQI is a large database. Over 1,100 hospital report quarterly data on nursing workforce characteristics, including process measures, and patient outcomes. NDNQI also conducts an annual RN survey, which collects additional information on nursing workforce characteristics. In 2006, over 175,000 RNs responded to the survey.

NDNQI is a longitudinal database. Data were first reported to NDNQI for the third quarter of 1999 by 23 hospitals, and the number of reporting hospitals has grown steadily over the ensuing 31 quarters. The RN Survey data have been collected annually since 2002.

Data are collected for eight unit types: critical care, step down, medical, surgical, combined medical-surgical, rehabilitation, pediatric, and psychiatric. RN Survey data are collected for all hospital unit types, including outpatient and interventional units.

NDNQI contains many structure, process, and outcomes indicators. Measures of hospital structure include staffed-bed size, ownership, metropolitan/rural location, teaching status, and Magnet status. Measures of unit structure include unit type and over two dozen characteristics of the nursing workforce, including but not limited to: nursing hours per patient day (total, RN); skill mix; contract staff nursing hours; RN education; certification; years of experience in nursing; percent of RNs that float; shift type; intent to stay on the job; opinion on quality of care provided on the unit; RN satisfaction with RN to RN communication, with RN to MD communication, and with professional development; and RN age. Measures of nursing process include percent of patients with a risk assessment and, for those at risk, whether a prevention protocol was in place. Outcome measures include the patient fall rate, injury fall rate, hospital-acquired pressure ulcer rate, psychiatric patient injury assault rate, prevalence of pediatric IV infiltration, completeness of the pain assessment cycle for pediatric patients, and restraint prevalence.

Measures of hospital structure include staffed-bed size, ownership, metropolitan/rural location, teaching status, and Magnet status.

Indicators included in NDNQI have good measurement properties. Data are collected on 8 of the 15 National Quality Forum Consensus measures, which have demonstrated reliability and validity. NDNQI conducts a reliability study on an indicator each year; the most recent study on pressure ulcers supported the reliability of NDNQI hospital identification and staging of pressure ulcers (Gajewski, Hart, Bergquist & Dunton, 2007; Hart, Bergquist, Gajewski, & Dunton, 2006). The reliability of satisfaction data from the RN survey is confirmed annually. The average response rate is 64 percent.

Limitations of NDNQI

Hospitals in every state and the District of Columbia participate in NDNQI, but participation is voluntary. Hospitals choose to participate in NDNQI because of their interest in the quality of nursing care and because they have the staff, data, and economic resources to participate. Therefore, NDNQI hospitals are a self-selected sample, and are not representative of all hospitals in the United States.

To better understand the limitations on representativeness of the NDNQI sample, NDNQI hospital characteristics were compared with data from the American Hospital Association's (AHA) Annual Survey. Due to differences in variable definitions and reference time period, however, the comparisons are not definitive. As with the NDNQI, the AHA database relies on self-reported data.

When compared to all hospitals in AHA's 2005 survey, NDNQI hospitals are significantly different on a number of characteristics (Table 1). Although the large sample sizes result in even minor differences achieving statistical significance, many of the characteristics are substantively different as well.

Hospitals of various sizes participate in NDNQI, with 12% having less than 100 staffed beds and 18% having more than 500 beds. On average, NDNQI hospitals were significantly larger than all hospitals in the AHA database. Over 80% of NDNQI hospitals were non-governmental, not-for profit facilities. Fewer NDNQI hospitals were for-profit than all hospitals in the AHA database. Approximately 15% of NDNQI hospitals were

recognized as American Nurses Credentialing Center (ANCC) Magnet facilities, a higher percentage than for all AHA hospitals.

Table 1
NDNQI Hospital Characteristics (2005) Compared With Characteristics of All Hospitals from the American Hospital Association's Annual Survey (2003)

	Percent				
Characteristic	**NDNQI**	**AHA**	**X 2**	**df**	**p-value**
Staffed Bed Size			1001.624	7	<.0001
6-24	0.6	7.3			
25-49	2.4	19.2			
50-99	8.7	22.2			
199-199	21.4	23.7			
200-299	21.8	12.3			
300-399	16.9	6.6			
400-499	10.0	3.3			
500+	18.3	5.4			
Total	100.1	100.0			
Hospital Ownership			352.22	3	<.0001
Government, Non-Federal	10.5	23.8			
Government, Federal	1.6	4.0			
Private, Not for Profit	82.6	53.6			
Investor Owned, For Profit	5.3	18.6			
Total	100.0	100.0			
American Nurses					
Credentialling Center					
Magnet Status			739.221	1	<.0001
Magnet	15.7	2.5			
Non-Magnet	84.3	97.5			
Total	100.0	100.0			

Source: National data come from the American Hospital Association Annual Survey Database, 2003.

NDNQI Data Collection Methods

After a hospital joins the NDNQI, the facility is assisted by NDNQI staff in correctly classifying its units into unit types. After taking an on-line tutorial and passing quizzes on the key aspects of standardized data collection guidelines, hospital staff may enter their quarterly nurse staffing and patient outcomes data into web-based forms or submit their data through an XML batch upload. NDNQI quarterly data are collected via a secure website. Each hospital uses a code and password for access to the NDNQI system. Permissions for all hospital users except the site coordinator are reset quarterly. The website provides hospitals with data review tools, error reports, and immediate feedback on a number of common data entry errors. Submitted data are reviewed each quarter by NDNQI statisticians for outliers or significant changes across months in the quarter. Suspected errors are reviewed by hospitals and corrected. If suspected errors are not corrected, the data are deleted. Reports are downloaded from the NDNQI website in PDF and Excel files. Site coordinators in each facility are asked to review their reports for accuracy and completeness and notify NDNQI if they find errors, which are then corrected.

The RN survey data, the source of many nursing workforce characteristics, are collected primarily via a web interface. Each facility is guided through a two month preparation period and given materials, such as announcements and reminder cards, to promote a satisfactory response rate. Hospital survey coordinators have access to a live, web-based, unit-specific response rate, so they can tailor efforts to reach out to collect data from all units. From 2002 through 2006, a few hospitals (<50 per year) in which staff who had limited access to web-linked computers were allowed to collect survey data using paper surveys and Scantron sheets. However, this form of data collection activity was discontinued in 2007. Data are cleaned for illogical and out of range responses prior to report production. For privacy reasons, data are reported only for units with at least five responses and a 50% response rate. Survey reports are downloaded by hospitals via a secure web-connection and survey coordinators are asked to review their reports for apparent errors and report such to NDNQI.

A Study to Assess the Economic Value of Nursing Staff and RNs

A recent study was conducted using NDNQI data to assess the value of nurses in terms of averting patient falls and hospital-acquired pressure ulcers. The analysis file, the analytic approach, and the findings of this study will be described and discussed below. This study was the first NDNQI study to include the workforce characteristic of RN experience. All data were collected under protocols approved by the University of Kansas Medical Center's institutional review board.

Analysis File

Annualized measures were calculated from the quarterly data for the period from July 1, 2005, through June 30, 2006. RN characteristics from the RN survey were matched to quarterly data on staffing and outcomes on the basis of the quarter in which the survey month occurred. The hospital unit was the unit of analysis and included 1,610 critical care, step down, medical, surgical, combined medical-surgical, and rehabilitation units.

Analytic Approach

The analysis proceeded in two phases. First, an exploratory analysis using regression trees examined the relationship between several nursing workforce characteristics and the adverse events of patient falls and hospital-acquired pressure ulcers (HAPUs). The models included five hospital characteristics (staffed bed size, teaching status, metropolitan location, Magnet status, and ownership), six unit types, and 20 nursing workforce attributes. Regression trees sequentially identified independent variables most highly related to the dependent variable, in this case the fall rate or HAPU rate. The regression trees were used to narrow the number of indicators to be included in the formal modeling, comprising the second phase of the analysis. The formal modeling was conducted using mixed linear models, which are hierarchical and account for the dependencies among units within the same hospital. Each patient outcome was related to three hospital characteristics, six unit types, and eight nursing workforce characteristics (Table 2).

Table 2
Hospital and Unit Structure Variables Included in the Analysis of Patient Fall and Hospital Acquired Pressure Ulcer Rates

Hospital Structure	Unit Structure	Patient Outcomes
Staffed Beds • <100 • 100-499 • 500+	Total Nursing Hours per Patient Day	Total Falls per 1,000 Patient Days
Teaching Status	RN Hours Per Patient Day	HAPU Rate

• Academic Medical Center • Other Teaching • Non-Teaching		• Patients with HAPUs per Total Patients Assessed
Magnet Hospital • Yes • No	Skill Mix • Percent of Hours Supplied by RNs	
	Percent of Total Nursing Hours Supplied by Agency Staff	
	Percent of RNs with a National Certification	
	% of RNs with a BSN or Higher Degree	
	Years of Experience in Nursing	
	Mean Job Enjoyment Scale Score	
	Unit Type • Critical Care • Floor combination (step down, medical, surgical and combined medical-surgical) • Rehabilitation	

Findings: Evidence of the Value of Nursing from NDNQI Data

The results indicated that lower fall rates were related to higher total nursing hours (including RN, LPN/LVN, and unlicensed nursing assistants) per patient day, a higher percentage of nursing hours supplied by RNs, and a higher percentage of nurses on a unit with more than 10 years experience in nursing.

- For every increase of one hour in total nursing hours per patient day, fall rates were 1.9% lower.
- For every increase of 1 percentage point in the percent of nursing hours supplied by RNs, the fall rate was 0.7% lower.
- For every increase of a year in average RN experience, the fall rate was 1% lower.
- Fall rates were highest on rehabilitation units and lowest on critical care units.
- Fall rates in Magnet facilities were 10.3% lower than rates in non-Magnet facilities.

To promote the lowest fall rates, nurse managers could simultaneously optimize total nursing hours and both percentage of hours supplied by RNs and RNs with longer experience in nursing. For example, by increasing nursing hours from 6 to 7 hours per patient day, increasing the percentage of hours supplied by RNs from 60% to 70%, and increasing the average experience of RNs by 5 years, the fall rate would, on average, be reduced by 7.7%.

Lower HAPU rates were related to fewer total nursing hours per patient day, a higher percentage of hours supplied by RNs, and a higher percentage of RNs with 10 or more years of experience in nursing.

- For every increase of 1 hour in total nursing hours per patient day, HAPU rates were 4.4% higher. Although the analysis controlled for unit type, which is accepted as a proxy for patient acuity, this anomalous result may indicate inadequate risk adjustment or acuity adjustment. That is, net of hospital size, teaching status, Magnet status, and unit type, units with sicker patients at risk of pressure ulcers may have higher levels of nurse staffing.
- For every percentage point increase in the percentage of nursing hours supplied by RNs, HAPU rates were 0.7% lower.
- For every increase of a year in average RN experience, the HAPU rate was 1.9% lower.
- HAPU rates are highest on critical care units and lowest on the combined floor units, i.e. step down, medical, surgical, and combined medical-surgical units.

Nurse managers could promote the lowest HAPU rates if they would simultaneously increase the percentage of hours supplied by RNs from 60% to 70% and increase the average experience of RNs by 5 years. If managers arranged the staffing in this way, the HAPU rate could be reduced by an average of 11.4%.

Limitations

The findings from this study are limited in two ways. First, the results are generalizeable only to NDNQI facilities, which are self-selected for their interest in nursing quality indicators and their ability to participate in a national database. These facilities are larger, less likely to be for-profit, and more likely to be Magnet facilities than all hospitals in the AHA database. Second, the anomalous relationship between total nursing hours per patient day and HAPU rates suggests that more specific controls for patient acuity or risk should be included in the formal models.

Discussion of Study Implications

The findings from this analysis of the relationship between nursing workforce characteristics and the two patient outcomes of patient fall rates and HAPU rates not only confirmed, but also expanded, previous research insights regarding the importance of nurses in achieving safe patient outcomes. The significant relationship between nursing hours and skill mix and observed fall rates had been established previously. This analysis expanded the list of influential nursing workforce characteristics to include RN experience. Having a higher percentage of experienced RNs on the unit was related both to lower fall rates and lower HAPU rates. The effect sizes of experience were larger than those for skill mix. This particular finding provides salience to the argument that retaining experienced nurses on patient care units is paramount in the provision of high quality nursing care. The significance of RN experience demonstrates the importance of looking beyond nursing hours or patient-to-nurse ratios in the promotion of safe patient outcomes.

...retaining experienced nurses on patient care units is paramount in the provision of high quality nursing care.

The results of this study underscore the importance of including multiple characteristics of the nursing workforce in public reporting of the quality of nursing care. Nursing administrators and managers can apply the results of this study to promote quality of care by incorporating all three characteristics, i.e., nursing hours, skill mix, and experience in hiring and unit staffing decisions. In addition, businesses, insurers, and governments engaged in the design and implementation of value-based purchasing programs can use these findings by enhancing the proportion of nursing staff having greater skill and experience and by increasing the number of nursing hours.

This study also emphasizes the importance of assessing and tracking the quality of nursing care at the patient care unit level.

