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 $\geq 80\%$ 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

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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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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 $\leq$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 $\geq$ 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 $\geq 80\%$ 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 $\geq 80\%$ 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 $\geq 80\%$ 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 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.

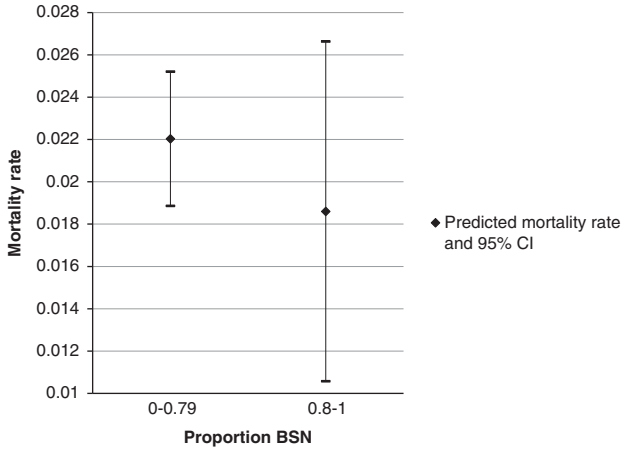

FIGURE 1. The predicted rates of in-hospital mortality, and the 95% confidence interval (CI) bounds, for the BSN categories of 0–0.79 and 0.80–1, calculated using the predictions of the adjusted categorical BSN model, N = 8256.

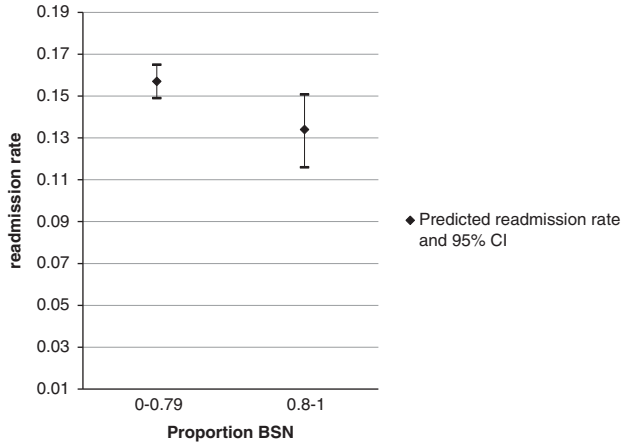

FIGURE 2. The predicted rates of 30-day readmission, and the 95% confidence interval (CI) bounds, for the BSN categories of 0–0.79 and 0.80–1, calculated using the predictions of the adjusted categorical BSN model, N = 8526.

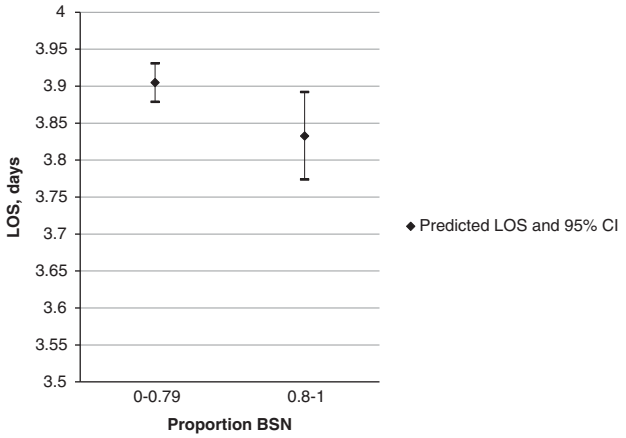

FIGURE 3. The predicted values of the length of stay, and the 95% confidence interval (CI) bounds, for the BSN categories of 0–0.79 and 0.80–1, calculated using the predictions of the adjusted categorical BSN model, N = 8526.

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 $\geq 80\%$ 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 $\geq 80\%$.

