Economic Evaluation of the 80% Baccalaureate Nurse Workforce Recommendation

A Patient-level Analysis

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Background: Higher proportions of BSN-educated nurses were associated with improved outcomes in hospital-level studies. A recent Institute of Medicine report calls for increasing the proportion of BSN-educated nurses to 80% by 2020. Patient-level evidence of cost and quality implications of the 80% BSN threshold is needed for a business case to support these efforts.

Objectives: To conduct the economic analysis of meeting the 80% BSN threshold on patient outcomes and costs, using linked patient-nurse data.

Research Design: Retrospective observational patient-level analysis of electronic data. Linear and logistic regression modeling with patient controls and diagnosis and unit fixed effects.

Subjects: A total of 8526 adult medical-surgical patients matched with 1477 direct care nurses from an Eastern US academic medical center, during June 1, 2011–December 31, 2011.

Measures: Outcomes include hospital mortality, all-cause same-facility 30-day readmission, length-of-stay, and total hospitalization cost. BSN proportion is a continuous measure for the proportion of nurse assessment inputs into the patient's electronic medical record made by BSN-educated nurses; a dichotomous indicator for BSN proportion is 0.8–1.0.

Results: Continuous BSN proportion was associated with lower mortality (OR = 0.891, $P < 0.01$). Compared with patients with <80% BSN care, patients receiving ≥80% of care from BSN nurses had lower odds of readmission (OR = 0.813, $P = 0.04$) and 1.9% shorter length-of-stay ($P = 0.03$). Economic simulations support a strong business case for increasing the proportion of BSN-educated nurses to 80%.

Conclusions: A combined approach of increasing the hospital-level BSN proportion to 80% and assuring a high BSN dose through individual patient-level staffing assignments is needed to achieve projected quality and costs benefits.

Key Words: business case, 80% BSN, patient level

(*Med Care* 2014;52: 864–869)

A recent Institute of Medicine (IOM) report[1] calls for increasing the proportion of baccalaureate-educated (BSN) nurses in the workforce to 80% by 2020. Critical steps toward achieving the IOM recommendation are establishing an evidence base for the relationship between the recommended proportion of BSN-level staffing and patient outcomes and an evidence-informed business case for increasing the proportion of BSN-educated nurses to the recommended levels. The economic value of increasing the BSN nurse proportion within hospital staffing stems from improved patient outcomes, some of which can only be valued within a quality of life economic model (eg, lower mortality), while others produce direct savings (eg, fewer readmissions).

The evidence supporting the IOM recommendation is expanding. In a seminal study, Aiken et al[2] brought to national attention a link between nurse education and patient outcomes showing that in hospitals where the proportion of BSN-educated nursing staff was 10% higher, the odds of 30-day postsurgical mortality and failure to rescue were 5% lower. A subsequent meta-analysis in 2007[3] found that the limited evidence available at that time suggested an inverse association of BSN proportion with mortality and failure to rescue. More recently, 4 multihospital studies[4–7] added substantive support for a hospital-level association: hospitals with a 10% higher BSN proportion had a 4%–7% lower 30-day mortality,[4,6] with a greater effect for patients with complications,[5] and better outcomes on measures of failure to rescue,[4,7] congestive heart failure mortality, pressure ulcers, postoperative deep vein thrombosis or pulmonary embolism, and length-of-stay (LOS).[7]

Although the existing evidence has been influential in supporting the IOM recommendation, the growth of the BSN-prepared workforce has been slow, from 50% to 55%,

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O.Y. and R.L. were funded by the RWJ Call for Action: Future of Nursing Research Manager Program. O.Y. acknowledges support from AHRQ 5 T32 HS 017589.

The authors declare no conflict of interest.

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Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Website, www.lww-medicalcare.com.

ISSN: 0025-7079/14/5210-0864

in the first 3 years since the recommendation was issued in 2010.[8] Beginning in 2014, hospitals seeking Magnet hospital recognition must have an action plan and demonstrate progress toward achieving at least 80% of their staff holding a BSN or higher degree.[9] A better understanding of the variation in patient outcomes and costs around the 80% threshold is urgently needed to help health care institutions establish the business case for meeting the IOM target, and to facilitate the transition of the BSN-educated workforce to the recommended levels.