This study also emphasizes the importance of assessing and tracking the quality of nursing care at the patient care unit level. The odds of an adverse event occurring vary by unit type, reflecting differing patient populations. Future research is needed to determine if the relationships between nursing workforce characteristics and patient outcomes vary across unit type-patient outcome combinations.

Data from NDNQI will be a valuable tool for researchers interested in nursing systems research. The large sample size, unit detail, longitudinal scope, and array of nursing workforce measures will support the examination of many and varied research questions.

Data from NDNQI will be a valuable tool for researchers interesting in nursing systems research.

Conclusion

Characteristics of the nursing workforce have been shown in this article to be important factors promoting the quality of safe and effective hospital care.To be comprehensive, quality improvement initiatives, such as public reporting and value-based purchasing, should incorporate nursing workforce measures. Previous research has demonstrated that nursing hours and RN hours of care are important factors. The study reported in this article has demonstrated that additional characteristics, such as

To be comprehensive, quality improvement initiative...should incorporate nursing workforce measures.

years of experience, also are influential. The broad array of nursing workforce characteristics in the NDNQI database will support many future analyses of the role of nursing in achieving high quality patient care.

Authors

Nancy Dunton, PhD
E-mail: ndunton@kumc.edu

Dr. Nancy Dunton is an Associate Professor in the University of Kansas Medical Centers School of Nursing, with a joint appointment in the School of Medicine's Department of Health Policy and Management. She received a Ph.D. in Sociology from the University of Wisconsin-Madison. Dr. Dunton has been the director of the National Database of Nursing Quality Indicators since it was established in 1998. She has made numerous presentations on NDNQI to nursing groups across the United States and internationally. Dr. Dunton has more than 25 years of experience in helping organizations use outcome indicators in decision making. She has been the principal investigator on more than 20 health and social services research projects.

Byron Gajewski, PhD
E-mail: bgajewski@kumc.edu

Dr. Byron Gajewski is an Assistant Professor at the University of Kansas Medical Center, Schools of Nursing and Allied Health, and member of the Center for Biostatistics and Advanced Informatics. He has a PhD in Statistics from Texas A&M University-College Station. Dr. Gajewski has been an investigator on numerous health services and health behaviors research grants and contracts. He has conducted analyses on NDNQI data since 2002.

Susan Klaus, PhD, RN
E-mail: sklaus@kumc.edu

Dr. Susan Klaus received her PhD in Gerontology from the University of Kansas-Lawrence. She is an Instructor at the University of Kansas Medical Center, School of Nursing. She has been an investigator on the NDNQI project since 2002 and is the director of quarterly data processing

Belinda Pierson, MA
E-mail: belinda_pierson@yahoo.com

Belinda Pierson was a data analyst with the NDNQI project. She has a Master's degree in mathematics.

References

Blegen, M., Goode, C., & Reed, L. (1998). Nurse staffing and patient outcomes. *Nursing Research*, *47*, 43-50.

Bradley, E., Herrin, J., Elbel, B., McNamara, R., Magid, D., Nallamothu, B., et al. (2006). Hospital quality for acute myocardial infarction: Correlation among process measures and relationship with short-term mortality. *Journal of the American Medical Association*, *296*(1), 72-78.

Centers for Medicare & Medicaid Services. (2007a). *CMS Manual System, Pub 100-04 Medicare Claims processing, Change Request 5499.*

Centers for Medicare & Medicaid Services. (2007b). U.S. *Department of Health and Human Services, Medicare hospital value-based purchasing: Options paper. 2nd Public Listening Session*. Washington, DC: CMS.

Covaleski, M. (2005). The changing nature of the measurement of the economic impact of nursing care on health care organizations. *Nursing Outlook*, *54*, 310-316.

Donabedian, A. (1988). The quality of care: How can it be assessed? *Journal of the American Medical Association*, *260*,1743-1748.

Donabedian, A. (1992). The role of outcomes in quality assessment and assurance. *Quality Review Bulletin*, *11*, 356-360.

Dunton, N., Gajewski, B., Taunton, R.L., & Moore, J. (2004). Nursing staffing and patient falls on acute care hospital units. *Nursing Outlook*, *52*, 53-59.

Gajewski, B., Hart, S, Bergquist, S, & Dunton, N. (2007). Inter-rater reliability of pressure ulcer staging: probit Bayesian hierarchical model that allows for uncertain rater response. *Statistics in Medicine, 26*(25), 4602-4618.

Harless, D., & Mark, B. (2006). Addressing measurement error bias in nurse staffing research. *Health Services Research*, *41*, 2006-2024.

Hart, S., Bergquist, S, Gajewski, B, & Dunton, N. (2006). Reliability testing of the national database of nursing quality indicators pressure ulcer Indicator. *Journal of Nursing Care Quality*, *21(3),* 256-265.

Institute of Medicine. (1999). *To err is human: Building a safer health system.* Washington, DC: National Academies Press.

Institute of Medicine. (2001). *Crossing the quality chasm: A new health system for the 21st century*. Washington, DC: National Academies Press.

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

Kane, R. L., Shamliyan, T., Mueller, C., Duvai, S., & Wilt, T. (2007). *Nursing staffing and quality of patient care. Evidence report/technology assessment No. 151* (Prepared by the Minnesota Evidence-based Practice Center under Contract No. 290-0009.) AHRQ Publication No. 07-E005. Rockville, MD: Agency for Healthcare Research and Quality.

Mick, S., & Mark, B. (2005). The contribution of organization theory to nursing health services research. *Nursing Outlook*, *53*, 317-323.

National Database of Nursing Quality Indicators (n.d.). Retrieved June 8, 2007, from www.nursingquality.org/.

Needleman, J., Buerhaus, P., Mattke, S., Stewart, M., & Zelevinsky, K. (2001). *Nurse staffing and patient outcomes in hospitals.* (Contract No. 230-99-0021). Boston: Harvard School of Public Health.

Needleman, J., Buerhaus, P., Stewart M., Zelevinsky, K., & Soeren, M. (2006). Nurse staffing in hospitals: Is there a business case for quality? *Health Affairs, 25*(1), 204-210.

Whitman, G., Kim, Y., Davidson L., Wolf, G., & Wang, S-L. (2002). Measuring nurse-sensitive patient outcomes across specialty units. *Outcomes Management*, *6*(4), 152-158.

Article published September 30, 2007

Related Articles

- **The National Database of Nursing Quality Indicators® (NDNQI®)**
  Isis Montalvo, MS, MBA, RN (September 30, 2007)
- **Using Maslow's Pyramid and the National Database of Nursing Quality Indicators™ to Attain a Healthier Work Environment**
  Lisa Groff-Paris, DNP, RNC-OB, C-EFM; Mary Terhaar, DSNc, RN (December 7, 2010)
- **Mandatory Hospital Nurse to Patient Staffing Ratios: Time to Take a Different Approach**
  John M. Welton, PhD, RN (September 30, 2007)
- **Cost-Utility Analysis: A Method of Quantifying the Value of Registered Nurses**
  Patricia M. Vanhook, PhD, APRN, BC (September 30, 2007)
- **The Costs and Benefits of Nurse Turnover: A Business Case for Nurse Retention**
  Cheryl Bland Jones, RN, PhD, FAAN, Michael Gates, RN, PhD (September 30, 2007)

Research in Nursing & Health, 2010, 33, 413–425

Patient Falls: Association With Hospital Magnet Status and Nursing Unit Staffing

Eileen T. Lake,[1]* Jingjing Shang,[1] Susan Klaus,[2†] Nancy E. Dunton[3‡]**

[1]Center for Health Outcomes & Policy Research, University of Pennsylvania School of Nursing, Claire M. Fagin Hall, 418 Curie Boulevard, Philadelphia, PA
[2]NDNQI Quarterly Processing, University of Kansas School of Nursing, Kansas City, KS
[3]School of Nursing, Department of Health Policy & Management, University of Kansas Medical Center, Kansas City, KS
Accepted 10 July 2010

Abstract: The relationships between hospital Magnet® status, nursing unit staffing, and patient falls were examined in a cross-sectional study using 2004 National Database of Nursing Quality Indicators (NDNQI®) data from 5,388 units in 108 Magnet and 528 non-Magnet hospitals. In multivariate models, the fall rate was 5% lower in Magnet than non-Magnet hospitals. An additional registered nurse (RN) hour per patient day was associated with a 3% lower fall rate in ICUs. An additional licensed practical nurse (LPN) or nursing assistant (NA) hour was associated with a 2–4% higher fall rate in non-ICUs. Patient safety may be improved by creating environments consistent with Magnet hospital standards. Res Nurs Health 33:413–425, 2010

Keywords: patient safety; staffing; hospitals; magnet hospitals; nursing units; patient falls

Despite staff efforts to keep patients safe, some patients fall during their hospital stay. From one to eight patients fall per 1,000 inpatient days depending upon the type of nursing unit (Enloe et al., 2005). Patient falls are one of the eight patient outcomes included in the nursing care performance measures adopted by the National Quality Forum (NQF, 2004, 2009). We theorized that adequate evaluation, support, and supervision of patients by hospital staff can minimize the fall rate. The capacity for staff to evaluate, support, and supervise patients may depend on how a nursing unit is staffed with registered nurses (RNs), licensed practical nurses (LPNs), and nursing assistants (NAs), as well as the proportion of RNs with bachelor's degrees in nursing, specialty certification, or who are hospital employees. We therefore expected that patient fall rates on similar units would differ based on their nurse staffing and their RN composition (i.e., education, certification, and employment status).

The National Database of Nursing Quality Indicators data were supplied by the American Nurses Association. The ANA specifically disclaims responsibility for any analyses, interpretations or conclusions. This study was supported by the National Institute of Nursing Research (R01-NR09068; T32-NR007104; P30-NR005043).

Correspondence to Eileen T. Lake, 418 Curie Boulevard, Philadelphia, PA 19104-4217.
*Associate Professor of Nursing; Associate Professor of Sociology; Associate Director, Center for Health Outcomes and Policy Research.
**Post-Doctoral Fellow.
†Research Instructor; Manager, NDNQI Quarterly Data Processing.
‡Research Professor of Nursing, Secondary Faculty of Department of Health Policy & Management.
Published online 7 September 2010 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/nur.20399

The association between staffing and falls has been examined in several studies with scant evidence of a significant relationship. Few researchers evaluating falls have examined all types of nursing staff, the RN composition or considered the hospital's Magnet® status. Better understanding of the multiple factors that influence patient safety may assist hospital managers in making evidence-based recruitment and staffing decisions and encourage consideration of the potential benefits of Magnet recognition.

The purpose of this study was to examine the relationships among nurse staffing, RN composition, hospitals' Magnet status, and patient falls. We studied general acute-care hospitals, hereafter referred to as ''general hospitals.'' Our results may advance the understanding of how to staff nursing units better and support nurses to promote patient safety.

BACKGROUND

This study builds on a theoretical foundation, a decade of empirical literature, and a unique national database—the National Database of Nursing Quality Indicators (NDNQI®)—designed to measure nursing quality and patient safety. We outline these components before describing our methods.

Theoretical Framework

Our research was guided by a theoretical framework first presented by Aiken, Sochalski, and Lake (1997) that linked organizational forms such as Magnet hospitals and dedicated AIDS units through operant mechanisms including nurse autonomy, control, and nurse-physician relationships, to nurse and patient outcomes. Lake (1999) modified the framework to specify two dimensions of nursing organization: nurse staffing (i.e., the human resources available) and the nursing practice environment (i.e., the social organization of nursing work). In terms of nurse staffing, Lake hypothesized that more registered nurses (RNs), both per patient and as a proportion of all nursing staff, would result in better outcomes for both nurses and patients. The nurse staffing dimension has evolved to detail the composition of the RN staff such as level of education and specialty certification.

The two organizational factors examined in this study are nurse staffing and Magnet status. The American Nurses Credentialing Center developed the Magnet Recognition Program® in 1994 to recognize health care organizations that provide nursing excellence (American Nurses Credentialing Center, 2009). Currently, of roughly 5,000 general hospitals in the U.S., over 350 or 7% have Magnet recognition.

We theorized that adequate evaluation, support, and supervision of patients to prevent falls depend on having a sufficient number of well-educated and prepared RNs as well as sufficient numbers of LPNs and NAs (we use NA to refer to all nursing assistants and unlicensed assistive personnel). The relationships between staffing and Magnet status with patient falls are presumed to operate through evaluation, support, and supervision, which were not measured in this study. We considered the evaluation component to pertain principally to the RN role. Adequate patient evaluation would be influenced by nurse knowledge, judgment, and assessment skills, which may vary according to nurse education, experience, certification, and expertise. We attributed the supervision role predominantly to RNs and LPNs, and the support role to NAs. Patient supervision and support would be directly influenced by staff availability, measured here as hours per patient day (Hppd).

To explore multiple aspects of staffing for this study we considered all nurse staffing measures available in the NDNQI. The database did not contain measures of nurse experience or expertise. Because the relative importance of nursing evaluation, support, and supervision in the prevention of falls is unknown, and because different types of staff may play different roles in fall prevention, we examined Hppd for RNs, LPNs, and NAs separately.