Economic simulations revealed that increasing the BSN dose to $\geq 80\%$ 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 $\geq 80\%$ 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 $\geq 80\%$ 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]

REFERENCES

1. Institute of Medicine. *The Future of Nursing: Leading Change, Advancing Health*. Washington, DC: National Academies Press; 2011.
2. Aiken LH, Clarke SP, Cheung RB, et al. Educational levels of hospital nurses and surgical patient mortality. *JAMA*. 2003;290:1617–1623.
3. Kane RL, Shamliyan T, Mueller C, et al. *Nursing Staffing and Quality of Patient Care. AHRQ Publication No. 07-E005: Evidence Report/Technology Assessment No. 151 (Prepared by the Minnesota Evidence-based Practice Center under Contract No. 290-02-0009)*. Rockville, MD: Agency for Healthcare Research and Quality; 2007.
4. Aiken LH, Cimiotti J, Sloane DM, et al. The effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Med Care*. 2011;49:1047–1053.
5. Kutney-Lee A, Sloan DM, Aiken LH. An increase in the number of nurses with baccalaureate degrees is linked to lower rates of postsurgery mortality. *Health Aff (Millwood)*. 2013;32:579–586.
6. Aiken LH, Sloane DM, Bruyneel L, et al. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet*. 2014;383:1824–1830.
7. Blegen MA, Goode CJ, Park SH, et al. Baccalaureate education in nursing and patient outcomes. *J Nurs Adm*. 2013;43:89–94.
8. Health Resources and Services Administration, National Center for Health Workforce Analysis. The US nursing workforce: trends in supply and education, 2013. Available at: http://bhpr.hrsa.gov/healthworkforce/reports/nursingworkforce/nursingworkforcefullreport.pdf.
9. Magnet Recognition Program® Overview. Washington, DC: American Nurse Credentialing Center. Available at: http://www.nursecredentialing.org/Magnet/ProgramOverview. Accessed May 26, 2013.
10. Schwartz S. The fallacy of the ecological fallacy: the potential misuse of a concept and the consequences. *Am J Public Health*. 1994;84:19–824.
11. Clarke SP, Donaldson NE. Nurse staffing and patient care quality and safety. In: Hughes RG, ed. *Patient Safety and Quality: An Evidence-based Handbook for Nurses. AHRQ Publication No. 08-0043 (Prepared with support from the Robert Wood Johnson Foundation). Vol. 2*. Rockville, MD: Agency for Healthcare Research and Quality; 2008:111–136.
12. Manojlovich M, Sidani S. Nurse dose: what's in a concept? *Res Nurs Health*. 2008;31:310–319.
13. Sidani S, Manojlovich M, Covell C. Nurse dose: validation and refinement of a concept. *Res Theory Nurs Pract*. 2010;24:159–171.
14. Manojlovich M, Sidani S, Covell C, et al. Nurse dose: linking staffing variables to adverse patient outcomes. *Nurs Res*. 2011;60:214–220.
15. Kansagara D, Englander H, Salanitro A, et al. Risk prediction models for hospital readmission: a systematic review". *JAMA*. 2011;306:1688–1698.
16. Rothman SI, Rothman MJ, Solinger AB. Placing clinical variables on a common linear scale of empirically-determined risk: a step toward construction of a general patient condition score from the Electronic Health Record. *BMJ Open*. 2013;3:e002367.
17. Rothman MJ, Rothman SI, Beals J IV, et al. Development and validation of a continuous measure of general patient condition spanning the hospital acuity spectrum using common electronic medical record data. *J Biomed Inform*. 2013;46:837–848.
18. Rothman MJ, Solinger AB, Rothman SI, et al. Clinical implications and validity of nursing assessments: a longitudinal measure of patient condition from analysis of the electronic medical record. *BMJ Open*. 2012;2:e000849.
19. Rosenbaum PR. Discussing hidden bias in observational studies. *Ann Intern Med*. 1991;115:901–905.
20. Bradley E, Yakusheva O, Horwitz LI, et al. Identifying patients at increased risk for unplanned readmission. *Med Care*. 2013;51:761–766.
21. Clayton DG, Hills M. *Statistical Models in Epidemiology*. Oxford, UK: Oxford University Press; 1993.
22. Manning WG. The logged dependent variable, heteroscedasticity, and the retransformation problem. *J Health Econ*. 1998;17:283–295.
23. Manning WG, Mullahy J. Estimating log models: to transform or not to transform. *J Health Econ*. 2001;20:461–494.
24. Duan N. Smearing estimate: a nonparametric retransformation method. *J Am Stat Assoc*. 1983;78:605–610.
25. HCUP Clinical Classifications Software (CCS) for ICD-9-CM. Healthcare Cost and Utilization Project (HCUP). 2006-2009. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp. Accessed July 11, 2013.
26. Greene W. The behaviour of the maximum likelihood estimator of limited dependent variable models in the presence of fixed effects. *Economet J*. 2004;7:98–119.
27. US Department of Health and Human Services, Health Resources and Services Administration. *National Sample Survey of Registered Nurses [database online]*. Rockville, MD: US Department of Health and Human Services, Health Resources and Services Administration; 2008.
28. Jones CB. The costs of nursing turnover, part 2: application of the nursing turnover cost calculation methodology. *J Nurs Adm*. 2005;35:41–49.
29. Yakusheva O, Wholey D, Frick K. What can we learn from the existing evidence of the business case for investments in nursing care: importance of content, context, and policy environment. *Med Care*. 2013;51:S47–S52.
30. Nasir K, Lin Z, Bueno H, et al. Is same-hospital readmission rate a good surrogate for all-hospital readmission rate? *Med Care*. 2010;48:477–481.
31. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff (Millwood)*. 2008;27:759–769.

