



Published in final edited form as:

*Health Aff (Millwood)*. 2013 March ; 32(3): 579–586. doi:10.1377/hlthaff.2012.0504.

## An Increase In The Number Of Nurses With Baccalaureate Degrees Is Linked To Lower Rates Of Postsurgery Mortality

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### Abstract

An Institute of Medicine report has called for registered nurses to achieve higher levels of education, but health care policy makers and others have limited evidence to support a substantial increase in the number of nurses with baccalaureate degrees. Using Pennsylvania nurse survey and patient discharge data from 1999 and 2006, we found that a ten-point increase in the percentage of nurses holding a baccalaureate degree in nursing within a hospital was associated with an average reduction of 2.12 deaths for every 1,000 patients—and for a subset of patients with complications, an average reduction of 7.47 deaths per 1,000 patients. We estimate that if all 134 hospitals in our study had increased the percentage of their nurses with baccalaureates by ten points during our study's time period, some 500 deaths among general, orthopedic, and vascular surgery patients might have been prevented. The findings provide support for efforts to increase the production and employment of baccalaureate nurses.

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The recent Institute of Medicine report titled *The Future of Nursing: Leading Change, Advancing Health* has drawn attention to the issue of nurses' education.<sup>1</sup> The report calls for America's nurses to be better positioned to meet the health care needs of the public, especially in a context of health care reform. One of the most ambitious recommendations made in the report was that 80 percent of the registered nurse workforce should hold at least a baccalaureate degree by 2020.<sup>1</sup> The most recent National Sample Survey of Registered Nurses revealed that in 2008 only 45 percent of nurses in the United States had earned a baccalaureate degree.<sup>2</sup>

The recommendation for a more highly educated nurse workforce emerged from a body of research that has examined the relationship between nurse education and patient outcomes over the past decade. In 2003 Linda Aiken and colleagues first demonstrated empirically that higher proportions in hospitals of nurses holding at least a baccalaureate degree in nursing were associated with lower surgical patient mortality and failure to rescue—that is, death following the development of a complication.<sup>3</sup> Several studies since then, conducted in a variety of countries, have come to similar conclusions,<sup>4–9</sup> although others have been equivocal.<sup>10</sup>

The underlying mechanism for the association between higher nurse education and better patient outcomes is unclear. However, previous work has linked the proportion of nurses with baccalaureates to nurses' ongoing surveillance of patients to prevent adverse

outcomes.<sup>11</sup> As part of their practice, nurses are responsible for the continual assessment and monitoring of a patient's condition, identifying changes that could indicate clinical deterioration, and initiating interventions when necessary.<sup>11</sup>

Most studies of nurse education and patient outcomes have been cross-sectional. This longitudinal study, in which repeated cross-sectional samples of patients and nurses in the same acute care hospitals in Pennsylvania were compared at two points in time, enhances our understanding of the relationship between nurse education and patient outcomes. We examined whether changes in the percentage of nurses with baccalaureates were accompanied by concomitant changes in rates of surgical patient mortality and failure to rescue. We also accounted for simultaneous changes in nurse-reported staffing levels, skill mix, and years of experience as a registered nurse.

## Study Data And Methods

### Design

We used a retrospective, two-stage panel design. The study involved the following three data sources from 1999 and 2006: nurse survey data, administrative patient discharge data, and the American Hospital Association Annual Survey. There were 134 hospitals for which all data were available at both time points.

### Data Sources And Study Population

**NURSES**—In 1999 the University of Pennsylvania conducted the Pennsylvania Registered Nurse Survey, which was mailed to the homes of a 50 percent random sample of all licensed registered nurses in the state. A similar survey, the Multi-State Nursing Care and Patient Safety Survey, conducted by the University of Pennsylvania in 2006, was mailed to a 40 percent random sample of all licensed registered nurses in Pennsylvania. Both surveys contained several questions about the respondent's present position; workload; and demographic characteristics, including age, experience, and highest degree earned in nursing.

The final response rate for the 1999 survey was 52 percent, approximately 42,000 nurses. The final response rate for the 2006 survey was 39 percent, more than 25,000 nurses.