Literature Review

Patient falls in hospitals have been a focus of outcomes research to assess the variation in patient safety across hospitals and explore whether nurse staffing may be associated with safety. Lake and Cheung (2006) reviewed published literature through mid-2005 and concluded that evidence of an effect of nursing hours or skill mix on patient falls was equivocal. Subsequently, six studies of nursing factors and patient falls were published using data from California (Burnes Bolton et al., 2007; Donaldson et al., 2005), the US (Dunton, Gajewski, Klaus, & Pierson, 2007; Mark et al., 2008), Switzerland (Schubert et al., 2008), and England (Shuldham, Parkin, Firouzi, Roughton, & Lau-Walker, 2009).

In the US, Donaldson et al. (2005) and Burnes Bolton et al. (2007) investigated whether staffing

improvements following the California staffing mandate were associated with improved patient outcomes in 252 medical-surgical and stepdown nursing units in 102 hospitals. The nursing factors studied were total nurse staffing, RN and licensed staffing levels, and skill mix. No significant changes in falls were found for the period 2002–2006. In cross-sectional data they detected nonsignificant trends linking staffing level to falls with injury on medical-surgical units and falls on stepdown units. Dunton et al. (2007) studied a subset of units in hospitals who reported data to NDNQI ($n = 1{,}610$) from July 2005 to June 2006. Calculating annualized measures from quarterly data and controlling for hospital size, teaching status, and six nursing unit types, Dunton et al. found a statistically significantly lower patient fall rate (10.3% lower) in Magnet hospitals. They also found negative associations between the fall rate and three nursing factors: total nursing hours, RN skill mix, and RN experience. Negative associations are consistent with the theoretical assumption that more nursing hours, a greater fraction of RN hours of total hours, and more RN experience could minimize the fall rate. Mark et al. (2008) studied unit organizational structure, safety climate, and falls in 2003 and 2004 data from 278 medical-surgical units from a nationally representative sample of 143 hospitals. They controlled for the nursing unit's average patient age, sex, and health status and found that units with a high capacity (i.e., a high proportion of RNs among total nursing staff and a high proportion of RNs with nursing baccalaureate degrees) and higher levels of safety climate had higher fall rates. They did not find significant direct effects of unit capacity or safety climate on the fall rate. They speculated that higher unit capacity may mean fewer support personnel are available to assist patients with toileting or other daily activities.

In Europe, findings from Schubert et al.'s (2008) study of 118 Swiss nursing units in 2003–2004 showed that rationing of care, the principal independent variable, was positively associated with falls. Staffing and the practice environment were not significant predictors, perhaps because they operate through rationing. Shuldham et al. (2009) studied staffing, the proportion of staff who was permanent employees, and patient falls in two English hospitals in 2006–2007. They reported null findings and noted that the study may not have been sufficiently robust to detect significant associations.

In summary, recent findings reveal a lack of association between staffing and falls in data from California, Switzerland, and England with the exception of Dunton et al. (2007) who identified significant negative relationships in a U.S. sample. In each of these studies, RN-only hours or total nursing hours combining RN, LPN, and NA were used. The influence of nursing hours from LPN or NA staff on patient falls has not been studied separately.

NDNQI Database Overview

The NDNQI, a unique database that was well-suited to our study aims, is part of the American Nurses Association's (ANA) Safety and Quality Initiative. This initiative started in 1994 with information gathering from an expert panel and focus groups to specify a set of 10 nurse-sensitive indicators to be used in the database (ANA, 1995, 1996, 1999). The database was pilot tested in 1996 and 1997 and was established in 1998 with 35 hospitals. Use of the NDNQI has grown rapidly (Montalvo, 2007). In 2009 1,450 hospitals—one out of every four general hospitals in the U.S.—participated in it.

The NDNQI has served as a unit-level benchmarking resource, but research from this data repository has been limited. NDNQI researchers have published two studies on the association between characteristics of the nursing workforce and fall rates (Dunton et al., 2007; Dunton, Gajewski, Taunton, & Moore, 2004). Their more recent study was described earlier. Their earlier study of step-down, medical, surgical, and medical-surgical units in 2002 showed that higher fall rates were associated with fewer total nursing hours per patient day and a lower percentage of RN hours for most unit types. The scope of work on this topic was extended in the current study by: (a) specifying nurse staffing separately for RNs, LPNs, and NAs, (b) using the entire NDNQI database, (c) selecting the most detailed level of observation (month), and (d) applying more extensive patient risk adjustment than had been evaluated previously.

METHODS

Design, Sample, and Data Sources

This was a retrospective cross-sectional observational study using 2004 NDNQI data. These data were obtained in 2006. NDNQI data pertain to selected nursing units in participating hospitals. In conjunction with NDNQI staff, participating hospitals identify units by type of patient population and primary service: intensive care, step-

down, medical, surgical, medical-surgical, and rehabilitation. Our sample contained 5,388 nursing units in 636 hospitals.

Data are submitted to the NDNQI from multiple hospital departments (e.g., human resources, utilization management) either monthly or quarterly. We assembled an analytic file of monthly observations for all nursing units that submitted data for any calendar quarters for the year 2004. Each observation had RN, LPN, and NA nursing care hours, patient days, RN education and certification, a count of the number of reported falls, average patient age, and proportion of male patients. The RN education and certification data were submitted quarterly and assigned to each month in that quarter. Missing quarters of RN education and certification data or months of nursing care hours and patient days data were filled with data from a quarter or month just before or after the missing data. In compliance with the contractual agreement between the NDNQI and participating hospitals, no hospital identifiers (i.e., hospital ID, name, address, or zip code) were included with the data.

Data external to the NDNQI included hospital characteristics from the American Hospital Association (AHA) 2004 Annual Hospital Survey, the Medicare Case-Mix Index (CMI), and the hospital's Magnet status. The AHA has surveyed hospitals annually since 1946. The Annual Hospital Survey is the only survey that details the structural, utilization, and staffing characteristics of hospitals nationwide. Presently the AHA survey database contains 800 data fields on 6,500 hospitals of all types. Missing data are noted as missing, and estimation fields are filled in with estimates based on the previous year or information from hospitals of similar size and orientation (AHA, 2010). The CMI database, a public use file, is released by Medicare annually as part of the rules governing the inpatient prospective payment system (Centers for Medicare and Medicaid Services, 2010). NDNQI staff obtained information from the Magnet website (http://www.nursecredentialing.org/Magnet/facilities.html) on hospital Magnet status. Hospital characteristics, CMI, and Magnet status were merged by NDNQI staff and provided with the de-identified dataset.

Variables

The dependent variable, a patient fall, is defined by the NDNQI as an unplanned descent to the floor, with or without an injury to the patient. The NDNQI data contain the number of falls in a unit during the month, including multiple falls by the same patient in the same month. Only falls that occurred while the patient was present on the unit were counted. Nursing unit fall rates were calculated as falls per 1,000 patient days. A patient day is defined as 24 hours beginning the day of admission and excluding the day of discharge.

The independent variables studied were nurse staffing, RN staff composition, and hospital Magnet status. Nurse staffing was measured as nursing care Hppd. Nursing care hours were defined as the number of productive hours worked by RNs, LPNs, or NAs assigned to the unit who had direct patient care responsibilities for greater than 50% of their shift. Nursing Hppd was calculated as nursing care hours divided by patient days. The nursing Hppd measure is the accepted standard in the nurse staffing and patient outcomes literature, receiving the highest consensus score from a panel of international experts when asked to rate the importance and usefulness of staffing variables (Van den Heede, Clarke, Sermeus, Vleugels, & Aiken, 2007). Hppd by RNs, LPNs, and NAs and fall rates are NQF-endorsed standards.

Measures of RN composition included nurse educational level, national specialty certification, and proportion of hours supplied by agency employee nurses. Nursing educational level was measured as the proportion of unit nurses who have a Bachelor of Science degree in Nursing (BSN) or higher degree. Certification was measured as the proportion of unit nurses who have obtained certification granted by a national nursing organization. Agency staff was measured as the proportion of nursing hours on a unit that were supplied by contract or agency nurses.

Magnet recognition was used to measure a hospital's adherence to standards of nursing excellence, which may translate into greater safety and quality. In the study a hospital was defined as a Magnet if it had been recognized as such for the year 2004.

The control variables were selected to address the differential risk of falling across patients, a major consideration in analysis of falls. Our principal approach was to control for nursing unit type, which clusters patients by case mix and acuity. Additional control variables were the nursing unit's patient age and gender mix, the hospital's Medicare CMI, and hospital structural characteristics. The risk of falling varies by both age and gender—older people and women have a higher likelihood of falling (Chelly et al., 2009;

Hendrich, Bender, & Nyhuis, 2003). To better account for differences in patient characteristics across units, we computed the nursing unit's average patient age and proportion of male patients. These demographic data were obtained from NDNQI quarterly prevalence studies of pressure ulcers. The 2004 CMI was used to measure a hospital's patient illness severity. Measuring the relative illness severity of a hospital's patients is only possible with patient-level data on many hospitals. The only national patient-level hospital data are from hospitals that participate in Medicare. The CMI is the average Diagnosis-Related Group (DRG) weight for a hospital's Medicare discharges. Each DRG's weight is based on the resources consumed by patients grouped into it. Thus, the CMI measures the resources used and implies severity of a hospital's Medicare patients relative to the national average. The nationwide average CMI across 4,111 hospitals in 2006, the earliest year downloadable online, was 1.32 and ranged from 0.36 to 3.14.

Prior researcher have found that both nurse staffing and patient outcomes vary by structural characteristics of hospitals such as ownership, size, teaching status and urban versus rural location (Blegen, Vaughn, & Vojir, 2008; Jiang, Stocks, & Wong, 2006; Mark & Harless, 2007). This variation in staffing and outcomes may be due to variation in patient acuity. If so, models linking staffing to outcomes should control for hospital characteristics as an additional measure of patient acuity. If the staffing variation is unrelated to patient acuity and is instead due to other factors, such as nurse supply in the market area, including these characteristics in multivariate models will not add to variance explained or improve estimation of the independent variable. We included hospital size, teaching intensity, and ownership as control variables. We specified hospital size as less or greater than 300 beds, as this size divided our sample in half. Teaching intensity was specified as non-teaching, minor teaching (less than 1 medical resident per 4 beds), and major teaching (more than 1 medical resident per 4 beds). We classified hospitals as non-profit, for profit, and public. We classified the three Veterans Administration hospitals in the sample as public hospitals because they are government owned.

Analysis

Descriptive statistics were used to summarize the data. To explore staffing patterns in greater depth, we examined the distribution of hours for each type of nursing staff. We evaluated bivariate associations between all nursing factors (RN, LPN, and NA Hppd, RN education, certification, and employment status) and the patient fall rate. Nursing factors found to be statistically significant were analyzed as independent variables in multivariate models. The independent variables were specified at two different levels consistent with their multilevel effects. The Magnet/non-Magnet comparison was at the hospital level. The staffing and RN composition variables' effects were at the nursing unit level.

The dependent variable was fall count, and patient days was the exposure on the right side of the equation. This approach is equivalent to a model with the fall *rate* as the dependent variable. The advantage of analyzing the actual fall count and patient days is that all available information in the data is used for estimation. Because the fall count follows a negative binomial distribution (i.e., its variance exceeds its mean) a negative binomial model was used. Coefficients were estimated using Generalized Estimating Equations (GEE), which take into account repeated measures and clustering (Hanley, Negassa, Edwardes, & Forrester, 2003). GEE corrects the standard errors for the within-hospital clustering in the NDNQI.

We ran four multivariate models. Model 1 used only independent variables. Model 2 added all control variables. Model 1 revealed the initial effect sizes of the independent variables alone. Model 2 showed the final effect sizes accounting for control variables. Four percent of the observations were missing AHA hospital characteristics or Medicare CMI. These observations were included in all models by adding flag variables that excluded them from the estimation of variables they were missing but used their non-missing data otherwise.

Models 3 and 4 were for ICUs and non-ICUs separately. Fundamental differences between ICUs and non-ICUs may result in different patterns of relationships among nursing factors and falls. ICUs have a high level of RN hours and a nearly all RN-level staff. ICU patients may be at lower risk for falling because they are critically ill and frequently sedated. In contrast, non-ICU units (stepdown, medical, surgical, medical-surgical, and rehabilitation) staff with RNs, LPNs, and NAs, and they care for less critically ill patients who are physically able to move enough to fall. Based on Dunton et al. (2004), who found a shift in the relationship direction linking staffing to falls,

we tested for a shift in direction at a certain level of nursing hours; we found a consistent slope across nursing hours.

Because the NDNQI is a benchmarking database, we speculated that the overall nurse staffing may differ from typical general hospitals. Different staffing levels might influence the relationships we detect within the NDNQI vs. those that may be observed in a more typical sample. To explore this sampling implication, we analyzed AHA staffing data to compare US general hospitals to NDNQI hospitals by using *t*-tests.