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HEALTH SERVICES RESEARCH IMPACTS DEBATE

In a highly controversial decision in 1965, the American Nurses Association called for the baccalaureate degree in nursing (BSN) to be required for licensure of professional nurses by 1985.[1] However, hospital diploma education—the pathway to nursing for most students in 1965—gave way not to bachelor's education but largely to associate degree education, fueled by public subsidies to community colleges. Meanwhile, many other countries, including Canada, Australia, New Zealand, Norway, Spain, Philippines, and many in South America, standardized entry into professional nursing at the baccalaureate level. In the United States, where physicians have the most years of education of any country in the world, nursing education pathways remain varied and confusing to prospective nurses, employers, and consumers alike, and two thirds of new RNs still enter practice with less than a baccalaureate degree.[2] However, a decade of health services research showing better patient outcomes associated with better educated nurses has had a remarkable impact on employer preferences for nurses with baccalaureate qualifications,[3] the return of 100,000 RNs to school to obtain BSNs,[4] and may well be the catalyst for achieving in the future a largely bachelor's educated nurse workforce in the United States after decades of debate.

The breakthrough in health services research came with the reconceptualization of nurses' education as a modifiable property of a health care organization,[5] much like the Institute of Medicine's redefinition of patient safety as a property of an organization.[6] In both cases, new definitions served as catalysts for action on old problems by putting the onus on health care organizations to respond. The initial paper defining BSN education as a modifiable property of hospitals was a study of outcomes following general surgery in 168 Pennsylvania hospitals in 1999. Each 10% increase in the proportion of BSN staff nurses was associated with 5% lower odds on death and failure to rescue after taking into account how sick the patients were and other characteristics of hospitals that had been shown to be associated with mortality rates, including physician qualifications.[5] A front page story about these findings in the Newark Star Ledger published the names of major New Jersey hospitals linked to the proportion of their bedside nurses who were bachelor's qualified, an illustration of the action potential for changing practice by engaging employers for the first time in a meaningful way.[7] The American Organization of Nurse Executives, a subsidiary of the American Hospital Association, issued a historic statement not long after the publication and extensive media coverage of the paper supporting the BSN as the desired credential for hospital nurses. From a methodological perspective, nurses' education as an organizational property, operationalized as the percentage of bedside care nurses with BSNs or higher, was a reasonably straightforward dashboard measure that could be monitored by individual organizations and included in large-scale studies of hospital performance.

Other studies followed, replicating and expanding the evidence of an association between BSN qualifications and better patient outcomes.[8,9] Replications in other countries

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with differently organized and financed health care yielded remarkably similar findings, including Canada,[10] 9 countries in Europe,[11] and China[12] where patient satisfaction was the outcome measure because of the absence of standardized mortality data. Recently, researchers expanded from cross-sectional to hospital panel data to probe causality in the relationship between BSNs and patient outcomes. Results show that hospitals that increased their proportion of nurses with BSNs over time have greater reductions in mortality and failure to rescue than do hospitals that did not.[13]

RESEARCH DRIVING CHANGE

The 2010 Institute of Medicine's (IOM) recommendation in its report on *The Future of Nursing* that the nation move to a nurse workforce comprising 80% BSNs by 2020 would not have been made in the absence of a robust evidence base.[14] The goal set by the IOM is daunting as only a little over half of the nurses have BSNs, and those who do are not distributed equally by geography, reflecting variations in the state support for baccalaureate nursing education. A recent report suggests that Pennsylvania hospitals, for example, would have to increase employment of BSNs by 78% overall between 2006 and 2020 to meet the IOM target of 80% BSNs.[15] Moreover, although some hospitals have moved to all bachelor's-qualified nurses, as of 2006, the latest comprehensive data on the distribution of proportion of BSNs at the hospital level, there was significant variation across hospitals in BSN employment with at least 10% of hospitals employing <20% of nurses with BSNs.[8]

