

# Educational Levels of Hospital Nurses and Surgical Patient Mortality

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Growing evidence suggests that nurse staffing affects the quality of care in

**N**URSE UNDERSTAFFING IS ranked by the public and physicians as one of the greatest threats to patient safety in US hospitals.<sup>1</sup> Last year we reported the results of a study of 168 Pennsylvania hospitals showing that each additional patient added to the average workload of staff registered nurses (RNs) increased the risk of death following common surgical procedures by 7%, and that the risk of death was more than 30% higher in hospitals where nurses' mean workloads were 8 patients or more each shift than in hospitals where nurses cared for 4 or fewer patients.<sup>2</sup> These findings are daunting given the widespread shortage of nurses, increasing concern about recruiting an adequate supply of new nurses to replace those expected to retire over the next 15 years,<sup>3</sup> and constrained hospital budgets. These findings also raise questions about whether characteristics of the hospital RN workforce other than ratios of nurses to patients are important in achieving excellent patient outcomes.

Nurses constitute the surveillance system for early detection of complications and problems in care, and they are in the best position to initiate actions that minimize negative outcomes for patients.<sup>4</sup> That the exercise of clinical judgment by nurses, as well as staffing adequacy, is key to effective surveillance may explain the link be-

tween higher nursing skill mix (ie, a higher proportion of RNs among the nursing personnel of a hospital) and better patient outcomes.<sup>5-10</sup>

Registered nurses in the United States generally receive their basic education in 1 of 3 types of programs: 3-year diploma programs in hospitals, associate degree nursing programs in community colleges, and baccalaureate nursing programs in colleges and universities. In 1950, 92% of new RNs graduated from hospital diploma programs,<sup>11</sup> whereas by 2001, only 3% graduated from hospital diploma programs, 61% came from associate degree programs, and 36% were baccalaureate program graduates.<sup>12</sup> Surprisingly little is known

about the benefits, if any, of the substantial growth in the numbers of nurses with bachelor's degrees. Indeed the conventional wisdom is that nurses' experience is more important than their educational levels.

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Despite the diversity of educational programs preparing RNs, and a logical (but unconfirmed) connection between education and clinical judgment, little if anything is known about the impact of nurses' education on patient outcomes.<sup>13</sup> Results of some studies have suggested that baccalaureate-prepared nurses are more likely to demonstrate professional behaviors important to patient safety such as problem solving, performance of complex functions, and effective communication.<sup>14-16</sup> However, few studies have examined the effect of nurse education on patient outcomes, and their findings have been inconclusive.<sup>17</sup>

The 168 Pennsylvania hospitals included in our previous study<sup>2</sup> of patient-to-nurse staffing and patient mortality varied substantially in the proportion of staff nurses holding baccalaureate or higher degrees. This variability provides an opportunity to conduct a similar study examining the association between the educational composition of a hospital's RN staff and patient outcomes. Specifically, we tested whether hospitals with higher proportions of direct-care RNs educated at the baccalaureate level or above have lower risk-adjusted mortality rates and lower rates of failure to rescue (deaths in patients with serious complications). We also examined whether the educational backgrounds of hospital RNs are a predictor of patient mortality beyond factors such as nurse staffing and experience. These findings offer insights into the potential benefits of a more highly educated nurse workforce.

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We analyzed outcomes data derived from hospital discharge abstracts that were merged with information on the characteristics of the treating hospitals, including unique data obtained from surveys of hospital nurses.<sup>2</sup> The institutional review board of the University of Pennsylvania approved the study protocol.

Hospitals. The sample consisted of 168 (80%) of the 210 adult acute-care general hospitals operating in Pennsylvania in 1999 that (1) reported surgi-

cal discharges to the Pennsylvania Health Care Cost Containment Council in the specific categories studied here, (2) had data on structural characteristics available from 2 external administrative databases (American Hospital Association [AHA] annual survey<sup>18</sup> and Pennsylvania Department of Health Hospital Questionnaire<sup>19</sup>), and (3) had at least 10 nurses responding to our questionnaire, which previous empirical work demonstrated was sufficient to provide reliable estimates of survey-based organizational characteristics of the hospitals. Six of the excluded hospitals were Veterans Affairs hospitals, which do not report discharge data to the state. Twenty-six hospitals were excluded because of missing data, most often because their reporting to external administrative sources was done as aggregate multihospital entities. Ten small hospitals, most of which had 50 or fewer beds, had an insufficient number of nurses responding to the questionnaire to be included.

A 50% random sample of RNs residing in Pennsylvania and on the rolls of the Pennsylvania Board of Nursing received questionnaires at their homes in the spring of 1999. Surveys were completed by 10 184 nurses, an average of more than 60 nurses per hospital, and the 52% response rate compares favorably with other voluntary, anonymous surveys of health professionals.<sup>20</sup> We compared our data with information from the AHA annual survey and found that the number of nurses from each hospital responding to our survey was directly proportional to the number of RN positions in each hospital. This suggests similar response rates across hospitals and no response bias at the hospital level. Moreover, demographic characteristics of the respondents paralleled those of Pennsylvania hospital nurses in the National Sample Survey of Registered Nurses.<sup>21</sup> For example, the mean ages of Pennsylvania hospital nurses in our sample and in the National Sample Survey of Registered Nurses were 40 and 41 years, respectively; the percentages of Pennsylvania hospital nurses working full-time were

66% and 69%, respectively; and those having earned bachelor of science in nursing (BSN) degrees were 30% and 31%, respectively.