We followed the recommendations of experts based on recent empirical work to evaluate nurse staffing measures calculated from AHA data (Harless & Mark, 2006; Jiang et al., 2006; Spetz, Donaldson, Aydin, & Brown, 2008). We calculated RN staffing as RN hours per *adjusted* patient day (Hpapd; note the difference in this abbreviation, which indicates that these are adjusted patient days). For the numerator we calculated RN hours for the year from the AHA full time equivalent RNs (RN FTE) multiplied by 2,080, which is the number of work hours in 1 year (40 hours per week × 52 weeks). The RN FTE variable includes RNs in acute, ambulatory, and long-term care. For the denominator we chose adjusted patient days to match the service areas of the numerator. To incorporate outpatient services, the AHA adjusts patient days by the ratio of outpatient to inpatient revenue. There are limitations in these AHA data, and results should be interpreted with caution. Harless and Mark (2006) found that the adjusted patient days method was less biased than alternatives but still led to deflated coefficients in multivariate models. Our use was to compare overall staffing across hospital groups. Jiang et al. (2006) compared this staffing measure in a California hospital sample using AHA data and state data, which are considered more accurate. They found greater than 20% difference in nurse staffing values for small, rural, nonteaching, public, and for-profit hospitals. These discrepancies imply that the AHA staffing estimates for NDNQI hospitals would be more accurate than the estimates for hospitals throughout the US because the NDNQI database contains more large, urban, nonprofit, and teaching hospitals.

We speculated further that NDNQI Magnet hospitals may staff at higher levels than NDNQI non-Magnet hospitals. We compared staffing levels at the hospital level using AHA Hpapd data and at the nursing unit level using NDNQI Hppd data.

RESULTS

Descriptive Results

As shown in Table 1, the NDNQI and US general hospitals had similar geographic and teaching status distributions. Compared with general hospitals NDNQI hospitals were more often not-for-profit and had more than 300 beds. Seventeen percent of NDNQI hospitals had achieved Magnet recognition. The average CMI for NDNQI hospitals was 1.65, indicating that NDNQI hospitals cared for more complex Medicare patients than the average hospital. Fifty-seven percent of nursing units were either medical, surgical or medical-surgical units, 24% were intensive care, 15% were stepdown, and 4% were rehabilitation. The average age of patients in these nursing units was 50, and 41% of patients were male.

In 2004, the sample nursing units reported 113,067 patient falls. The observed fall rate across all nursing units was 3.32 per 1,000 patient days (1,000PD). Table 2 shows that falls were most common in rehabilitation units and least common in intensive care units. Most patients (72%) had no

Table 1. Characteristics of NDNQI Hospitals and General Acute Care Hospitals in the US

	NDNQI Hospitals[a] ($n=636$), %	General Acute Care Hospitals[b] ($n=4{,}919$), %
Ownership		
Non-profit	82	60
For-profit	6	17
Public	12	23
Bed size		
<100	8	48
100–299	41	36
300–499	30	11
500+	21	5
Teaching status		
Academic medical center	19	7
Region		
Northeast	21	13
Midwest	31	29
West	14	18
South	34	40

NDNQI, National Database of Nursing Quality Indicators; AHA, American Hospital Association.
Of the 636 NDNQI hospitals, 32 could not be matched to AHA for ownership and bed size. These hospitals are omitted from the percent distribution.
[a]2004 NDNQI Database.
[b]2004 AHA Annual Hospital Survey Database.

injury from their falls; most of the others (23%) suffered a minor injury from the fall. Five percent had a moderate or major fall-related injury.

Overall, most nursing staff hours were provided by RNs: 88% of hours in intensive care (15 out of 17 hours) and 63% of hours in non-intensive care (5 out of 8 hours). NAs provided 2–3 hours of care per patient day; LPNs provided less than an hour of care per patient day. Forty-four percent of RNs had a BSN or higher degree, and 11% of RNs had national specialty certification. Of the six types of units, intensive care units had the highest proportions of nurses with a BSN or higher degree (52%) and certification (15%). Four percent of RN hours were provided by agency staff.

Table 2 also displays the nursing hours for different unit types. RN Hppd ranged from 14.8 for intensive care to 4.0 for rehabilitation. Conversely, average LPN and NA Hppd were highest for intensive care and lowest for rehabilitation. Both LPN and NA Hppd were normally distributed. RN Hppd exhibited a bimodal distribution.

Figure 1 shows that most units were staffed so that RN Hppd were either about 5 hours or about 15 hours. The units with over 10 RN Hppd were primarily ICUs (84%). As shown in Table 2, units with more RN hours had fewer LPN and NA hours. This relationship changes direction at the point of 2 NA Hppd (see Fig. 2), which reflects the ICU and non-ICU patterns observed in Table 2. The line superimposed on the scatter plot of Figure 2 is a locally weighted regression line of NA Hppd on RN Hppd.

Bivariate Results

Nursing staff hours and hospital Magnet status were significantly associated with the fall rate. RN Hppd were negatively associated with the fall rate; conversely, LPN and NA Hppd were positively associated with the fall rate: $r = -.29$ for RN Hppd, .12 for LPN Hppd, and .10 for NA Hppd ($p < .001$). The average fall rates were 8.3% lower in Magnet hospitals as compared to non-Magnet hospitals: 3.11 and 3.39 per 1,000PD, respectively ($t = 7.99$; $p < .001$). These rates were aggregated from the participating nursing units, and may reflect differing subsets of unit types in the Magnet and non-Magnet hospital subgroups. Elements of RN staff composition—proportions of BSNs, specialty-certified nurses, and agency nurse hours—were not significantly associated with the fall rate. These RN staff composition elements were excluded from multivariate analyses.

Multivariate Results

Table 3 displays incident rate ratios (IRRs) estimated from the negative binomial model using GEE. The IRR is the expected change in the incidence of the dependent variable with one unit change in the independent variable holding all other model variables constant. Hospital Magnet recognition was negatively associated with patient falls. The likelihood of falls was 5% lower in Magnet hospitals (IRR = 0.95), which is equivalent to a 5% lower fall rate. At the nursing unit level, all types of nursing staff hours were significantly associated with patient falls, but in different directions; the directions were consistent with their bivariate patterns. RN hours were negatively associated with falls; an additional hour of RN care per patient day reduced the fall rate by 2%. LPN and NA hours had positive relationships with falls; an additional hour of LPN care increased the fall rate by 2.9% and an

Table 2. Nursing Staff Hours Per Patient Day (Hppd) and Fall Rate by Nursing Unit Type

Nursing Unit Type	% ($n = 5{,}388$)	Staff Hppd: RN, Mean (*SD*)	Staff Hppd: LPN, Mean (*SD*)	Staff Hppd: NA, Mean (*SD*)	Falls per 1,000PD[a], Mean (*SD*)
ICU	24	14.84 (3.06)	0.13 (0.51)	1.67 (1.47)	1.38 (2.79)
Stepdown	15	7.03 (2.29)	0.39 (0.68)	2.51 (1.24)	3.35 (3.32)
Medical	19	5.11 (1.65)	0.55 (0.76)	2.39 (0.98)	4.51 (3.45)
Surgical	14	5.22 (1.50)	0.58 (0.74)	2.38 (1.01)	2.79 (2.71)
Med-surg	24	5.04 (1.68)	0.65 (0.87)	2.39 (1.06)	3.93 (3.42)
Rehab	4	4.02 (1.47)	0.75 (0.85)	2.87 (1.29)	7.33 (6.62)

Data Source: 2004 NDNQI Database.
ICU, intensive care unit; Med-Surg, medical-surgical; Rehab, rehabilitation; Hppd, hours per patient day; RN, registered nurse; LPN, licensed practical nurse; NA, nursing assistant.
[a]Per 1,000 patient days.

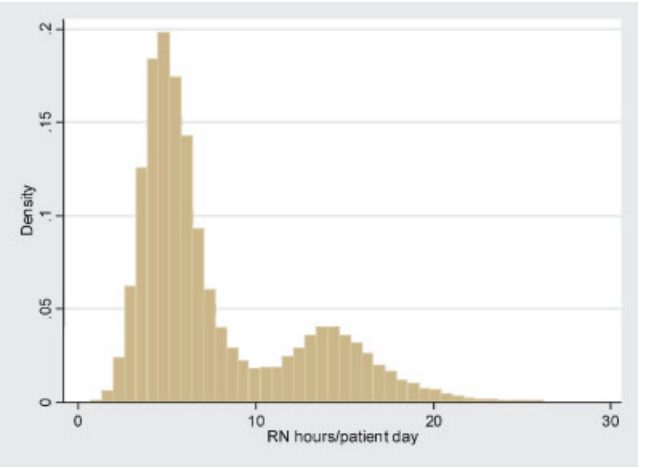


FIGURE 1. Distribution of RN hours per patient day.

additional hour of NA care increased the fall rate by 1.5%. Note that the increment of 1 hour of care per patient day has different implications across types of nursing staff and nursing units due to differing standard deviations. One RN hour is only a third of a standard deviation in ICUs (*SD* for RN Hppd = 3.06). At the other extreme, one LPN hour is two standard deviations in ICUs (*SD* for LPN Hppd = 0.51).

Because ICUs were at the extreme ends of the nursing hours and falls distributions, we duplicated our analyses in ICUs and non-ICUs (Models 3 and 4 in Table 3). We found that the effect of RN hours was slightly larger in ICUs than in all units combined (Model 2; IRRs of 0.967 and 0.984, respectively) and became nonsignificant in non-ICUs. Conversely, the LPN hours effect was larger in non-ICUs than ICUs, while the NA hours effect became nonsignificant in ICUs. The standard deviation of NA Hppd is about 1 hour in non-ICUs. Therefore, the association between NA Hppd and falls in non-ICUs can readily be interpreted as a one standard deviation increase (i.e., 1 hour) is associated with a 1.5% higher fall rate. Although the coefficient for LPN Hppd in ICUs was the highest among the different models (IRR = 1.098) its clinical significance is trivial due to the minimal Hppd of

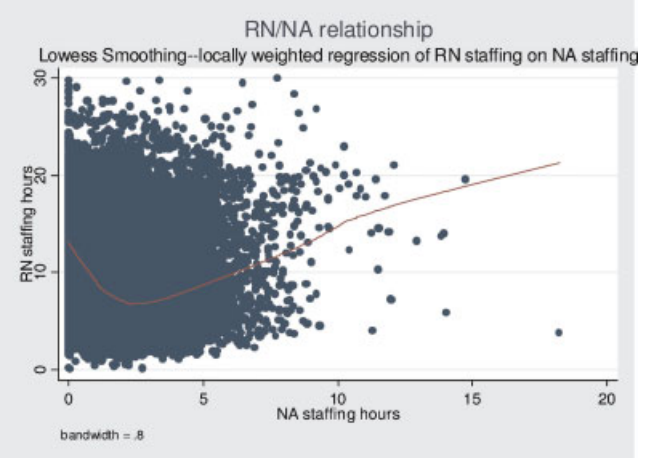


FIGURE 2. Scatter plot of the relationship between RN and NA hours per patient day. RN, registered nurse; NA, nursing assistant; Note: Line on plot is the locally weighted regression line.

Table 3. Incident Rate Ratios of Patient Falls Based on Negative Binomial Regressions

	Model 1, IRR ($n = 50,810$)	Model 2, IRR ($n = 50,810$)	Model 3 (ICU), IRR ($n = 11,520$)	Model 4 (non-ICU), IRR ($n = 39,290$)
Nurse staffing				
RN Hppd	0.910***	0.984***	0.967***	0.994
LPN Hppd	1.015	1.030**	1.098**	1.035**
NA Hppd	1.043***	1.011*	0.989	1.015*
Magnet hospital	0.948***	0.947***	0.860***	0.960**
Nursing unit type			N/A	
ICU		0.211***		
Stepdown		0.484***		0.471***
Medical		0.632***		0.627***
Surgical		0.397***		0.396***
Med-surg		0.545***		0.544***
Rehab		Reference		Reference
R^2	0.030	0.049	0.008	0.019

Notes: $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$. Observations are nursing unit months.
Incident rate ratios are from generalized estimating equations models that clustered observations within nursing units. Models 2, 3, and 4 controlled for the hospital's 2004 Medicare Case Mix Index, teaching status, bedsize, and ownership, and the nursing unit's average patient age and sex.
RN, registered nurse; LPN, licensed practical nurse; NA, nursing assistant; Hppd, hours per patient day; ICU, intensive care unit; Med-Surg, medical-surgical; Rehab, rehabilitation.

LPNs in ICUs, which was on average 0.13 hours (i.e., 8 minutes).

To translate our findings into scenarios that may be useful from policy and management perspectives, predicted fall rates for each nursing unit type by Magnet status are presented in Table 4. The predicted fall rate was calculated from Models 3 and 4 by entering the nursing unit type and Magnet status into the relevant model depending on the scenario. The sample mean was used for all other variables. Table 5 displays the annual number of falls expected by unit type in Magnet and non-Magnet hospitals. Here we multiplied the respective predicted fall rate from Table 4 by the number of patient days on average for that unit type. For example, in an average medical-surgical unit, which had 8,282 patient days in 2004, we would have expected 1.4 fewer falls per year in Magnet ($3.75/1,000 \times 8,282 = 31.1$ falls per year) as compared to non-Magnet hospitals ($3.92/1,000 \times 8,282 = 32.5$ falls per year; $32.5 - 31.1 = 1.4$).