In addition to a lack of empirical evidence that specifically examines the 80% threshold, no studies to date have examined the relationship between nurse education and patient outcomes at the microlevel of a patient and their direct care nurses. While the fundamental origins of this relationship lie at the individual patient level, the current empirical evidence is based on aggregate hospital-level measures of nurse education and patient outcomes. Inference about microlevel relationships based on aggregated measures may be subject to the ecological fallacy principle that warns of potential misinterpretation of aggregate-level correlations in the presence of unobserved heterogeneity (eg, unmeasured unit-level and hospital-level practices),[10] and are also confounded by measurement error.[11]

This study contributes to the existing literature in 2 ways. First, we examine the potential impact of achieving the IOM target of 80% BSN workforce on patient outcomes and costs of care. Second, we use a unique dataset that recorded the actual contact between patients and nurses to create a variable that measures, at the individual patient level, the proportion of BSN nurses who provided direct nursing care to each patient.

METHODS

Study Design

This is a retrospective observational patient-level study of the association between the proportion of care received from a BSN-educated nurse (BSN proportion) and patient mortality, readmission, LOS, and inpatient costs. Specific attention was given to the 80% and above range of BSN proportions. All study data were extracted from electronic databases at the study hospital. The study was approved by the hospital's Institutional Review Board.

Sample and Setting

The sample was derived from adult nonpsychiatric inpatient discharges from an urban Magnet-designated academic medical center.

Our data extraction criteria included all discharges from medical-surgical units of adult (18 and older) patients during a 7-month period between June 1, 2011 and December 31, 2011 and their direct care nurses, resulting in a linked sample of n = 10,310 patients and n = 1477 nurses. We excluded patient admissions for observation or LOS of ≤24 hours (n = 1260) and for pediatric or nonmedical-surgical services (n = 524), resulting in the final sample of 8526 eligible inpatient discharges.

Measures

Patient Outcomes

In-hospital all-cause mortality and same-hospital all-cause 30-day readmission were coded as dichotomous variables with nonoccurrence as the reference category. LOS was computed in minutes from the time of admission to the time of discharge and then rescaled to represent days. Inpatient costs were calculated using the sum of direct and indirect costs from the hospital's cost accounting system.

BSN Proportion

The amount of individual patient exposure to BSN nurses during an inpatient stay is a measure of the dose of BSN-level care. The concept of nurse dose is comprised of 2 attributes: (1) nursing knowledge, the "active ingredient" unique to nursing, that is operationalized as education, experience, and skill mix; and (2) intensity, an indicator of patient care capacity, that is operationalized as amount and frequency of nurse-patient interaction.[12–14]

Recent advances in hospital data management technologies allowed us to measure the dose of BSN-level care provided to each patient over the course of their entire hospitalization. Each nurse assessment entered into a patient's electronic medical record was treated as assignment of the nurse as the direct care provider to the patient at that time. Nurse identifiers in the electronic record were linked to level of education retrieved from the hospital's nursing administrative database. The BSN proportion was calculated as the ratio of the number of nurse assessments made by a nurse with a BSN or post-baccalaureate degree to the total number of nurse assessments during a patient's hospitalization. The BSN proportion was measured as a continuous (range 0–1), and a categorical variable (BSN proportion ≥ 0.80).

Patient control variables were consistent with controls for patient outcomes in earlier studies[15]: demographic characteristics (age in years, sex), insurance, the type of service (medical, surgical), and hospitalization within 30 days before the index admission. The Rothman Index (RI) score was used as a measure of severity of the patient's clinical condition on admission,[16–18] to reduce potential bias from selective matching of better educated nurses to higher risk patients.[19] The RI score was calculated using proprietary software adopted by the study site, and is an integrated measure of 26 clinical parameters available in the electronic health records, including nurse assessments using parameters that reflect the patient's condition (eg, food/nutrition, skin, psychosocial, etc.), vital signs, heart rhythms, and results of laboratory tests. The RI score has a range of −69 to 100, with higher values indicating better clinical condition. RI scores have been associated with risks of 30-day mortality and unplanned readmission.[16–18,20]

Analysis Methods

We estimated patient-level regression models with diagnosis and unit fixed effects to test the associations of each of the outcome variables with the BSN proportion measures, controlling for patient characteristics. We first measured the change in each outcome associated with a 10%

increase in the continuous BSN proportion, for comparison with papers by Aiken and colleagues.[2,4–6] We then replaced the continuous measure with a categorical variable for ≥ 80% BSN proportion.