To make such a large change, employers need evidence that it is in their interests to do so. The paper by Yakusheva et al in this issue of *Medical Care* is an innovative and timely study contributing to the development of the business case in support of hospitals making the transition to a largely BSN nurse workforce.[16] The authors depart from the design of previous large-scale studies of nurses' education and patient outcomes and focus on a single hospital in which they overcome a limitation of previous studies by linking specific nurses with specific patients. They determined from nurses' assessments entered into a patient's electronic medical record, matched with hospital administrative records, whether the nurse responsible for each patient had a BSN. The BSN proportion was measured by the ratio of the number of nurse assessments made by a nurse with a BSN to the total number of nurse assessments during a patient's hospitalization, with appropriate adjustments for length of stay. They found that a 10% increase in BSN proportion reduced the odds of mortality by 10.9%, an effect size larger than reported in previous studies in which specific nurses could not be matched to specific patients and where effect sizes ranged from 4% to 7% reduction in the odds of mortality.

Their approach is intuitively appealing and provides additional evidence validating the association found in multihospital studies between baccalaureate nursing education and better outcomes for patients. This study, like that of Needleman et al[17] on the impact of nurse staffing on mortality in a single hospital, illustrates the value of researchers using different designs to address similar research questions, especially if the findings of earlier studies have been considered controversial by some stakeholders. There has been a useful order in how research on the association between nurse education and nurse staffing on patient outcomes evolved with studies "too large to ignore" first capturing stakeholder attention[5,8,10,11] and setting the stage for the innovative single-hospital study in this issue[16] to have greater impact than might have been the case in the absence of the larger studies. The success of single-site studies with novel designs by Yakusheva et al,[16] and by Needleman et al,[17] in producing significant results should send a cautionary message to those who would use null findings from a single institution and small studies to try to discount mounting evidence from more rigorous research. Null findings may be less a reflection of the absence of an association between the factors of interest and more a reflection of study design and measurement limitations.

BUSINESS CASE FOR 80% BSN WORKFORCE

The economic evaluation of the 80% BSN nurse workforce recommendation ploughs new ground and is valuable from a number of perspectives. The paper provides compelling evidence that the employment of a largely BSN nurse workforce can return financial value to institutions and third-party payers, as well as better outcomes for patients. This has been difficult to examine in previous studies that have operationalized BSN contribution as the percentage of bedside care nurses qualified at the BSN level or higher because there are still relatively few entire hospitals with 80% BSN nurses. The strategy of calculating the "dose" of BSN care at the individual patient level enables a reasonable test of whether there is a threshold effect on certain patient outcomes that have been difficult to discern in previous research. Readmissions and length of stay are important examples relevant to the business case. Hospital readmission rates have been found to be associated with nurse staffing and the quality of nurse work environments,[18] and thus with CMS penalties for excessive readmissions,[19] but not with the proportion of nurses qualified at the baccalaureate level. The paper in this issue, like previous research, did not find a significant association between nurses' education and readmissions and length of stay using continuous measures of proportion of BSNs. However, significant associations were found between the proportion of BSNs and readmissions and length of stay when individual patients got $\geq 80\%$ of their care from BSN-qualified nurses. This finding of a threshold effect may help explain why other research has not documented the expected association between readmissions, length of stay, and BSN education, and suggests new research strategies in the future, especially as more hospitals achieve the 80% target.

Economic simulations revealed for the study hospital that increasing the BSN dose to 80% for every patient could potentially result in $5.6 million in savings annually, primarily due to decreased readmissions and slightly shorter lengths of stay that would more than offset annual costs of about $1.8 million in increased salaries associated with BSN qualifications. For the many hospitals that do not provide a

salary differential for nurses with BSNs, the business case would be stronger. Admittedly, these are best estimates and do not take into account potential savings that might be achieved through improved patient outcomes not measured in this study, such as infection reduction, or potential costs for achieving the 80% BSN target, including, for example, tuition and other institutional costs associated with assisting already employed RNs obtain BSN education. In addition, as noted by the authors, value-based purchasing is still evolving and does not yet fully reward hospitals for cost savings that often accrue to public and private payers even though the hospital largely bears the costs.