Nurse Staffing Comparisons Across Hospital Groups

Using AHA data, we found that NDNQI hospitals had nearly 2 hours higher RN Hpapd than US general hospitals (means = 7.86 and 6.06 respectively, $t = 11.52$, $p < .001$). Among NDNQI hospitals, at the hospital level, the RN Hpapd in Magnet hospitals was nearly 1 hour higher than non-Magnet hospitals (mean = 8.50 and 7.70 respectively, $t = 2.92$, $p < .01$). At the nursing unit level, NDNQI data showed the RN Hppd in Magnet hospitals was significantly higher for every unit type. This difference ranged from 0.20 to 0.80 Hppd (12–48 minutes). The LPN Hppd in Magnet hospitals was 0.07 to 0.30 (4–18 minutes)

Table 4. Predicted Patient Fall Rate per 1,000 Patient Days on Different Types of Nursing Units by Hospital Magnet Status

	Unit Type					
	ICU	Stepdown	Medical	Surgical	Med-Surg	Rehab
Magnet	1.12	3.29	4.35	2.67	3.75	6.84
Non-magnet	1.30	3.44	4.54	2.79	3.92	7.15

ICU, intensive care unit; Med-surg, medical-surgical; Rehab, rehabilitation.

Table 5. Estimated Number of Patient Falls Per Year in Magnet and Non-Magnet Hospitals by Nursing Unit Type

	Unit Type					
	ICU	Stepdown	Medical	Surgical	Med-Surg	Rehab
Magnet	4.5	24.0	23.1	34.8	31.1	43.3
Non-magnet	5.2	25.1	24.2	36.3	32.5	45.3

ICU, intensive care unit; Med-Surg, medical-surgical; Rehab, rehabilitation.

lower for five unit types; the exception was rehabilitation units where the difference was not statistically significant. The NA Hppd did not exhibit consistent patterns across unit types between Magnet and non-Magnet hospitals.

DISCUSSION

Key Findings

Using a sample of 5,388 units in 636 hospitals, we investigated the relationships among nurse staffing (i.e., RNs, LPNs, NAs), RN staff composition, hospital Magnet status, and patient falls to develop evidence about how the distribution of nursing resources and achievement of nursing excellence contribute to patient safety. Our principal findings suggest that staffing levels have small effects on patient falls, that RN hours are negatively associated with falls in ICUs, LPN, and NA hours are positively associated with falls principally in non-ICUs, and that fall rates are lower in Magnet hospitals. This evidence suggests there are potentially two mechanisms for enhancing patient safety: becoming or emulating a Magnet hospital, or adjusting staffing patterns at the unit level.

Our reported fall rate of 3.3 falls per 1,000 patient days is similar to the rate of 3.73 from the analysis of the 2002 NDNQI database (Dunton et al., 2004). We found higher fall rates on medical units compared to surgical units. Typical medical, surgical, and medical-surgical units in this sample had about 693 patient days per month, meaning about 2–3 patients fell each month on the most common acute care units.

We separated nursing staff hours into RN, LPN, and NA hours, a new approach in the staffing literature. We identified statistically significant opposite effects of RN hours as compared to LPN and NA hours. RN education level and certification did not appear to be associated with falls in a meaningful way. Our insignificant finding regarding agency RN hours and falls may be due to the small percentage of RN hours by agency nurses, which would not be expected to have a substantial influence. We did not analyze skill mix (i.e., the RN proportion of total nursing staff) due to its high correlation with all types of nursing hours per patient day.

The negative association between RN hours and falls in the ICU may reflect the causal explanation that providing more RN hours will lead to fewer falls. The alternative explanation is that ICUs with higher RN hours have patients who are too ill to move and accordingly have a lower fall risk. In this case, the lower risk, rather than the better staffing, accounts for the fewer falls. We cannot rule out this explanation with the data at hand. We note that given the extremely low risk of falls in ICUs, they may not be a productive focus for future research.

The positive association between NA hours and falls in non-ICUs was not expected. Because NAs provide toileting assistance and would seem to have a greater opportunity to prevent falls, we expected this relationship to be negative. Because cross-sectional regression models cannot determine causality, one possibility for this unexpected positive relationship between NA Hppd and falls is that nursing units attempted to address high fall rates by increasing their least expensive staffing component, NAs, rather than higher NA staff causing a higher fall rate.

The fall rate was substantially higher on rehabilitation units than on medical units, the nursing unit type with the next highest fall rate (7.33 vs. 4.51 per 1,000PD). The high rate of falls in rehabilitation settings is likely due to people learning to walk again post-surgery. How to reduce falls on rehabilitation units is a compelling topic for future study. Research questions could include the role of physical therapy or the effectiveness of alternative fall prevention protocols.

Our multivariate results show that patients in Magnet hospitals had a 5% lower fall rate. This difference is important to identify as it controls for multiple factors influencing fall risk, principally

nursing unit type, which may differ across the Magnet and non-Magnet hospitals in this sample. This is the second study to analyze Magnet status and patient falls. The first study using NDNQI data from July 2005 to June 2006 (Dunton et al., 2007) identified a 10.3% lower fall rate in Magnet hospitals. The difference between the Dunton et al. (2007) report and our findings may be due to sampling differences: Dunton et al. evaluated only the 1,610 NDNQI nursing units that participated in the NDNQI RN survey. By contrast our findings reflect the entire 2004 NDNQI database of 5,388 nursing units.

The beneficial finding of Magnet status is consistent with the limited literature showing better patient outcomes such as lower mortality and higher patient satisfaction in Magnet hospitals (Aiken, 2002), although the earlier empirical evidence is from the cohort of Magnet hospitals identified by reputation and predates the Magnet Recognition Program era. We confirmed in two different data sources that Magnet hospitals in this sample had higher RN staffing levels than non-Magnet hospitals. In multivariate regression analyses we identified a Magnet hospital effect independent of the RN staffing level. Therefore, higher RN staffing was not the reason for the lower fall rates identified in Magnet hospitals. The basis for lower fall rates in Magnet hospitals remains an open question for future research.

Using the NDNQI for Research

The NDNQI database granted us the benefits of its unprecedented national scope. However, the NDNQI database is a benchmarking database that may not represent all general hospitals. In particular, the NDNQI has more not-for-profit and large hospitals than the national profile. Therefore, our results will generalize best to not-for-profit and larger hospitals. The disproportionate share of Magnet hospitals in the NDNQI database (17% in this sample vs. 7% nationally in 2004) likely reflects the Magnet recognition requirement that a hospital participate in a quality benchmarking system as well as the interest in quality improvement that is common to the Magnet hospital ethos.

Two aspects of the NDNQI sample may yield effect sizes that differ from those that might be estimated in a representative sample of general hospitals. First, the benchmarking purpose of the NDNQI attracts hospitals oriented towards quality improvement through nursing systems decisions. The feedback provided through benchmarking reports may lead these hospitals to implement similar staffing patterns. The result could be less variability in nursing hours than would be observed typically in general hospitals. This possibility was reflected in AHA staffing statistics for the entire hospitals by a lower standard deviation for RN Hpapd in the NDNQI cohort as compared to all U.S. general hospitals ($SD = 0.50$ vs. 0.75 respectively).

In addition, we detected significantly higher RN staffing in NDNQI hospitals as compared to US general hospitals, suggesting that our multivariate model results apply to hospitals at the high end of the staffing range. Moreover, the Magnet hospital effect identified here may underestimate the ''true'' Magnet effect were we to compare Magnets with all general hospitals. That is, the ''comparison'' hospitals in this sample already participate in a quality benchmarking initiative and may therefore differ from hospitals not involved in nursing benchmarking. Lastly, the ''non-Magnet'' group includes some ''Magnet applicants'' in various stages of implementing Magnet standards.

The NDNQI remains useful for research questions that incorporate new measures including other nursing workforce characteristics (e.g., expertise, experience), a survey measure of the nursing practice environment, nursing unit types (psychiatric), and outcomes (restraint use). The NDNQI also can be useful to test fall-prevention interventions by comparing the pre- and post-intervention fall rate.

Limitations

Our study is limited by a cross-sectional design, the limited data to adjust for patient characteristics, and the age of the data. Another limitation discussed previously is the convenience sample.

The classic weakness of the cross-sectional study design is the inability to establish causality. One hypothesized causal sequence is that providing more nursing hours will lead to fewer falls. Our results showing the opposite, that more LPN and NA hours are associated with more falls, may reflect this design weakness. Another hypothesized causal sequence is that the nursing excellence acknowledged by Magnet Recognition translates into safer practice and fewer patient falls. However, the converse may be plausible: hospitals with fewer falls happen to become Magnet hospitals. Future research on patient falls before and after hospital Magnet Recognition may illuminate this question.

Outcomes studies must control for differences in patients to discern the effects of nursing variables. In this study we controlled for nursing unit type and each nursing unit's average patient age and gender, thus the control variables were limited. At the hospital level we controlled for patient differences that may be reflected in the Medicare CMI and hospital structural characteristics. This set of control variables exceeds those of most earlier studies of falls by including average patient demographics and hospital CMI. Mark et al. (2008) included average health status but not CMI in their analysis of falls. In fact our additions of the nursing unit's average patient demographics and hospital CMI contributed minimally to explained variance (not shown). The diminished effect sizes of the independent variables and the increased variance explained in Model 2 was due predominantly to nursing unit type; the other control variables had minimal influence. The NDNQI data do not contain patient diagnosis, cognitive impairment, time or shift of the fall, or acuity mix within nursing unit types. Better risk adjustment may yield other findings.

The age of the data (2004) limits the results in two ways. Several national initiatives since 2004 have heightened attention to the prevention of patient falls. In 2005, the Joint Commission implemented a new National Patient Safety Goal to reduce the risk of patient harm resulting from falls with a requirement of fall risk assessment and action (Joint Commission, 2010). By 2009, the requirement had evolved to implement and evaluate a falls reduction program. In October 2008, Medicare stopped reimbursing hospitals for care due to preventable falls (Centers for Medicare and Medicaid Services, 2008). These changes may have altered the roles of nursing staff, the incidence of patient falls, and the associations between them. The age of the data also limit how well the results generalize to NDNQI hospitals presently. The database has more than doubled in the past 5 years and hospitals under 100 beds are now a larger share of the participants. The study variables have been stable during the years 2004–2010, except for a few clarifications in the data collection guidelines. The changes were minor and would be unlikely to influence the findings reported herein.

CONCLUSION

This study stands apart from previous staffing/fall literature due to the measurement of three different categories of nursing staff hours, the national scope of the hospital sample, the range of nursing unit types, as well as analysis of count data at the unit-months level, the most detailed level of observation. An additional noteworthy feature was risk adjustment for the nursing unit's average patient characteristics (age, gender) and the hospital's Medicare CMI. This study provided a thorough presentation of staffing patterns across unit types. We used a national data source, the AHA's Annual Hospital Survey, to provide a national context for the RN staffing levels in NDNQI hospitals and to compare RN staffing levels in hospitals with and without Magnet recognition within the NDNQI.

Our study findings have implications for management, research, and policy. At the highest management level, hospital executives can improve patient safety by creating environments consistent with Magnet hospital standards. Fewer falls can yield cost savings and prevent patients' pain and suffering. Nursing unit managers can use these nursing hours and falls statistics for their nursing unit type as reference values to support their staffing decisions. The current study strengthens the evidence base on how nurse staffing patterns and practice environments support patient safety.

REFERENCES

Aiken, L.H. (2002). Superior outcomes for magnet hospitals: The evidence base. In M.L. McClure & A.S. Hinshaw (Eds.), Magnet hospitals revisited: Attraction and retention of professional nurses (pp. 61–81). Washington, DC: American Nurses Publishing.

Aiken, L.H., Sochalski, J., & Lake, E.T. (1997). Studying outcomes of organizational change in health services. Medical Care, 35(11 Suppl), NS6–NS18.

American Hospital Association. (2010). AHA Data: Survey History & Methodology, from http://www.ahadata.com/ahadata/html/historymethodology.html.

American Nurses Association. (1995). Nursing care report card for acute care. Washington, DC: Author.

American Nurses Association. (1996). Nursing quality indicators: Definitions and implications. Washington, DC: Author.

American Nurses Association. (1999). Nursing-sensitive quality indicators for acute care settings and ANA's Safety and Quality Initiative (No. PR-28). Washington, DC: Author.

American Nurses Credentialing Center. (2009). Magnet recognition program overview, from http://www.nursecredentialing.org/Magnet/ProgramOverview.aspx.

Blegen, M.A., Vaughn, T., & Vojir, C.P. (2008). Nurse staffing levels: Impact of organizational characteristics and registered nurse supply. Health Services Research, 43, 154–173.

Burnes Bolton, L., Aydin, C.E., Donaldson, N., Brown, D.S., Sandhu, M., Fridman, M., et al. (2007). Mandated nurse staffing ratios in California: A comparison of staffing and nursing-sensitive outcomes pre- and post-regulation. Policy, Politics, & Nursing Practice, 8, 238–250.

Centers for Medicare & Medicaid Services. (2008). Medicare program: Changes to the hospital inpatient prospective payment systems and fiscal year 2009 rates. Final Rules. Federal Register, 73(16), 48433–49084.

Centers for Medicare & Medicaid Services. (2010). Acute Inpatient PPS, from http://www.cms.hhs.gov/AcuteInpatientPPS/.