Because patients with lower severity of illness were assessed less frequently and had shorter hospitalizations, they had fewer nurse assessment points for calculating the BSN dose. Therefore, they were more likely to have either high or low BSN proportions (while patients with a large number of nurse assessments tended to be near the sample mean, 57% BSN). This systematic variation in the severity of illness along our BSN measure could bias our analyses, particularly in the categorical models for ≥ 80% BSN. We tested 1st–10th degree polynomials of the number of nurse assessments, using the admission RI score to measure patient severity. The tests favored a hexic polynomial (6th degree) specification, which we included in all models (see Online Supplement Figure 1, Supplemental Digital Content 1, http://links.lww.com/MLR/A762 for uncorrected and corrected data.)

We estimated a complementary log-log regression rather than conventional logistic regression to examine mortality due to the low incidence (n = 184) of the outcome of interest.[21] Logistic regression was used to examine readmission; and ordinary least squares regressions were estimated for LOS and costs. Because of positively skewed distributions, LOS and costs were log-transformed before estimation[22–24] and the estimated coefficients can be interpreted as the approximate percentage changes. For the 80% BSN threshold, the coefficients represent the approximate percentage reduction in LOS and costs for patients in 0.80–1.00 BSN proportion range, relative to patients with BSN proportions lower than 0.80. The resulting predicted values were adjusted for smearing[24] to allow for interpretation on the untransformed scale. We also estimated generalized linear models with log-links but specification tests supported the ordinary least squares model with a logged dependent variable.[23]

Our fixed effect approach adjusted for a full set of diagnosis and unit assignment profile groups, to reduce potential endogeneity bias from selective assignment of BSN nurses to patients with more complex diagnoses and units with high-risk patients, such as intensive care units. Discharge diagnosis groups were categorized using the Agency for Healthcare Research and Quality Clinical Classification Software.[25] Unit assignment profile fixed effects fully captured each patient's admissions/discharges/transfers during hospitalization. Categories with ≥ 15 patients with the same diagnosis or unit assignment profile were assigned a unique fixed effect; the rest were combined into the respective diagnosis and unit assignment profile reference groups, resulting in 110 diagnosis and 115 unit assignment profile fixed effects. Fixed effect categories with at least 15 observations per category reduced finite sample bias from inclusion of fixed effects in a nonlinear model.[26]

We conducted policy simulations for each outcome with a significant relationship to the 80% BSN threshold using the regression estimates to compute predicted outcomes under the assumption that all patients receive care in the 0.80–1.00 BSN proportion range, resulting in an estimate of the improvement in outcomes relative to the observed sample mean. Predicted cost reductions were aggregated to estimate annual cost savings, based on annualized eligible discharges at the study site.

We estimated the incremental increase in annual salary of transitioning from the current BSN staffing level of 57%–80% and 100% BSN staffing as follows. First, we estimated the current average annual staff nurse earnings using the observed 57% BSN-educated nursing staff in the study sample and the national averages of annual nurse earnings for nurses with and without a baccalaureate degree ($60,890 and $66,316, respectively), from the 2008 National Sample Survey of Registered Nurses.[27] Then, we replaced the current BSN proportion with the low and the high bounds of the 80%–100% range and calculated the increase in salary needed to achieve each threshold.

All analyses were conducted in STATA 11.0 (College Station, TX) statistical software.

RESULTS

The sample of patients was 50.8% male, with a mean age of 56.3 years, and comprised of 59.4% medical and 40.6% surgical discharges (Table 1). The average RI score at admission was 73.74 (ranging from −23 to 99), which is consistent with other studies that used the RI score.[16–18,20] Approximately, 15% of the sample had a prior hospitalization within 30 days of admission. On average, patients were linked to 8.93 nurses over the course of hospitalization (range, 1–188) and were assessed by nurses 2.80 times per day (range, 0.6–12). Approximately one fifth of the sample (n = 1554) received ≥ 80% of their care from BSN-educated nurses.

The in-hospital mortality rate was 2.2% (n = 184), and the readmission rate was 15.1% (n = 1286). Raw means of LOS and costs were 6.34 days (median, 4 d; range, 1–474 d) and $22,751.33 (median, $11,920.13; range, 0–$1,150,377.00), respectively. The skewness statistic was 14.31 for LOS and 9.75 for cost, suggesting a high degree of positive skewness, which motivated us to use a log transformation for these variables. Smearing-adjusted retransformed means of the log-transformed LOS and costs were 3.89 days and $12,981.73, respectively.