In 2006 a double sampling approach involving the resurveying of initial nonresponders ( $n = 650$ ) was used to show that there was no response bias associated with the variables of interest.<sup>12,13</sup> The representativeness of both samples for our study was confirmed by comparing the educational preparation of nurses in the surveys with the Pennsylvania nurse data collected in the 2000 and 2008 National Sample Surveys of Registered Nurses<sup>2,14</sup> (see Appendix Exhibit A).<sup>15</sup>

Approximately one-third of the respondents on both surveys worked as staff nurses in general acute care hospitals, comprising our analytic sample. There were, on average, 80 and 48 respondents from each of the 134 hospitals in 1999 and 2006, respectively.

**PATIENTS**—Patients ages 20–85 with a diagnosis-related group classification of general, orthopedic, or vascular surgery were included in the study. These patients were selected because they constitute a substantial proportion of all hospital discharges and because our risk-adjustment model has been well validated for use with adult patients who had these procedures.<sup>3,4,16</sup>

Patient data were obtained from the Pennsylvania Health Care Cost Containment Council. These data files included the following information: facility identification; patient

demographic characteristics; admission information; principal *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM), diagnosis and procedure codes; up to eight secondary diagnoses and procedures codes; and whether the patient was alive or dead at discharge.

Our patient outcomes of interest included mortality within thirty days of admission and failure to rescue, meaning that the patient died following the development of a condition that could have been remedied but wasn't. Death record files were linked to the patient discharge records so that deaths occurring outside of the hospital would be captured. Following the approach of Jeffrey Silber and colleagues, we classified a patient death as involving a failure to rescue if the patient died following the development of at least one of thirty-nine clinical adverse events, such as wound infection, sepsis, and shock.<sup>17</sup>

**HOSPITALS**—The 134 hospitals in our sample represented about 80 percent of all acute care hospitals in Pennsylvania in 2006. For both 1999 and 2006 we aggregated nurse survey data to create hospital-level measures of nurse education, nurse-reported staffing and skill mix, and years of experience as a registered nurse.

Nurse education was measured by calculating the percentage of respondents in each hospital whose highest degree in nursing was a baccalaureate degree. Nurses who reported having earned an advanced degree in nursing—that is, a master's or doctoral degree—were excluded from the study. A sensitivity analysis confirmed that including nurses who had earned a degree higher than a baccalaureate did not change our results substantially.

The nurse staffing measure was derived from a question on the surveys that asked nurses about the number of patients they had cared for on their last shift. To calculate the measure, we included nurses who reported caring for at least one patient, but no more than twenty. Responses from all nurses in a hospital were aggregated to produce a measure of nurse-reported staffing: the average number of patients cared for per nurse. The predictive validity of using nurse reports in this manner to assess staffing levels has been previously demonstrated.<sup>3,6,18</sup>

Obtaining estimates of workload directly from staff nurses has advantages over using data from administrative sources. The chief advantage is that the surveys elicited nurses' work setting and role in patient care. Therefore, we were able to exclude nurses from our staffing measure who worked in outpatient settings or in roles that did not involve patient care. Nurses were asked to report the number of registered nurses, licensed practical nurses, and unlicensed assistive personnel who had provided direct patient care on their unit during their last shift. A skill mix variable was created by calculating the percentage of registered nurses compared to other nursing staff—that is, licensed practical nurses and unlicensed assistive personnel—for each hospital.

Nurses also provided the number of years they had worked as a registered nurse, which was aggregated to the hospital level to create a measure of average years of experience. The American Hospital Association Annual Survey was used to obtain data on other hospital characteristics, including size, capability for highly technical procedures, and teaching status.

### Statistical Analysis

Patient-level outcomes of mortality and failure to rescue were aggregated to produce standardized risk-adjusted rates for each hospital that accounted for differences in the numbers and characteristics of patients. The risk-adjustment model included age, sex, admission type, and surgical diagnosis-related group. It also included a set of twenty-seven

comorbidities, such as hypertension and diabetes, defined by Anne Elixhauser and colleagues.<sup>19</sup> Fluid or electrolyte disorders and coagulopathy were excluded.<sup>20,21</sup> The adjusted outcome rates for each hospital were calculated per 1,000 surgical patients.