Chelly, J.E., Conroy, L., Miller, G., Elliott, M.N., Horne, J.L., & Hudson, M.E. (2009). Risk factors and injury associated with falls in elderly hospitalized patient in a community hospital. Journal of Patient Safety, 4, 178–183.

Donaldson, N., Burnes Bolton, L., Aydin, C., Brown, D., Elashoff, J.D., & Sandhu, M. (2005). Impact of California's licensed nurse-patient ratios on unit-level nurse staffing and patient outcomes. Policy, Politics, & Nursing Practice, 6, 198–210.

Dunton, N., Gajewski, B., Klaus, S., & Pierson, B. (2007). The relationship of nursing workforce characteristics to patient outcomes. OJIN: The Online Journal of Issues in Nursing, 12(3), Manuscript 3.

Dunton, N., Gajewski, B., Taunton, R.L., & Moore, J. (2004). Nurse staffing and patient falls on acute care hospital units. Nursing Outlook, 52, 53–59.

Enloe, M., Wells, T.J., Mahoney, J., Pak, M., Gangnon, R.E., Pellino, T.A., Hughes, S., et al. (2005). Falls in acute care: An academic medical center six-year review. Journal of Patient Safety, 1, 208–214.

Hanley, J.A., Negassa, A., Edwardes, M.D., & Forrester, J.E. (2003). Statistical analysis of correlated data using generalized estimating equations: An orientation. American Journal of Epidemiology, 157, 364–375.

Harless, D.W., & Mark, B.A. (2006). Addressing measurement error bias in nurse staffing research. Health Services Research, 41, 2006–2024.

Hendrich, A.L., Bender, P.S., & Nyhuis, A. (2003). Validation of the Hendrich II fall risk model: A large concurrent case/control study of hospitalized patients. Applied Nursing Research, 16, 9–21.

Jiang, H.J., Stocks, C., & Wong, C. (2006). Disparities between two common data sources on hospital nurse staffing. Journal of Nursing Scholarship, 38, 187–193.

Joint Commission. (2010). National Patient Safety Goals. Retrieved Jan 28, 2010, from http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/.

Lake, E.T. (1999). The organization of hospital nursing. Philadelphia: University of Pennsylvania (unpublished dissertation).

Lake, E.T., & Cheung, R. (2006). Are patient falls and pressure ulcers sensitive to nurse staffing? Western Journal of Nursing Research, 28, 654–677.

Mark, B.A., & Harless, D.W. (2007). Nurse staffing, mortality, and length of stay in for-profit and not-for-profit hospitals. Inquiry 44, 167–186.

Mark, B.A., Hughes, L.C., Belyea, M., Bacon, C.T., Chang, Y., & Jones, C.A. (2008). Exploring organizational context and structure as predictors of medication errors and patient falls. Journal of Patient Safety, 4, 66–77.

Montalvo, I. (2007). The National Database of Nursing Quality IndicatorsTM (NDNQI®). OJIN: The Online Journal of Issues in Nursing, 12(3), Manuscript 3.

National Quality Forum. (2004). National voluntary consensus standards for nursing-sensitive care: An initial performance measure set—A consensus report, Available from http://www.qualityforum.org/Projects/n-r/Nursing-Sensitive_Care_Initial_Measures/Nursing_Sensitive_Care__Initial_Measures.aspx.

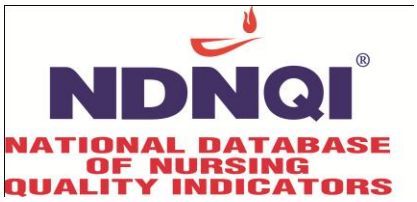
National Quality Forum. (2009). Nursing-sensitive care: Measure maintenance, from http://www.qualityforum.org/Projects/n-r/Nursing-Sensitive_Care_Measure_Maintenance/Nursing_Sensitive_Care_Measure_Maintenance.aspx.

Schubert, M., Glass, T.R., Clarke, S.P., Aiken, L.H., Schaffert-Witvliet, B., Sloane, D.M., et al. (2008). Rationing of nursing care and its relationship to patient outcomes: The Swiss extension of the International Hospital Outcomes Study. International Journal for Quality in Health Care, 20, 227–237.

Shuldham, C.M., Parkin, C., Firouzi, A., Roughton, M., & Lau-Walker, M. (2009). The relationship between nurse staffing and patient outcomes: A case study. International Journal of Nursing Studies, 46, 986–992.

Spetz, J., Donaldson, N., Aydin, C., & Brown, D. (2008). How many nurses per patient? Measurements of nurse staffing in health services research. Health Services Research, 43, 1674–1692.

Van den Heede, K., Clarke, S.P., Sermeus, W., Vleugels, A., & Aiken, L.H. (2007). International experts' perspectives on the state of the nurse staffing and patient outcome literature. Journal of Nursing Scholarship, 39, 290–297.



National Database of Nursing Quality Indicators®
Methods Development Project

Final Report to
The American Nurses Association

August 3, 2011

Prepared by the National Database of Nursing Quality Indicators
School of Nursing
University of Kansas Medical Center

Table of Contents

Executive Summary

NDNQI staff have developed methodologies for bringing mixed acuity units into the database for reporting on clinical and staffing indicators and for creating hospital-level indicators. The process used in the development of these methodologies involved literature review, advice from methodological experts, new data collection, and statistical simulation. Key findings included:

- There were many barriers to creating risk or acuity-adjusted unit-level measures.
    - Acuity data are not available for units.
    - Risk data for specific outcomes would require a large, and perhaps burdensome, increase in data collection and reporting for participating hospitals.
- A method for creating categories of mixed acuity units was developed based on Medicare billing days. The method has face and criterion validity.
- Six types of mixed acuity units were identified for adult or pediatric populations:
    - Mixed Acuity III: Units with at least 50% critical care patient days each month.
    - Mixed Acuity II: Units with at least 25% critical care days each month or at least 50% step-down days each month; includes only units not meeting the criterion for Mixed Acuity III.
    - Mixed Acuity I: Units not meeting the criteria for Mixed Acuity III or II.
    - Burn units
    - Bone Marrow Transplant units
    - Critical Access units
- Rolling up unit-level indicators should take into account the unit composition of a hospital, as well as the size of each unit. Results should be meaningful to users.
- Hospital level indicators can be developed from a weighted average or unit-level z-score. The weights are based on the staffed bed size of each unit. For hospital reporting, the z-scores are translated back into the original metric of the indicator.
- Data collection and reporting for mixed acuity units and reporting for hospital-level indicators may be implemented at the direction of the American Nurses Association.

Background and Objectives

The National Database of Nursing Quality Indicators® (NDNQI®) is a proprietary database of the American Nurses Association (ANA). NDNQI collects and evaluates nursing-sensitive data from 1,800 hospitals in the United States

Hospitals that participate in NDNQI receive quarterly unit-level comparative data reports. NDNQI comparative data are currently stratified by unit type and hospital characteristics. Thus, each unit can compare its nurse staffing and patient outcomes to national percentiles for similar units. Hospitals value the NDNQI reports and want to have all of their units included. Mixed acuity units are currently excluded from NDNQI as they are too diverse to be included in comparative data. NDNQI has identified a methodologically and conceptually sound method of acuity adjustment or acuity stratification to allow inclusion of mixed acuity units in NDNQI reports. To date, most risk or acuity adjustment work has been done at the hospital level, using patient characteristics, diagnostic related groups, or the hospital case mix index.

NDNQI also was asked to create a methodology to produce hospital-level measures. Hospital executives want summary measures of performance for their entire facility. Consumers and oversight organizations want information to make conclusions about a facility's nursing quality. Typically, hospital-level reporting is either based on patient-level data or weighted averages of unit-level data. The patient-level approach is divergent from NDNQI's unit-based data collection. Incorporating the unit orientation into the measurement model is consistent with NDNQI's focus on nursing unit performance. A methodology was needed that was based on unit level data and takes into account the fact that hospitals may not submit data on all eligible units and hospitals vary in unit composition.

The methods development project had two main goals:

1. Develop a method for unit-level acuity adjustment of nursing indicators
2. Develop a method to calculate hospital-level indicators

Development Process

The project originally had two goals:

1. Develop adjustment methods for unit data on nurse staffing and patient outcomes.
2. Develop a method for rolling-up unit-level data to hospital totals.

The requirements for adjustments and roll-up methodologies that are consistent with the NDNQI paradigm include:

1. The nursing care unit should continue to be the unit of observation.
2. Post-adjustment results should be interpretable by clinicians
3. Data used in adjustment must be comparable across sites.
4. If adjustment is to occur with every reporting period, data must be available for update on a quarterly basis and within 45 days of the end of a calendar quarter.
5. Within a group of effective methods, the method requiring the least additional respondent burden should be selected.
6. Adjustment and summary methods should have attributional and face validity.

The development process consisted of four phases:

1. Literature review
2. Advisory panel input
3. Data collection

4. Statistical methods development

The report concludes with a description of a work order for implementation of the adjustment and roll-up methodologies.

Literature Review

The project began with a literature review of risk and acuity adjustment as they might apply to the inclusion of mixed acuity units into NDNQI reporting. It also covered the development of hospital-level measures that maintain NDNQI's unit-level focus. The review identified the following information:

Adjusting Staffing Measures

- Risk adjustment is a statistical method that accounts for patient characteristics known to the correlated with a particular outcome measure. In general, outcome measures are adjusted for risk.
- Acuity adjustment refers to the use of a composite variable reflecting the level of patients' need for care. In general, staffing measures are adjusted for acuity.
- Adjustment variables that are themselves measures of quality should be excluded in order to avoid over-adjustment.
- There was disagreement in the literature on which specific variables to use for adjustment.
    - A hospital's case mix index is the average of its patients' diagnosis-related group (DRG) weights. DRG weights reflect the relative resource consumption. Each patient is assigned one DRG for their entire inpatient stay. The level of measurement for DRGs is hospital, not nursing care unit. Further, the extent to which DRG weights capture *nursing* resource consumption is questionable. DRG weights do not explicitly account for variation in need for daily nursing.
    - Nursing intensity weights (NIW) were developed as a nursing-specific refinement of the DRG payment system. Nursing intensity weights reflect the relative level of nursing care needed by a typical patient in each diagnosis-related group. NIW, being based on DRGs, are at the hospital-level, rather than the nursing care unit-level.
    - Numerous proprietary software programs classify patients' severity of illness or project a unit's nursing workload. There is no predominant patient classification system in use across the U.S., so comparable data are not available.

Adjusting Patient Outcomes

- Outcome-specific adjustments are needed for pressure ulcers, falls, and other patient outcomes. Published examples of adjusted outcomes typically rely on patient-level measures of risk specific to each outcome, as opposed to more general illness severity or acuity measures.
- Adjusting outcomes based on patient characteristics would place a large data collection burden on hospitals that do not yet have electronic health records. Further, the data are protected health information which hospitals may be reluctant to release. Finally, the evidence for the use of PHI data producing effective adjustments was limited.

Hospital-Level Reporting

- Hospital level reporting typically is done by counting all of the various conditions or events that occur in the hospital and then dividing by the number of patients, days, device days, etc. across the hospital.
- This approach is patient-focused and abandons the unit-performance perspective that is the primary unit of analysis for NDNQI.
- Minnick (2000) noted that nursing-sensitive indicators typically vary more across units in the same hospital than across hospitals. Hospital summary measures of pressure ulcers, patient falls, and other indicators that mask variation between units within the organization are not as meaningful as unit-type comparisons across hospitals.
- In 2009, the National Quality Forum's report on Voluntary Consensus Standards for Nursing-Sensitive Care: An Initial Performance Measure Set

Expert Panel

ANA established an expert advisory panel to provide guidance on the data and methodological issues of adjustment and roll-up. Panelists brought forth a variety of issues, but no consensus was established on methodological approach. The following issues were identified.

- NDNQI's unit-based approach may not provide stable measures, much less enough data for unit-level risk adjustment.
- Risk adjusters must have high levels of sensitivity and specificity. More research would need to be done to identify which, if any, adjusters have these measurement properties.
- Nursing intensity weights are based on AP-DRGs, which reflect the care provided for an entire hospital stay, not the care provided on a specific unit. Current NIW have 2-3 levels within each DRG to distinguish critical vs. acute care. DRGs reflect patients at their sickest during the hospital stay.
- Use of patient classification systems may eventually be mandated nationally, but they vary across sites and are generally not well validated.
- Admissions-Transfer and Discharge data is another important predictor of workload that varies widely across units.
- Data for risk adjustment should be based on admission risk assessments. DRGs are not admission-based.
- Mixed acuity units use billing levels that correspond to existing NDNQI unit type strata. Validity of unit type as a proxy for acuity is uncertain.
- Rolling up different sized units in a hospital creates a weighted average, which complicates statistical issues. Some units will have a higher put-through than others so their average occupancy rate will be lower but the total number of people seen might be high.
- The statistical issues for dealing with weighted averages are pretty straight forward but the average needs to be interpretable.
- Any adjustment method will make mistakes. How high you set the standard for accuracy is subjective. Public reporting requires a higher standard than internal use for quality improvement.