Association Between Patient Outcomes and Nurse Education

There was an inverse association between the continuous BSN proportion and the odds of in-hospital mortality (Online Supplement Table 1, Supplemental Digital Content 2, http://links.lww.com/MLR/A763). Adjusted for patient control variables and fixed effects, a 10% increase in the proportion of BSN-educated care was associated with a 10.9% reduction in the odds of mortality, OR = 0.891 ($P < 0.01$). Using the continuous BSN proportion measure, associations with odds of readmission, LOS, and costs were not statistically significant.

The estimates from the categorical models revealed strong associations between the 80% threshold and 2 of the 4 patient outcomes (Online Supplement Table 2, Supplemental

TABLE 1. Descriptive Statistics of Sample, N = 8526

Variables	N (%)
Age	
Mean (SD)	56.30 (19.31)
Sex	
Male	4331 (50.8)
Female	4195 (49.2)
Insurance type	
Medicare	3396 (39.8)
Medicaid	1972 (23.1)
Blue Cross/commercial	2885 (33.8)
Other/uninsured	273 (3.2)
Service type	
Medical	5064 (59.4)
Surgical	3462 (40.6)
Hospitalization within 30 d before admission	
No	7284 (85.4)
Yes	1242 (14.6)
Rothman index (RI) at admission	
Mean (SD)	73.74 (18.66)
Proportion of care received from BSN-educated nurses	
0–0.39	1950 (22.9)
0.40–0.59	2531 (29.7)
0.60–0.79	2491 (29.2)
0.80–1.00	1554 (18.2)
Mean (SD)	0.57 (0.24)
Patient died during hospitalization	
No	8342 (97.8)
Yes	184 (2.2)
Patient readmitted within 30 d	
No	7240 (84.9)
Yes	1286 (15.1)
Length of stay (d)	
Mean (SD)/median/retransformed mean*	6.34 (11.63)/4/3.89
Total cost of hospitalization ($)	
Mean (SD)/median/retransformed mean*	22,751.33 (41,600.32)/11,920.13/ 12,981.73

*Retransformed mean of the log-transformed variable.

Digital Content 3, http://links.lww.com/MLR/A764). The association of the categorical BSN measure and mortality was not statistically significant in this sample (OR = 0.788, $P = 0.36$) (Fig. 1). Compared with patients with < 80% proportion of care from BSN-educated nurses, patients who received ≥ 80% of care from BSN nurses had 18.7% lower odds of readmission (OR = 0.813, $P = 0.04$). The predicted readmission rate was 15.7% for BSN proportion of < 0.80 and 13.4% for BSN proportion ≥ 0.80 (Fig. 2). Patients with BSN proportions in the 0.80–1.00 range had a 1.9% ($P = 0.04$) shorter LOS. The smearing-adjusted predicted LOS decreased from 3.90 days for BSN proportion < 0.80 to 3.83 days when BSN proportion was 0.80–1.00 (Fig. 3). The association of BSN proportion and inpatient costs was not significant (0.006, $P = 0.70$) (Online Supplement Figure 2, Supplemental Digital Content 4, http://links.lww.com/MLR/A765).

Simulations

Simulations of the reduction in readmission risk associated with raising the BSN proportion to ≥ 80% for all patients resulted in an estimated reduction in the aggregate readmission rate of 1.7 percentage points (sample average of

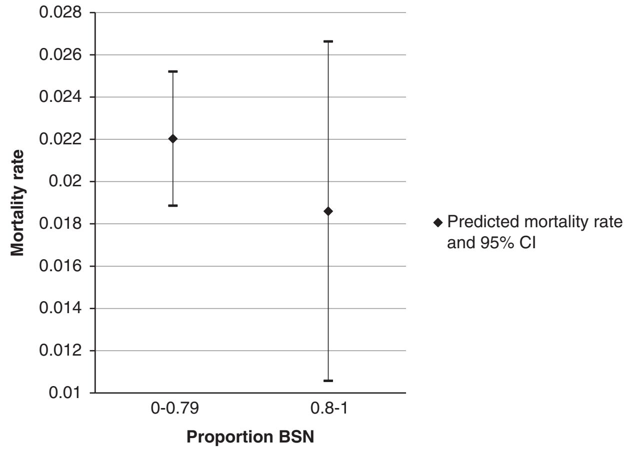

FIGURE 1. The predicted rates of in-hospital mortality, and the 95% confidence interval (CI) bounds, for the BSN categories of 0–0.79 and 0.80–1, calculated using the predictions of the adjusted categorical BSN model, N = 8256.