We first examined the characteristics of patients in our 1999 and 2006 samples and quantified the extent of changes across the hospitals in terms of nurse education, nurse-reported staffing and skill mix, and experience levels between the two years. Then we implemented a two-period fixed effects difference model to examine the relationship between surgical patient outcomes and nursing factors.<sup>22</sup>

We chose this approach because we wanted to quantify the effect of changes in the educational qualifications of the hospital workforce on changes in our outcomes of interest. Our primary covariates were nurse education, nurse-reported staffing and skill mix, and years of experience as a registered nurse. We scaled nurse education and skill mix by a factor of ten so that the coefficient could be interpreted as the change in patient outcomes associated with a ten-point increase in the percentage of nurses with a baccalaureate degree, or a ten-point increase in the percentage of nurses in a hospital who were registered nurses—as opposed to licensed practical nurses or unlicensed assistive personnel—respectively.

We included time-invariant hospital characteristics in our models because they had differing effects at the two time points. All statistical analyses were conducted using the statistical analysis software SAS, version 9.2.

## Limitations

Although we took a large methodological step forward by using panel data methods to explore the relationship between nurse education and patient outcomes, we were faced with some limitations. More than two time points would have allowed for a more rigorous longitudinal analysis over time and provided stronger support for causality.

The generalizability of our findings is limited by our analysis of surgical patients in hospitals in just one state. However, Pennsylvania is one of the largest and most geographically diverse states in the country.

We chose to limit our sample to the surgical population. However, we believe that nurses' education would affect outcomes for other patient populations, such as medical patients, in much the same way. We found that, overall, surgical mortality rates decreased between 1999 and 2006, although the rates of various chronic health conditions increased considerably. Several explanations have been offered for lower mortality rates after surgery, including improved technology and the increase in patient safety initiatives,<sup>23</sup> but we were unable to measure the use of such initiatives or technology directly in our study.

## Study Results

Exhibit 1 displays the characteristics of the surgical patient samples in 1999 and 2006. The number of surgical patients in the study hospitals increased by nearly 10 percent over the time period, from approximately 223,000 to more than 244,000. In both years, the average age of patients was about sixty, and the majority of the sample was female. The percentage of emergency admissions increased slightly over time, while the number of transfer admissions decreased marginally.

The thirty-day mortality rate diminished markedly. The percentage of patients who developed complications, and the percentage of patients who died following the development of a complication, decreased.

Exhibit 2 shows the degree to which the percentage of nurses with baccalaureates changed in individual study hospitals over time. The overall mean percentage of nurses with baccalaureates across all hospitals did not change significantly between 1999 and 2006. However, many hospitals had increases in the percentages of nurses holding a baccalaureate degree over the period, while many others had decreases. And some of the changes in both directions were quite sizable.

According to nurse reports, the mean number of patients per nurse across all hospitals was 5.7 in both 1999 and 2006. The vast majority of hospitals either decreased or increased the average number of patients that nurses reported caring for by less than one patient (see Appendix Exhibit B).<sup>15</sup>

Nurse-reported skill mix declined significantly. In 1999 nearly 75 percent of all nursing staff were registered nurses, but in 2006 the figure was 72 percent ( $p < 0.01$ ). Between the two time points, 64.9 percent of the hospitals reduced their proportion of registered nurses (see Appendix Exhibit C).<sup>15</sup>

In contrast, average years of experience as a registered nurse across hospitals increased significantly, from 14.5 in 1999 to 17.9 in 2006 ( $p < 0.001$ ). Ninety-one percent of the hospitals showed an increase in the average years of experience of their nurses, and in many cases the increase was more than five years (see Appendix Exhibit D).<sup>15</sup>

Exhibit 3 presents the regression coefficients from the difference models that we estimated to show whether, and to what extent, changes in the four nursing factors were related to changes in surgical mortality and failure-to-rescue rates. The first set of models shows that increases in the percentage of nurses with baccalaureates from 1999 to 2006 within a hospital were associated with significant reductions in surgical mortality and failure-to-rescue rates over the same time period.

We found that a ten-point increase in a hospital's percentage of nurses with a baccalaureate degree in nursing was associated with an average reduction of 2.12 deaths for every 1,000 patients ( $p < 0.01$ ). For the subset of patients with complications, we found that the same ten-percentage-point increase was associated with an average reduction in mortality of 7.47 deaths per 1,000 patients ( $p = 0.001$ ).