Revised Study Purpose

After the completion of the discovery portion of the project, NDNQI researchers concluded that the original scope of work should be modified to reflect the information from the literature review and expert panel.

Due to questions about feasibility and advisability of various approaches to adjustment, we limited our objective to the primary goal of our adjustment work, namely to have a way to make meaningful comparisons of mixed acuity units so that these units can begin submitting data on NDNDQI clinical and staffing indicators.

The method we propose for hospital roll-up is a straightforward weighting technique. The original scope of work stated that we would collect data from a variety of hospitals to test alternative approaches. Because there are a wide variety of unit profiles within hospitals and unpredictable patterns of non-reporting, the sample size required to test all combinations of circumstances would be very large. Yet, even a large sample might not encounter all possible situations. A more satisfactory, and efficient, approach was to conduct the development tests with simulated data. It is quite feasible to vary systematically the composition of unit profiles and patterns of missing data.

Results

Mixed Acuity Units

The purpose of this study was to develop acuity adjustment methods to allow meaningful comparisons of mixed acuity units' patient outcomes, and to compare the feasibility and effectiveness of these methods using data collected from a sample of NDNQI hospitals. Due to questions about the feasibility and advisability of various approaches to adjustment (discussed below), we limited our objectives to the primary goal of finding a way to make meaningful comparisons of mixed acuity units so that these units can begin submitting data on NDNDQI quarterly indicators. During the discovery activities for unit-based acuity adjustments a variety of issues were uncovered. We concluded the following:

- Adjustment of staffing measures is not warranted. Staffing measures themselves are a measure of acuity, so adjusting them for acuity is analogous to adjusting SAT scores for test-taker IQ.
- Device-related infection measures are based on at-risk patients and are thus already adjusted for acuity to a large degree.
- Gathering patient clinical admission data for use in risk or acuity adjustment would represent a sizeable data collection burden for hospitals, as well as a substantial expansion in the scope of NDNQI's data collection. Even if certain clinical variables proved useful for adjusting NDNQI outcome measures, any adjustment method based on these variables could be used only for hospitals willing and able to provide these data to NDNQI; other hospitals' mixed acuity units would continue to be excluded from participation in quarterly indicators. Moreover, a patient's risk and acuity often change over the course of the hospital stay due to surgery, healthcare-acquired infection, effectiveness of treatment, etc.

- It was argued in the first Advisory Council meeting that one-day prevalence measures, which are unstable because they are based on data for only one day out of every 90, should not undergo unit-level risk adjustment. We disagree that the instability of these measures is a reason not to adjust them for risk or acuity, but we advise against adjustment using patient risk or acuity variables for the reasons stated above.

The mixed acuity unit study is described below. We propose creating new acuity-based unit types using the proportions of patient billing days at the critical, step-down, and standard levels of care, as well as comparison groups based on unit sub-specialty for unit types for which this is practicable.

NDNQI member hospitals with at least one mixed acuity unit enrolled were invited to participate in a survey on a volunteer basis. No specific sample size was targeted, as the study does not involve statistical inference. Hospitals submitted data for March, 2011, on nursing care hours, patient days, and (in the case of adult units) patient falls. Data were also submitted for a single pressure ulcer prevalence survey conducted in 2011 (prior to the data submission deadline of May 6).

In addition, hospitals reported for each mixed acuity unit the number of patient days billed by level of care/acuity for March, 2011. NDNQI sent a customized Excel spreadsheet to each participating site coordinator for recording these data. Patient days were classified using the following billing levels:

1. Critical/intensive care (highest level of care).
2. Step-down/intermediate/progressive care. This may also be called transitional care.
3. Standard/routine care (e.g. medical or surgical care).
4. Rehabilitation care.
5. Skilled nursing/sub-acute care.
6. Inpatient hospice care. This level applies only to patients who have been discharged from acute care.
7. Short-stay observational care. This includes 23-hour observational care.

Adult Mixed Acuity Units. Patient days by billing level were reported by 52 adult mixed acuity units. Critical, step-down, and standard care days made up the bulk of the days for these units. Five units reported at least one hospice or rehabilitation day, but these days did not make up more than 1.1% of the total patient days for any unit. One unit reported skilled nursing days, which accounted for 27.8% of its total days, the remainder being standard care days. Most units billed one or more short stay days; the average percentage of short stay days was 2.3%.

All 52 units billed at least 45% of their patient days at a single level, and 48 billed over 50% of their days at one level. Three units met NDNQI's 90% criterion for an existing unit type for the month of the study. For all 52 units, one or two billing levels accounted for at least 75% of patient days. Some units combined primarily critical and step-down care days, some combined step-down and standard care days, and some combined critical and standard care days (in some cases with no step-down days; some hospitals do not have a billing level between critical and standard care).

Pediatric Mixed Acuity Units. Of the ten pediatric mixed acuity units that submitted data on patient billing days, nine billed at least 60% of their patient days at either the critical, step-down, or standard care level. No rehabilitation, skilled nursing, or hospice days were billed. Short stay days accounted for less than 8% of patient days for all units save one, for which they accounted for 36%.

Other Unit Types. Four critical access units submitted data for the study. Their proportions of days at the critical, step-down, standard, skilled nursing, and short stay levels varied widely. Data were also submitted for one bone marrow transplant unit, one neonatal mixed acuity unit, and one obstetrics unit.

Approaches to Acuity Adjustment

Adjusting Outcomes Using Patient Days by Billing Level. If NDNQI collected data on patient days at various billing levels from all participating units, these data could be used to adjust each unit's scores on the NDNQI measures using an appropriate regression model. Each measure could be regressed on the proportions of patient days billed at the critical, step-down, and standard levels to obtain a predicted value on the measure for each unit, and this could be compared to the unit's observed value on the measure to compute an acuity-adjusted score. This would require regular collection of data on billing days so that adjusted scores could be reported to hospitals each month/quarter.

There are two problems with this approach. First, not all hospitals use the same billing levels, or even the same number of billing levels, and reconciling the various sets of levels would be difficult. And second, it would be burdensome for hospitals would submit these data on a regular basis.

Using RNHPPD as a Proxy for Acuity. Another option is to use RN hours per patient day (RNHPPD)—a variable on which NQNDI already collects data—as a proxy for acuity to classify units and/or compute acuity-adjusted scores on NDNQI measures. In an internal study conducted in 2010 using four quarters of data from critical, step-down, medical, surgical, and medical/surgical units, RNHPPD was shown to contain much of the same information as unit type. As shown in Table 1, critical, step-down, and standard care units differ markedly in RNHPPD. Using a general linear model, unit type was found to account for 82% of the variation in RNHPPD. Moreover, in linear models in which unit type was included as a predictor of fall rate or rate of hospital-acquired pressure ulcers, the addition of RNHPPD as a predictor resulted in virtually no change in the proportion of variance accounted for by the models.

Table 1
RN Hours per Patient Day by Unit Type (Data from 2009-2010)

Unit Type	**Mean**	**SD**
Critical Care	15.3	*2.6*
Step Down	7.7	*1.9*
Med	5.8	*1.4*
Surg	6.0	*1.4*
Med-Surg	5.9	*1.5*

There is further evidence from the present study that RNHPPD is linked to patient acuity. As part of the study, units submitted data on three staffing variables—RNHPPD, total nursing care hours per patient day (TNHPPD), and skill mix (percentage of nursing care hours provided by RNs). The correlations between these variables and the proportions of patient days billed at the critical, step-down, standard, skilled nursing, hospice, and short stay levels are shown in Table 2. Both RNHPPD and TNHPPD were positively correlated with the proportions of days at the critical and hospice care levels and negatively correlated with the proportions at the standard, skilled nursing, and short stay levels. Correlations with skill mix were generally much weaker.

Table 2
Correlations of Staffing Variables with Proportions of Patient Days at Billing Levels (N = 59)

Billing Level	Critical Care	Step-down	Standard	Skilled Nursing	Hospice	Short Stay
Correlation with RNHPPD	0.73	0.11	–0.59	–0.42	0.38	–0.37
Correlation with TNHPPD	0.65	0.17	–0.56	–0.44	0.25	–0.40
Correlation with Skill Mix	0.44	–0.07	–0.25	–0.27	0.30	–0.09

Given the strong associations between RNHPPD and both unit type and patient acuity, RNHPPD could be used to adjust scores on NDNQI outcome measures in the same way as proportions of patient days at various billing levels (as described above). However, RNHPPD is associated not only with acuity but also with quality of care, and adjusting quality measures for RNHPPD (or other staffing variables) would involve more than adjustment for acuity. The unintended consequence of such an adjustment would be that units with higher RNHPPD would have their scores favorably adjusted regardless of the acuity of their patients or the quality of care provided, and whereas current NDNQI outcome measures reflect both quality of care and patient acuity, these adjusted scores would reflect some combination of quality of care, patient acuity, and staffing, making them difficult to interpret as indicators of quality.

Alternatively, RNHPPD could be used to define new unit types for mixed acuity units. For example, a mixed acuity unit with RNHPPD between the critical care and step-down RNHPPD means could be assigned to a critical/step-down mixed unit type. While this would be less problematic than using RNHPPD to adjust outcome measures, defining unit types based on staffing would tend to favor units with high RNHPPD relative to patient acuity by placing them in comparison groups with higher-acuity units that have RNHPPD in the same range.

Proposed Method for Mixed Acuity Units. We propose using the billing-days data collected in this study to create new acuity-based unit types for mixed acuity units, and to define these unit types using simple rules similar to the 90% classification rule we currently use.

A number of factors were considered in creating these new unit types. First, it is important to have enough types to ensure within-type homogeneity, but not so many types that some have too few units to serve as a meaningful comparison group. Second, the rules for classifying units

must be easy to understand and based on numbers that site coordinators can accurately estimate if they do not have exact data. Third, the new unit types should reflect the proportion of billing days at the critical, step-down, and standard care levels, as well as the RNHPPD, reported by the units in this study. And fourth, the mean RNHPPD and ulcer rates for the units assigned to the new unit types should fit reasonably well in an acuity-ordered list of unit type means, including the means for the existing critical care, step-down, and medical/surgical types.

With these considerations in mind, three new unit types were created for adult units that do not meet the 90% criterion for an existing unit type. They are defined as follows:

1. Mixed Acuity III: Units with at least 50% critical care patient days each month.
2. Mixed Acuity II: Units with at least 25% critical care days each month or at least 50% step-down days each month; includes only units not meeting the criterion for Mixed Acuity III.
3. Mixed Acuity I: Units not meeting the criteria for Mixed Acuity III or II.

We propose to use the same classification scheme to create three new unit types for pediatric mixed acuity units.

The definitions were used to assign each of the adult units in this study to a new unit type. Descriptive statistics for RNHPPD and unit-acquired pressure ulcer (UAPU) rate were calculated by unit type both for the new unit types and, using data from the first quarter of 2011, for the existing critical care, step-down, and med/surg unit types. As shown in Table 3, RNHPPD and UAPU rates are generally ordered as one would expect, with higher numbers for higher-acuity unit types.

Table 3
Descriptive Statistics for RNHPPD and UAPU by Unit Type

Unit Type	***RNHPPD***			***UAPU Rate (%)***		
	N	**Mean**	***SD***	**N**	**Mean**	***SD***
Critical Care	2267	15.1	*2.8*	2121	6.4	*9.5*
Mixed Acuity III	11	14.3	*2.7*	10	4.2	*5.7*
Mixed Acuity II	19	11.1	*2.2*	15	3.7	*8.8*
Step-down	1547	7.7	*2.0*	1417	2.6	*5.3*
Mixed Acuity I	13	7.3	*1.6*	12	0.7	*1.6*
Med/Surg	2429	5.8	*1.5*	2194	2.0	*4.0*

In addition to the six new unit types (three adult, three pediatric) defined above, we propose to introduce the following: Burn unit (adult), burn unit (pediatric), bone marrow transplant unit (adult), and bone marrow transplant (pediatric). These units, along with critical access units, should be allowed to submit data on appropriate indicators and to receive quarterly reports with

the understanding that there may be a high degree of within-group heterogeneity for their unit type.

Hospital-Level Indicators

The purpose of this portion of the study was to develop and compare several methods for measuring hospital-level performance on NDNQI indicators. The primary challenge in measuring NDNQI hospital performance is that hospitals differ in the number and type of nursing units they comprise. This makes meaningful comparison of hospitals difficult, even among hospitals of the same size and teaching status. Several hospital-level measures are presented below. We propose a method in which indicator scores are adjusted for unit type and unit size before being aggregated to the hospital level.

The rate of hospital-acquired pressure ulcers (HAPUs) is used as an example in this study without loss of generality; the methods described here can be applied to any indicator computed as a rate or proportion. For method demonstration and comparison, ulcer data were simulated for three fictitious hospitals, each with 1,000 patients assessed for pressure ulcers.

The simulated data are shown in Table 4. Note that the hospitals differ in both the types and sizes of their component units. Hospital 1 has one ICU, one step-down unit, and no rehabilitation unit. Hospital 2 has more ICU and step-down patients than Hospital 1 and has rehabilitation patients. Hospital 3 has the most ICU, step-down, and rehabilitation patients of the three hospitals. In addition, there are differences among the hospitals in the number and size of their medical, surgical, and medical/surgical units.