15.1% minus simulated average of 13.4% for the 0.80–1.00 BSN range). Simulations of LOS resulted in average reductions of 0.06 days (sample average LOS, 3.89, minus the simulated LOS 3.83 per patient). On the basis of the annualized eligible patient discharge volume for the study site (n = 14,616), increasing BSN nurse dose to ≥ 80% for every patient was estimated to reduce annual readmissions by 248.47 cases and inpatient days by 876.96 days. On the basis of the sample average of inpatient cost of $22,751.33, the cost savings from the reduced readmissions were estimated to be $5,653,022.97 annually.

The incremental annual salary expenditures from increasing the BSN-educated staff to the 0.80–1.00 range were estimated to be $1247.98 per nurse for the 0.80 bound and $2333.18 per nurse for the 1.00 bound, or $1,843,266.46–$3,446,106.86 for the 1477 nurses included in the study.

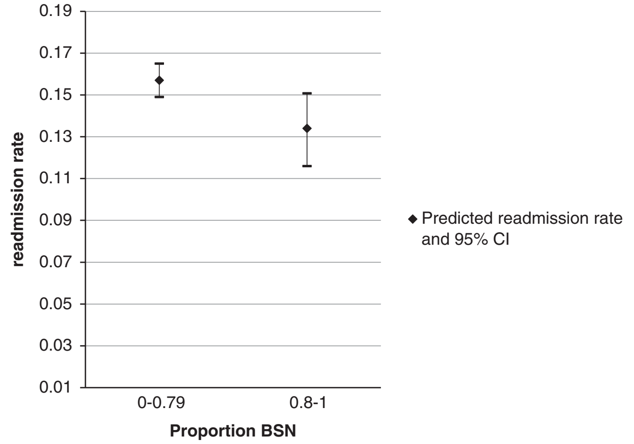

FIGURE 2. The predicted rates of 30-day readmission, and the 95% confidence interval (CI) bounds, for the BSN categories of 0–0.79 and 0.80–1, calculated using the predictions of the adjusted categorical BSN model, N = 8526.

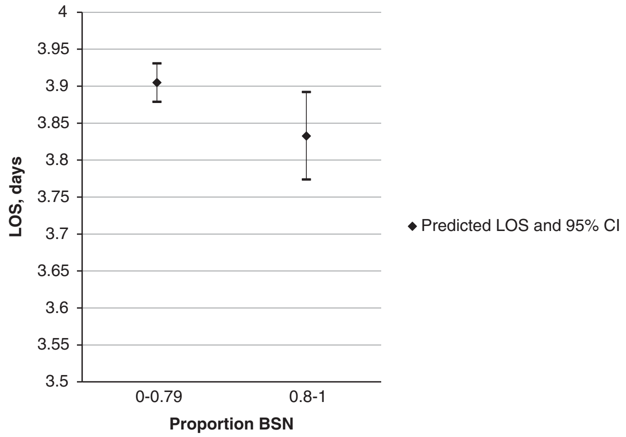

FIGURE 3. The predicted values of the length of stay, and the 95% confidence interval (CI) bounds, for the BSN categories of 0–0.79 and 0.80–1, calculated using the predictions of the adjusted categorical BSN model, N = 8526.

DISCUSSION

There was a strong association between the proportion of care received from BSN-educated nurses and improved patient outcomes of mortality, readmission, and LOS. In the analysis of the continuous BSN proportion measure, a 10% increase in the patient-level BSN dose was associated with an 10.9% reduction in the odds of in-hospital mortality, whereas the associations with readmission, LOS, and costs were not significant. In the categorical analyses of the 0.8–1.0 BSN proportion, patients receiving ≥ 80% care from BSN-educated nurses had an 18.7% reduction in the odds of readmission and a 1.9% reduction in LOS. The 21.2% estimated reduction in mortality odds was not significant, likely due to infrequent mortality of patients in the 80% and above BSN category (n = 27). Taken together, the results of this study reveal that mortality was continuously improving over the entire observed range of BSN proportions, whereas readmission and LOS were sensitive to BSN thresholds of ≥ 80%.

Economic simulations revealed that increasing the BSN dose to ≥ 80% for every eligible patient could potentially result in about 248 fewer readmissions and over $5.6 million in related annual savings for the study site's eligible patient population.

These findings support the premise that increasing the BSN proportion to ≥ 80% has the potential to improve patient outcomes and reduce costs. To achieve these improved outcomes, increasing the hospital-level proportion of BSN-educated staff nurses to ≥ 80% will need to be combined with staff management practices aimed at tracking assignment of direct care nurses to ensure a consistent dose of BSN care at the individual patient level.