There will undoubtedly be naysayers who will be tempted to critique some details of the study's design and variable measurement. Estimating the proportion of BSN care provided to a single patient using the educational credentials of the RN completing recorded nursing assessments in the electronic health record is creative and may be accurate. However, as the authors note, it was not possible to take into account skill mix and other details of direct care provision, largely because electronic health records are still evolving and do not yet encompass many important elements of professional nursing care.

Yakusheva et al are to be congratulated for significantly adding to our understanding of relationships between nurses' education and patient and economic outcomes of hospital care. Their findings will stimulate other research innovations that will continue to advance outcomes research and impact practice and policy decisions. The study's findings of a business case supporting an 80% BSN nurse workforce should serve as a catalyst to hasten a transition that has been a long time in the making and remains in the public's interest.

REFERENCES

1. American Nurses Association (ANA). Compendium of ANA education positions, position statements, and documents, 2013. Available at: http://nursingworld.org/MainMenuCategories/Policy-Advocacy/State/Legislative-Agenda-Reports/NursingEducation/NursingEducationCompendium.pdf. Accessed August 4, 2014.
2. National League for Nursing (NLN). Nursing data review academic year 2007-2008, 2010. Available at: http://www.nln.org/researchgrants/slides/ndr_0708.pdf. Accessed August 4, 2014.
3. Caramanica L, Thompson PA. AONE survey: gauging hospitals' use of preferential hiring policies for BSN-prepared nurses, 2012. Available at: http://www.aone.org/resources/publications/PDFs/Jan2012Voice.pdf. Accessed August 4, 2014.
4. American Association of Colleges of Nursing. Research brief on the employment of new nurse graduates and employer preferences for baccalaureate-prepared nurses, 2012. Available at: http://www.aacn.nche.edu/leading_initiatives_news/news/2012/employment12. Accessed August 4, 2014.
5. Aiken LH, Clarke SP, Cheung RB, et al. Educational levels of hospital nurses and surgical patient mortality. *JAMA*. 2003;290:1617–1623.
6. Institute of Medicine. *To Err is Human: Building a Safer Health System*. Washington: The National Academies Press; 2000.
7. Stewart A. *Surgical Death Rates are Tied to Level of Nurses' Education*. Newark: Star Ledger; 2003.
8. Aiken LH, Cimiotti J, Sloane DM, et al. The effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Med Care*. 2011;49:1047–1053.
9. Blegan MA, Goode CJ, Park SH, et al. Baccalaureate education in nursing and patient outcomes. *J Nurs Adm*. 2013;43:89–94.
10. Estabrooks CA, Midodzi WK, Cummings G, et al. The impact of hospital nursing characteristics on 30-day mortality. *Nurs Res*. 2005;54:74–84.
11. Aiken LH, Sloane DM, Bruyneel L, et al. Association of nurse staffing and education with hospital mortality in 9 European countries. *Lancet*. 2014;383:1824–1830.
12. You LM, Aiken LH, Sloane DM, et al. Hospital nursing, care quality, and patient satisfaction: cross-sectional surveys of nurses and patients in hospitals in China and Europe. *Int J Nurs Stud*. 2013;50:154–161.
13. Kutney-Lee A, Sloane DM, Aiken LH. An increase in the number of nurses with baccalaureate degrees is linked to lower rates of postsurgery mortality. *Health Aff (Millwood)*. 2013;32:579–586.
14. Institute of Medicine. *The Future of Nursing: Leading Change, Advancing Health*. Washington: The National Academies Press; 2011.
15. Kutney-Lee A, Singh S, Aiken LH. Representation of baccalaureate-prepared nurses in Pennsylvania hospitals: a research brief, 2014. Available at: http://www.nursing.upenn.edu/chopr/Documents/Research Brief.pdf. Accessed August 4, 2014.
16. Yakusheva O, Lindrooth R, Weiss M. Economic evaluation of the 80% baccalaureate nurse workforce recommendation: a patient-level analysis. *Med Care*. 2014;52:864–869.
17. Needleman J, Buerhaus P, Pankratz VS, et al. Nurse staffing and inpatient hospital mortality. *N Engl J Med*. 2011;364:1037–1045.
18. McHugh MD, Ma C. Hospital nursing and 30-day readmissions among Medicare patients with heart failure, acute myocardial infarction, and pneumonia. *Med Care*. 2013;51:52–59.
19. McHugh MD, Berez J, Small DS. Hospitals with higher nurse staffing had lower odds of readmissions penalties than hospitals with lower staffing. *Health Aff*. 2013;32:1740–1747.

