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The Association of Nurse–Physician Teamwork and Mortality in Surgical Patients

Xiao Linda Kang, PhD, RN,
Center for Health Outcomes and Policy Research, School of Nursing, University of Pennsylvania

Heather M. Brom, PhD, APRN [Postdoctoral Fellow, Associate Fellow],
Center for Health Outcomes and Policy Research, School of Nursing, University of Pennsylvania

Leonard Davis Institute of Health Economics

Karen B. Lasater, PhD, RN [Assistant Professor],
Center for Health Outcomes and Policy Research, School of Nursing, University of Pennsylvania

Matthew D. McHugh, PhD, JD, MPH, RN, FAAN [Independence Chair for Nursing Education, Professor of Nursing, Associate Director]
Center for Health Outcomes & Policy Research, School of Nursing, University of Pennsylvania

Abstract

In this study we describe nurse–physician teamwork, estimate its association with surgical patient outcomes (30-day mortality and failure-to-rescue) and determine whether these relationships depend upon other modifiable hospital nursing characteristics (nurse staffing and education levels) known to be associated with patient outcomes. This cross-sectional analysis included linked data from 29,391 nurses representing 665 acute care hospitals and 1,321,904 adult patients who underwent a general surgical, vascular, or orthopedic procedure. Surgical patients cared for in hospitals with better nurse–physician teamwork had significantly lower odds of 30-day mortality (OR=0.95) and failure-to-rescue (OR=0.95). Additionally, the odds of death and failure-to-rescue were lower for patients in hospitals with both higher nurse–physician teamwork and more favorable patient-to-nurse staffing ratios. Similar trends were observed related to nursing education levels. Improving interprofessional teamwork is one strategy to improve patient outcomes with the added importance of also considering additional features of their nursing workforce.

Keywords

teamwork; practice environment; staffing; surgical mortality; failure-to-rescue

There is wide variation in surgical mortality across hospitals in the U.S. (Ghaferi, Birkmeyer, & Dimick, 2009), despite interventions such as checklists, benchmarking, and

Corresponding author Heather Brom: Center for Health Outcomes and Policy Research, School of Nursing, University of Pennsylvania, 418 Curie Boulevard. Rm 338 Philadelphia, PA, 19104 hmbrom@nursing.upenn.edu.

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care pathways to decrease the incidence of surgical complications (Howell, Panesar, Burns, Donaldson, & Darzi, 2014). A growing body of evidence suggests that complex interactions between patient and organizational factors contribute to surgical morbidity and mortality (Ghaferi et al., 2009). Registered nurses make up the majority of hospital care providers (Bureau of Labor Statistics, 2014) and are the most consistent bedside presence in acute hospital settings. In this role, nurses are positioned to coordinate and influence direct patient care making nursing an important factor in determining patient outcomes (Camicia et al., 2013; Havens, Vasey, Gittell, & Lin, 2010).

Interprofessional Teamwork

Better nurse work environments have emerged as an essential element of patient safety (Aiken et al., 2011; Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Kutney-Lee, Sloane, & Aiken, 2013). Hospitals with good work environments are characterized by having sufficient staffing and resources, management that advocates for frontline staff and empowers them with the autonomy to make patient care decisions based on their professional expertise, and frontline nurses involved in decision-making about the care environment. Interprofessional teamwork is an important aspect of nurses' work environment and The Institute of Medicine has emphasized the importance of interprofessional teamwork in delivering safe, quality care in several of its reports (Institute of Medicine, 2001, 2004). Additionally, several national organizations were created within the past decade to support interprofessional education (IPE) in order to prepare future health care professionals to deliver team-based care and to develop core competencies of IPE such as communication and teamwork (Health Professions Accreditors Collaborative, 2014; Interprofessional Education Collaborative, 2018; National Center for Interprofessional Practice and Education, 2017). Since interprofessional teamwork is considered a hallmark of successful organizations (Naylor, 2011) and also part of the American Nurses Credentialing Center Magnet Recognition programs for hospitals (Kramer & Schmalenberg, 2004) various health care organizations are initiating programs to improve teamwork (Gilman, Chokshi, Bowen, Rugen, & Cox, 2014; Salas, Zajac, & Marlow, 2018).