We did not observe significant reductions in mortality or failure-to-rescue rates associated with changes in nurse-reported staffing levels, skill mix, or years of experience.

## Discussion And Implications

Using longitudinal methods, we found that increases in a hospital's percentage of nurses who held a baccalaureate degree in nursing were significantly associated with improvements over time in rates of surgical patient mortality and failure to rescue. We did not find significant associations between changes in nurse-reported staffing, skill mix, or years of experience and changes in surgical patients' outcomes.

Our inability to detect staffing and skill mix effects is most likely due to the fact that there were, in the vast majority of hospitals, only slight changes in nurse-reported staffing levels and skill mix between 1999 and 2006, the period of our study. Other longitudinal studies have found significant relationships between staffing, skill mix, and patient mortality over time.<sup>24–26</sup>

Our finding that changes in years of experience as a registered nurse did not affect changes in outcomes is consistent with previous work.<sup>3</sup> Using a longitudinal approach in the current

study, we now have stronger evidence that nurse experience—defined by the number of years worked as a registered nurse—is not a substitute for higher education in terms of improving patient outcomes. Greater clinical expertise does not result simply from years of experience; it also requires critically analyzing past clinical situations to improve practice.<sup>27</sup>

Our difference models revealed that, on average, a ten-point increase in a hospital's percentage of nurses with baccalaureates was associated with 2.12 fewer deaths per 1,000 surgical patients (Exhibit 3). We can use this coefficient to estimate the projected change in surgical deaths if each hospital were to increase the percentage of nurses with baccalaureates by ten points; and also to increase the percentage of nurses with baccalaureates to 80 percent, as recommended by the Institute of Medicine.<sup>1</sup>

The first estimate simply applies the nurse education coefficient, which indicates the change in surgical mortality associated with a ten-point increase in the percentage of nurses with a baccalaureate degree, to the number of surgical patients in each hospital. The second estimate was calculated by quantifying the difference between a hospital's 2006 nursing education level and the goal of a nurse workforce containing 80 percent of nurses with baccalaureates, then multiplying the result by the nurse education coefficient, and finally adjusting for the number of patients in each hospital.

The resulting estimates suggest that if all of the hospitals in our study had increased their percentage of nurses with baccalaureates by ten points between 1999 and 2006, some 500 deaths might have been prevented just among general, orthopedic, and vascular surgery patients. If all of the study hospitals had moved to a nursing workforce containing 80 percent of nurses with baccalaureates, more than 2,100 lives might have been saved—which is equivalent to 60 percent of the observed deaths in 2006. Although these projections demonstrate the clinical significance of our findings, we acknowledge that these extrapolations made some associated theoretical and empirical assumptions. First, we assumed that the coefficient associated with a ten-point increase in the percentage of baccalaureate-prepared nurses was linear. That is, the number of deaths prevented would be the same for hospitals increasing their percentage of nurses with baccalaureates from 20 percent to 30 percent as it would be for hospitals moving from 70 percent to 80 percent.

We also assumed that we correctly specified the model and omitted no variables that were significantly and jointly associated with changes in both surgical mortality rates and the percentage of nurses with baccalaureate degrees.

The American Association of Colleges of Nursing estimates that the nation will need to produce more than 760,000 additional nurses with baccalaureates by 2020 to meet the Institute of Medicine's recommended goal.<sup>28</sup> The most recent data from the Department of Education show that about 75,000 baccalaureate degrees in nursing were awarded in 2010, compared to more than 82,000 associate degrees.<sup>29</sup> The same pattern appears in current statistics from the nursing licensure exam, which roughly indicate the number of new nurses entering practice annually. Nearly 60 percent of candidates passing the exam in 2011 had an associate's degree, compared to approximately 40 percent of the passing candidates who had a baccalaureate degree.<sup>30</sup>

Our finding of a significant mortality advantage associated with improved nurse education in hospitals adds to the importance of public policies to help direct a substantial shift toward the production of nurses with baccalaureates in nursing. One specific recommendation that has been made is to target all new public funding of nursing education to the production of nurses with baccalaureates, through a variety of innovations such as the granting of baccalaureate degrees by community colleges.<sup>31</sup>