Hospital staff nurses were asked to indicate whether their highest credential in nursing was a hospital school diploma, an associate degree, a bachelor's degree, a master's degree, or another degree. The proportion of nurses in each hospital who held each type of credential was computed. Because the educational preparation of the 4.3% of nurses who checked "other" was unknown, their answers were not included in our hospital-level measures of educational qualifications. It was later verified that this decision did not bias the results. Because there was no evidence that the relative proportions of nurses holding diplomas and associate degrees affected the patient outcomes studied, those 2 categories of nurses were collapsed into a single category and the educational composition of the hospital staff was characterized in terms of the percentage of nurses holding bachelor's or master's degrees.

Two further variables were derived from the nurse survey. Nursing workload was computed as the mean number of patients assigned to all staff nurses who reported caring for at least 1 but fewer than 20 patients on the last shift they worked. Because nurse experience was an important potential confounding variable related to both clinical judgment and education, the mean number of years of experience working as an RN for nurses from each hospital was also calculated and used in the analyses.

Three hospital characteristics were used as control variables: size, teaching status, and technology. Hospital-level data were obtained from the 1999 AHA annual survey and the 1999 Pennsylvania Department of Health Hospital Survey. Three size categories (<100 beds, 101-250 beds,  $\geq$ 251 beds) were used. Hospitals without any postgraduate medical residents or fellows (nonteaching) were distinguished from those with

facilities for either open-heart surgery, major organ transplantations, or both.

**Patients and Patient Outcomes.** Discharge abstracts for the universe of 232 342 patients aged 20 to 85 years who underwent general surgical, orthopedic, or vascular procedures from April 1, 1998, to November 30, 1999, in the 168 nonfederal hospitals were obtained from

TABLE 2 describes characteristics of the patients in our sample and how they varied across hospitals with different nurse educational compositions. Of the patients studied, 43.7% were men and the mean (SD) age was 59.3 (16.9) years. Of the 232 342 patients, 53813 (23.2%) experienced a major complication not

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## 2. Characteristics of Surgical Patients in the Study Hospitals, Overall and by Educational Composition of Staff Registered Nurses\*

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pected. Moreover, Table 4 indicates that the effect on mortality of a 20% increase in the percentage of BSNs in the workforce would be roughly equivalent to the effect of a reduction in mean nurse workload of 2 patients, and that both the mortality and failure-to-rescue rates would be decidedly lower if both the workloads were lighter and the workforce were composed of higher percentages of BSN-prepared nurses.

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To our knowledge, this study provides the first empirical evidence that hospitals' employment of nurses with BSN and higher degrees is associated with improved patient outcomes. Our findings indicate that surgical patients cared for in hospitals in which higher proportions of direct-care RNs held bachelor's degrees experienced a substantial survival advantage over those treated in hospitals in which fewer staff nurses had BSN or higher degrees. Simi-

larly, surgical patients experiencing serious complications during hospitalization were significantly more likely to survive in hospitals with a higher

proportion of nurses with baccalaureate education.

When the proportions of RNs with hospital diplomas and associate de-

degrees as their highest educational credentials were examined separately, the particular type of educational credential for nurses with less than a bachelor's degree was not a factor in patient outcomes. Furthermore, mean years of experience did not independently predict mortality or failure to rescue, nor did it alter the association between educational background or of staffing and either patient outcome. These findings suggest that the conventional wisdom that nurses' experience is more important than their educational preparation may be incorrect. The improved outcomes associated with higher levels of BSNs in a hospital was found to be independent of and additive to the associations of superior outcomes in hospitals with better nurse staffing we reported previously.<sup>2</sup> Thus, both lower patient-to-nurse ratios and having a majority of RNs educated at the baccalaureate level appear to be jointly associated with substantially lower mortality and failure-to-rescue rates for patients undergoing common surgical procedures.

In our sample of 168 Pennsylvania hospitals in which the proportion of nurses with bachelor's degrees and mean patient-to-nurse ratios varied widely, 2% (4535/232 342) of the surgical patients undergoing the procedures we studied died within 30 days of hospital admission. Our results imply that had the proportion of nurses with BSN or higher degrees been 60% and had the patient-to-nurse ratio been 4:1, possibly 3810 of these patients (725 fewer) might have

died, and had the proportion of baccalaureate nurses been 20% and had staffing uniformly been at 8:1 patient-to-nurse ratios, 5530 (995 more) might have died. While this difference of more than 1700 deaths across 2 educational and staffing scenarios is approximate, it represents a conservative estimate of preventable deaths potentially attributable to nurses' education and RN staffing levels because our patient sample represents only about half of all surgical cases in the study hospitals.

One limitation of our analysis is the