Table 4
Hospital-Acquired Pressure Ulcers by Unit

	Hospital 1			Hospital 2			Hospital 3		
Unit	**HAPUs**	**Patients**	**Rate**	**HAPUs**	**Patients**	**Rate**	**HAPUs**	**Patients**	***Rate***
ICU 1	9	50	0.180	15	65	0.231	7	40	0.175
ICU 2	-	-	-	-	-	-	6	40	0.150
Step-down 1	12	120	0.100	7	74	0.095	8	78	0.103
Step-down 2	-	-	-	10	74	0.135	7	78	0.090
Medical 1	4	105	0.038	3	86	0.035	6	78	0.077
Medical 2	9	105	0.086	4	86	0.047	5	78	0.064
Medical 3	-	-	-	-	-	-	3	78	0.038
Surgical 1	1	95	0.011	1	84	0.012	0	69	0.000
Surgical 2	-	-	-	0	84	0.000	0	69	0.000
Med/Surg 1	7	105	0.067	5	93	0.054	5	78	0.064
Med/Surg 2	5	105	0.048	7	93	0.075	6	78	0.077
Med/Surg 3	8	105	0.076	8	95	0.084	5	78	0.064
Med/Surg 4	8	105	0.076	2	95	0.021	2	78	0.026
Med/Surg 5	7	105	0.067	-	-	-	-	-	-

Rehab	-	-	-	8	71	0.113	10	80	0.125
Totals	70	1000	-	70	1000	-	70	1000	-

Several methods for calculating a hospital-level ulcer rate measure are described below. In Table 5, which is intended to serve as a visual aid, unit-level data and the values used to compute the hospital measures for Hospital 2 are shown, along with ulcer rate means and standard deviations for the six unit types (based on third quarter 2010 NDNQI data). A comparison of the sample hospitals on the various measures is provided in Table 3.

Method 1. An overall hospital ulcer rate can be computed by dividing the total number of patients in the hospital who have a hospital-acquired pressure ulcer by the total number of patients assessed:

$$(HAPUs_1 + HAPUs_2 + \ldots + HAPUs_M)/(n_1 + n_2 + \ldots + n_M),$$

where the units in the hospital are numbered $j = 1, 2, \ldots, M$; $HAPUs_j$ is the count of HAPUs on the jth unit; and n_j is the count of patients assessed on the jth unit.

As shown in Table 6, the overall ulcer rate for the three hospitals in the study is 7.0%. Under this method differences among hospitals in the types of units they comprise are ignored, and performance of the three hospitals in preventing pressure ulcers appears to be equal.

Method 2. A raw average of unit ulcer rates can be computed by summing the unit ulcer rates within a hospital and dividing by the number of units:

$$(HAPUs_1/n_1 + HAPUs_2/n_2 + \ldots + HAPUs_M/n_M)/M.$$

As with Method 1, the three hospitals appear to be performing equally, each having an average unit ulcer rate of 7.5%. This number is higher than the overall hospital rate because the measure does not account for differences among units in the number of patients assessed, allowing small units with high rates to exert disproportionate influence on the average unit rate. For example, in Hospital 2 the ICU ulcer rate of 23.1%, which is based on 65 patients, is given the same weight as the low surgical unit rates, which are based on 84 patients each (see Table 2).

Moreover, like the overall hospital rate (Method 1), this measure ignores differences among hospitals in the types of units they comprise. For example, whereas the averages for Hospitals 2 and 3 include a rehabilitation unit rate, the average for Hospital 1 does not.

Method 3. Method 2 can be adjusted to control for differences in unit size by weighting each unit's ulcer rate by its number of patients assessed, summing these weighted rates, and dividing by the total number of patients assessed for the hospital. This is equivalent to weighting each unit ulcer rate by that unit's proportion of patients assessed and summing these weighted rates**.** This measure is identical to the overall hospital rate described under Method 1 and does not account for differences among hospitals in the types of units they comprise.

Method 4. The ulcer rate for each unit can be adjusted for unit type by subtracting the average ulcer rate for units of that type and then dividing by the standard deviation of the ulcer rates for units of that type. The resulting z-score is the difference, in standard deviations, of the unit's ulcer rate from the average ulcer rate for units of that type. For example (see Table 4), the ICU

in Hospital 2 has an ulcer rate of 23.1%, which is about 1.7 standard deviations above the average ulcer rate for ICUs (6.7%).

These z-scores, which are all on the same metric, can be averaged for each hospital to yield an average unit z-score: $(z_1 + z_2 + \ldots + z_M)/M$, where z_j is the z-score for the *j*th unit. As shown in Table 5, the average unit in Hospital 2 has an ulcer rate slightly over one-half a standard deviation above the mean rate for its unit type, while unit rates in Hospitals 1 and 3 average 0.69 and 0.54 standard deviations, respectively, above their unit type means (see Table 5). Like the raw average of unit ulcer rates (Method 2), the average unit z-score does not account for differences in unit size.

Method 5. A weighted average of unit z-scores can be computed by weighting each unit's z-score (defined under Method 4) by its number of patients assessed, summing these weighted scores, and dividing by the total number of patients for the hospital:

$$(z_1n_1 + z_2n_2 + \ldots + z_Mn_M)/(n_1 + n_2 + \ldots + n_M).$$

Under this method, which takes into account both the types and sizes of each hospital's units, Hospital 1 loses its advantage of having the fewest ICU patients and rehabilitation patients, and Hospital 3 is no longer penalized for having the greatest number of ICU and rehabilitation patients. As shown in Table 3, the score on this measure for Hospital 1 was 0.67, while the score for the other two hospitals was 0.52.

The weighted average of z-scores can be converted to the ulcer rate metric by multiplying by the ulcer rate standard deviation for units of all types (equal to 0.070 for quarter three of 2010) and adding the overall unit ulcer rate mean (0.038). Hospitals 2 and 3 have similar adjusted rates (7.4% and 7.5%, respectively), while the rate for Hospital 1 is a full percentage point higher (8.5%). These rates are higher than the overall hospital ulcer rates, reflecting adjustments for unit type and unit size.

Table 5
Examples of Unit and Hospital Measures for Hospital 2

Unit	Pts	Rate	Z-score	Weighted Z-score	Avg Rate for Unit Type	SD for Unit Type
ICU 1	65	0.231	1.67	0.109	0.067	0.098
Step-down 1	74	0.095	0.87	0.064	0.038	0.065
Step-down 2	74	0.135	1.49	0.111		
Medical 1	86	0.035	0.10	0.009	0.030	0.049
Medical 2	86	0.047	0.34	0.029		
Surgical 1	84	0.012	–0.20	–0.017	0.020	0.040
Surgical 2	84	0	–0.50	–0.042		
Med/Surg 1	93	0.054	0.49	0.045	0.029	0.051

Med/Surg 2	93	0.075	0.91	0.084		
Med/Surg 3	95	0.084	1.08	0.103		
Med/Surg 4	95	0.021	–0.16	–0.015		
Rehab	71	0.113	0.57	0.041	0.048	0.113
Average Unit Rate		0.075				
Average Unit Z-score			0.555			
Weighted Z-score Average				0.520		
Weighted Z-score Average on Ulcer Rate Metric				0.074		

Table 6
Comparison of Hospitals by Measure

	Measure	Hospital 1	Hospital 2	Hospital 3
Method 1	Hospital Rate	0.070	0.070	0.070
Method 2	Average Unit Rate	0.075	0.075	0.075
Method 4	Average Unit Z-score	0.69	0.56	0.54
Method 5	Weighted Z-score Average	0.67	0.52	0.52
	Weighted Z-score Average (Ulcer Rate Metric)	0.085	0.074	0.075

Proposed Method. We propose reporting to hospitals the weighted z-score average (Method 5). While this adjusted rate may not be transparent to all hospital users, since it will not be the same as the raw rate they have internally, it can be used to track a hospital's performance across time and, unlike the other measures considered, allows for meaningful comparison (e.g. percentile ranking) of hospitals within a given comparison group. It should be noted that this adjusted rate is a relative measure, affected not only by the performance of the other NDNQI hospitals but also by changes in the set of hospitals and units reporting data to NDNQI; however, given the number of units participating in NDNQI, we expect unit type averages and standard deviations to be quite stable across time for most indicators.

Discussion

This study resulted in a method for incorporating mixed acuity units into NDNQI data collection and reporting and producing hospital-level indicators, capabilities desired by participating hospitals. These enhancements can be implemented with minimal increase to respondent burden.

The information gathered for the methods development study underscored the difficulty of creating risk adjusted patient outcome measure for acute care units, while maintaining a low

respondent burden and transparency for users. The analysis of billing days data from the special study illustrated that mixed acuity unit types can be created that are consistent with NDNQI's existing unit classification scheme. The consistency indicates criterion validity. The stratification of mixed acuity units into types I, Ii and III produced indicator results that were intermediate between existing unit types. Implementation of the mixed acuity unit types required hospitals to go through unit enrollment with the NDNQI liaisons. Hospitals should monitor changes to patient populations on mixed acuity units as signified by changes in the proportion of billing days by payment level. Updates to mixed acuity unit classifications would become part of the site coordinators' responsibility for unit classification maintenance.

The method developed for producing hospital-level indicators accounts for both the unit composition of hospitals, as well as variation in the size of the unit. Implementation of the method requires only that hospitals report on the number of staffed beds per unit. The resulting indicators are in the native metric of the original indicator and thus have a high level of transparency for report users.

Proposed Work Order

KUMCRI has developed a scope of work to implement data collection for mixed acuity units and create and report on hospital level indicators. The cost for this work is $113,874.

Mixed Acuity Units

1. Specifications
    a. Indicators:
        i. Adult mixed acuity units will be eligible for all adult critical care indicators
        ii. Pediatric mixed acuity units will be eligible for all pediatric indicators
    b. Proposed list of mixed acuity unit types
        i. Bone Marrow Transplant with adult or pediatrics as the specialty
        ii. Burn Unit with adult and pediatric as the specialty
        iii. Critical Access
        iv. Mixed Acuity III (adult or pediatric): Units with between 50-<90% billing days at the critical care level in an average month
        v. Mixed Acuity II (adult or pediatric): Units with 25-49% critical care days each month or 50-<90% step-down days each month; includes only units not meeting the criterion for Mixed Acuity III.
        vi. Mixed Acuity I (adult or pediatric): Units not meeting the criteria for Mixed Acuity III or II.
        vii. Also, identified as potential mixed acuity units are:
            0. General acute care/hospice
            1. General acute care/swing bed.
2. Enroll mixed acuity units into specific mixed acuity unit types
3. Statistical analysis
    a. Modify and test SAS code to apply to the new unit types
4. Reports
    a. Define report changes
    b. IT will program required changes into the database, XML, website, ETL, etc.
5. Education
    a. Revise guidelines, survey and scoring guide, and description/glossary
    b. Answer questions from users
    c. Hold a roll-out teleconferences
    d. Present new mixed acuity unit types in quarterly newsletter

Hospital Roll-up

1. New data collection on number of staffed beds per unit
2. Reporting for 25 primary indicators
    a. Total Nursing Hours Per Patient Day
    b. RN Hours Per Patient Day
    c. Percent of Total Nursing Hours Supplied by RNs
    d. Percent of RN Hours Supplied by Agency Staff
    e. Total Falls Per 1,000 Patient Days
    f. Injury Fall Rate (Injury Falls Per 1,000 Patient Days)

g. Unassisted Falls Per 1,000 Patient Days
h. Percent of Surveyed Patients with Hospital Acquired Pressure Ulcers
i. Percent of Surveyed Patients with Unit Acquired Pressure Ulcers
j. Percent of Surveyed Patients with Hospital Acquired Pressure Ulcers Stage II and Above
k. Percent of Surveyed Patients with Unit Acquired Pressure Ulcers Stage II and Above
l. Percent of Patients with Physical Restraints (Limb and Vest)
m. Central Line Associated Blood Stream Infections per 1000 Central Line Days
n. Catheter Associated Urinary Tract Infections per 1000 Catheter Days
o. Ventilator Associated Pneumonias per 1000 Ventilator Days
p. Voluntary Turnover Rate—All nursing staff
q. Voluntary Turnover Rate—RNs
r. Controllable Turnover Rate—All nursing staff
s. Controllable Turnover Rate—RNs
t. Total Turnover Rate—All nursing staff
u. Total Turnover Rate—RNs
v. Pediatric PIV rate
w. Pediatric Pain AIR Cycle
x. Pediatric Pain—Average number of Assessments per Patient within the last 24 hours
y. Psychiatric Injury Assault Rate (for hospitals in which there are multiple types of psychiatric units

3. Analysts will write code to calculate new hospital-level scores
4. Education
    a. Revise guidelines, survey and scoring guide, and description/glossary
    b. Answer questions from users
    c. Hold Teleconferences (include with mixed acuity teleconference)
    d. Include article on hospital level measures in the quarterly Newsletter
5. Reports:
    a. By unit: Add new hospital-level tables containing select indicators (see list above) to current reports. Hospital-level table shows up first if report of all unit types.
    b. By indicator: Add new hospital-level “unit type” to top of select indicator tables
    c. Include hospital roll-up on current dashboards and web charts