Our findings also provide support for a number of increasing trends in the areas of health care practice and policy. Acute care employers not faced with a shortage favor the hiring of nurses with baccalaureates.<sup>32</sup> Nurses' physician colleagues agree with employers. A recent Robert Wood Johnson Foundation Nursing Research Network survey found that more than 75 percent of physicians strongly or somewhat agreed that nurses with a baccalaureate degree are more competent than those with an associate's degree.<sup>33</sup> And some states, including New York, are considering legislation that would require that all nurses earn a baccalaureate degree within ten years of obtaining a diploma or associate's degree in order to retain their licenses.<sup>34</sup>

In summary, our findings suggest that increasing the proportion in a hospital of nurses with a baccalaureate degree in nursing is associated with a significant decrease in fatal surgical outcomes over time. The outcomes of this study support the Institute of Medicine's recommendation for increasing the proportion of nurses who have a baccalaureate degree and for targeting increased funding to support baccalaureate nursing education.

## Acknowledgments

This research was supported by the Agency for Healthcare Research and Quality (Grant No. K08-HS-018534; Ann Kutney-Lee, principal investigator), the National Institute of Nursing Research (Grant No. R01-NR-004513; Linda Aiken, principal investigator), and the Robert Wood Johnson Foundation. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality, the National Institute of Nursing Research, or the Robert Wood Johnson Foundation. The authors acknowledge the assistance of Timothy Cheney and Evan Wu with data analysis and of Ryan Lee, Ryan Keating, and Megan Soisson with the preparation of the article.

## NOTES

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## Biographies



**Ann Kutney-Lee** is an assistant professor of nursing at the University of Pennsylvania.

In this month's *Health Affairs*, Ann Kutney-Lee and coauthors report on their study of the links between having baccalaureate-level nurses in hospitals and mortality following surgery. Analyzing patient discharge data from a group of Pennsylvania hospitals from 1999 and 2006, the authors determined that a ten-point increase in the percentage of nurses holding a baccalaureate degree within a hospital was associated with an average reduction of 2.12 deaths for every 1,000 patients—and for a subset of patients with complications, an average reduction of 7.47 deaths per 1,000 patients. The authors write that their findings provide support for efforts to increase the production and employment of baccalaureate nurses.

Kutney-Lee is an assistant professor of nursing, a core faculty member of the Center for Health Outcomes and Policy Research, and a senior fellow at the Leonard Davis Institute of Health Economics, all at the University of Pennsylvania. Her scholarship focuses on the organization and delivery of nursing care and patient outcomes. Kutney-Lee earned a master's degree and a doctorate in nursing from the University of Pennsylvania.



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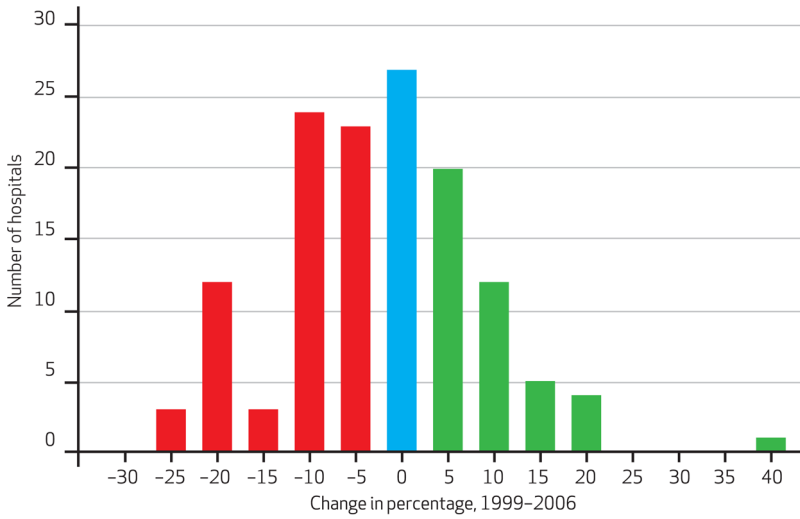
Accountability Office. He has a master's degree and a doctorate in sociology from the University of Arizona.



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Linda Aiken is the Claire M. Fagin Leadership Professor of Nursing, a professor of sociology, director of the Center for Health Outcomes and Policy Research, and a senior fellow at the Leonard Davis Institute of Health Economics, all at the University of Pennsylvania. She has won numerous awards for her research in the United States and abroad demonstrating the relationships between nursing care and patient outcomes.