Increasing the proportion of BSN-educated nurses would involve a significant commitment of organizational resources—over $1.8 million annually in increased salary costs to reach the 80% threshold for our annualized study sample, and over $3.4 million annually to reach 100% BSN, not including other forms of compensation (eg, education benefits for upgrading) or onboarding costs for new staff, which could add a 1-time expense of up to $60,000 per new hire.[28] Nevertheless, when compared with the potential perpetual stream of savings of over $5.6 million annually, our study findings provide strong support for an economic business case for investments in nurse education to meet the IOM target of 80% of BSN-educated nursing staff.

In the current reimbursement environment, some readmissions are reimbursed and others are not. When readmissions are prevented, savings from nonreimbursed cases accrue to the hospital, whereas savings from reimbursed readmissions accrue to public and private payers. This weakens the business case for investments in nurse education from the hospital's perspective. In contrast, hospitals with substantial unpaid readmissions and those that do not pay a premium for BSN-educated nurses, the business case will be stronger than estimated. As payment reform under the Affordable Care Act moves forward with readmission penalties and other performance-based reimbursement models, the hospital-level business case for investing in nurse education will continue to strengthen.[29]

The methodological strength of the study lies in using patient-level data linked to direct care nurses. The nurse-patient link enabled us to examine the relationship between nurse education and patient outcomes with greater reliability and precision, by avoiding the ecological inference fallacy and reducing measurement error. Measured at the individual patient level, a 10% increase in the BSN proportion reduced the odds of mortality by 10.9%, which is a larger effect than the 4%–7% reduction in mortality reported in aggregate-level studies.[4,6] Although the effect sizes are not directly comparable due to differences in outcome measures, sampled patient populations, and methodological differences unrelated to aggregation, the evidence of a strong patient-level association supports—and strengthens—the earlier hospital-level findings.

This study is subject to several limitations. First, the data came from a single facility with a high proportion of BSN-educated nursing staff, limiting generalizability to other settings. The effect of increasing the proportion of BSN-trained nurses may be substantially different in hospitals with different quality improvement processes, management practices, and other unmeasured characteristics that are correlated with the outcomes and also influence the effectiveness of the BSN degree. The cost analyses were specific to the study hospital; the business case will vary for other hospitals depending on their current BSN percentage, hospital-specific and regional differentials in BSN and non-BSN salaries, and patient mix. Information on onboarding costs is limited and may underrepresent current costs.

Second, the BSN-educated nurse dose was measured using the proportion of nurse assessments entered by a BSN-trained nurse and did not include care intensity or process measures. The study did not examine or control for nurse experience and skill level, nor their interaction. Third, the study used in-hospital mortality rates because 30-day mortality rates were unavailable; this also prevented us from adjusting the readmission models for the competing risk of 30-day mortality, possibly causing a downward bias in the readmission analyses. Fourth, the readmission measure did not include return visits to other facilities, which accounted for 19% of heart failure readmissions in 2006 CMS data[30] and could have further biased the effect on readmission downward. Fifth, the RI score was based on clinical indicators and nurse assessments only, and did not include direct measures of severity of illness. The diagnosis fixed effects were based solely on the primary discharge diagnosis and did not include secondary diagnoses and complications. Finally, causal inference is limited by endogeneity bias due to nonrandom nurse assignment and because BSN-educated nurses may have other unobserved characteristics that contribute to high-quality care. Purposeful assignment of better educated nurses to more complex patients would bias our results downward, especially if the RI adjustment did not fully capture severity of illness and risk of mortality.

Implications for Policy and Organizational Decision Making

The study provides foundational evidence in support of a business case for national initiatives to increase the BSN-educated workforce >80% and for consideration of the education mix when assigning nursing staff to patients. National policy efforts to increase funding for BSN-level education and to stimulate hospitals to transition to BSN-level staffing are critical to achieving workforce and patient outcome goals.

Hospital executive leadership is responsible for internal policy-setting regarding the minimum preparation levels of new employees. They can create incentives and support existing employees who pursue academic degrees and certifications. Administrators should also consider the proportion of BSN nurses when assigning staff to patients to ensure that each patient receives high-quality care.

The evidence that supports a business case for a BSN-prepared nursing staff is robust and continues to strengthen, further justifying hiring and education policies that favor BSN-educated nurses. The societal return on investment of a BSN workforce will be realized through achieving the Triple Aims of health care reform—high-quality care, improved health outcomes, and lower costs.[31]

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