Aiken is the senior adviser for nursing for the China Medical Board, a senior adviser for the Rita and Alex Hillman Foundation, and a research manager for the Robert Wood Johnson Foundation Initiative on the Future of Nursing at the Institute of Medicine. She also serves on the editorial boards of numerous journals, including *Health Affairs*. She earned a doctorate in sociology from the University of Texas at Austin and has been awarded numerous honorary doctorates, including degrees from the University of Maryland and the University of Florida.



**EXHIBIT 2. Change In Percentage Of Nurses With A Baccalaureate Degree In Nursing In Study Hospitals, 1999–2006**

**SOURCE** Authors’ analysis. **NOTES** The number of hospitals in the study was 134. The mean proportion of nurses with a baccalaureate degree in nursing was 32.5 percent (standard deviation, 12.6 percent) in 1999 and 32.7 percent (standard deviation, 13.1 percent) in 2006. The difference is not significant. Negative percentage numbers indicate a worsening percentage of nurses with baccalaureate degrees in nursing; positive numbers indicate an improvement.

**EXHIBIT 1****Characteristics Of Surgical Patients In Study Hospitals, 1999 And 2006**

<b>Characteristic</b>	<b>1999</b>		<b>2006</b>	
	<b>Number or mean</b>	<b>% or SD</b>	<b>Number or mean</b>	<b>% or SD</b>
Total patients	223,187	100.0%	244,147	100.0%
Age (years)	61.1	16.4	60.6	16.0
Men	96,358	43.2%	104,160	42.7%
Emergency admissions	67,859	30.4%	77,141	31.6%
Transfer admissions	3,762	1.7%	3,760	1.5%
Deaths within 30 days of admission	5,649	2.5%	3,615	1.5%
Patients with complications	83,880	37.6%	82,399	33.8%
Failure to rescue	5,649	6.7%	3,615	4.4%
<b>TYPE OF SURGERY</b>				
General	96,607	43.3%	99,350	40.7%
Orthopedic	109,669	49.1	130,579	53.5
Vascular	16,911	7.6	14,218	5.8
<b>COMORBIDITIES</b>				
Hypertension	78,020	35.0%	116,827	47.9%
Chronic pulmonary disease	27,824	12.5	37,824	15.5
Diabetes without chronic complications	26,883	12.1	37,228	15.3
Hypothyroidism	14,779	6.6	22,986	9.4
Congestive heart failure	11,655	5.2	12,206	5.0
Deficiency anemias	12,249	5.5	21,364	8.8
Obesity	8,296	3.7	16,749	6.9

**SOURCE** Authors' analysis. **NOTES** The number of hospitals in the study was 134. All differences are significant at  $p < 0.001$ . Failure to rescue is death following the development of a complication. SD is standard deviation.

**EXHIBIT 3****Regression Coefficients For Nursing Characteristics In Study Hospitals And Adjusted Rates Of Surgical Mortality And Failure To Rescue**

<b>Characteristic</b>	<b>Estimate</b>	<b>Standard error</b>	<b>p value</b>
<b>SURGICAL MORTALITY</b>			
Education	-2.12	0.71	< 0.01
Staffing	0.65	0.69	0.35
Skill mix	1.89	1.07	0.08
Years of experience as registered nurse	-0.01	0.28	0.96
<b>FAILURE TO RESCUE</b>			
Education	-7.47	2.24	0.001
Staffing	0.30	2.16	0.89
Skill mix	4.08	3.37	0.23
Years of experience as registered nurse	0.73	0.87	0.41

**SOURCE** Authors' analysis of data from 134 study hospitals. **NOTES** Regression coefficients represent changes from 1999 to 2006. Estimates for education reflect the average change in the outcome associated with a ten-point increase in the percentage of nurses with a baccalaureate degree in nursing in a hospital. Estimates for skill mix reflect the average change in the outcome associated with a ten-point increase in the percentage of registered nurses (as opposed to licensed practical nurses or unlicensed assistive personnel). Regressions were adjusted for fixed hospital characteristics (size, teaching status, and technology status). Failure to rescue is death following the development of a complication.