At the heart of interprofessional teamwork in the inpatient hospital setting is the nurse–physician relationship (Henkin et al., 2016; Yeager, 2005). Prior research has heralded interprofessional teamwork as a solution to improve patient outcomes (Baggs et al., 1999; Donovan et al., 2018; Mazzocco et al., 2009; O'Leary, Sehgal, Terrell, & Williams, 2012; Zwarenstein, Goldman, & Reeves, 2009). Recognizing the value of teamwork among health care professionals on patient outcomes, the Joint Commission issued a sentinel event alert to warn organizations of the harms posed by a lack of teamwork (The Joint Commission, 2008). Despite decades of research and national support for interprofessional teamwork, a lack of consistent nurse–physician teamwork persists in health care (McComb, Lemaster, Henneman, & Hinchey, 2017; Nair, Fitzpatrick, McNulty, Click, & Glembocki, 2012).

Medical errors are estimated to be the third leading cause of death in the United States (Makary & Daniel, 2016) and teamwork failures (communication, collaboration) are among the top root causes for medical errors (The Joint Commission, 2015). Health care systems have enormous complexity due to their complicated design and nonlinear, dynamic nature

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(Lipsitz, 2012). This complexity further stems from variations in resource availability, administrative systems, technology factors, unit norms, system processes in making patient care decisions, and co-worker relationships (Ebright, 2010). Nurse–physician interactions occur within these complicated hospital and health care systems. Thus, the level of and benefits from teamwork may depend on other hospital characteristics.

Existing evaluations of nurse–physician teamwork are limited in geography and size, with small health care provider samples from one unit, health system, or state (Baggs et al., 1999; Boyle, 2004; Knaus, Draper, Wagner, & Zimmerman, 1986; Mitchell & Shortell, 1997). Additionally, a gap exists in determining how other modifiable hospital factors also shown to be associated with good patient outcomes, such as nurse staffing levels, contribute to and interact with nurse–physician teamwork to affect patient outcomes (Kalisch & Lee, 2011; Manser, 2009). There is evidence suggesting that the well-documented benefits to patients of favorable nurse staffing and higher percentages of nurses with a bachelors (BSN) degree are conditional on the quality of the work environment generally (Aiken et al., 2003, 2011; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002); however, similar interactions with nurse–physician relations specifically have not been evaluated.

Purpose

This study sought to determine if there were associations between nurse–physician relationships and patient outcomes (30-day mortality and failure-to-rescue) in acute hospital settings and whether any relationship between nurse–physician teamwork and patient outcomes was conditional upon other modifiable characteristics of hospital nursing (nurse staffing and education levels).

Methods

Design

This was a retrospective, cross-sectional secondary analysis of data on hospitals in four states (California, Florida, New Jersey, and Pennsylvania) and the patients in those hospitals. We used three linked data sources from 2006–2007 including patient discharge data obtained from state agencies, the American Hospital Association (AHA) Annual Survey data, and survey data from hospital nurses. The University of Pennsylvania's Internal Review Board approved this study.

Setting and Sample

Hospitals.—Our study included adult non-federal acute care hospitals in California, Florida, New Jersey, and Pennsylvania (2006–2007) (N=665). The survey data from registered nurses (RNs) (N=29,391) in the four states were collected through the Penn Multi-State Nursing Care and Patient Safety Survey, a large mail-based study of a random sample of RNs. Responses were aggregated to characterize each hospital's nurse–physician teamwork, nurse staffing, and the percentage of nurses with at least a BSN degree. The survey of nurses employed a double-sample approach (Levy & Lemeshow, 1999; Smith, 2009), which yielded a response rate of 39% on the main survey. A second survey, which consisted of a re-survey of 1,300 non-respondents on the main survey using extensive

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follow-up reminders and incentives (Hansen & Hurwitz, 1946; Johnson & Wislar, 2012) yielded a 91% response rate among the initial non-responders. By comparing responders and non-responders (who subsequently completed a shorter version of the survey), we found that they did not differ on variables related to the organization of nursing and quality of nursing care (Smith, 2009). Since this is a study of nurse–physician teamwork as a characteristic of the hospital, the most important issue for us regarding generalizability is the representativeness of hospitals. The hospitals in our sample represent 86% of all general acute care hospitals and more than 90% of all adult general, vascular, and orthopedic surgical patient discharges in the four states, and over a quarter of the patient discharges in the country. Additional details regarding survey methodology have been presented previously (Aiken et al., 2011). Data on hospital characteristics such as technology and teaching status, and bed size were derived from the 2006–2007 AHA Annual Survey.

Patients.—Hospitalized patient discharge data were obtained from state agencies in the four states: California Office of Statewide Health Planning and Development, Florida Agency for Healthcare Administration, New Jersey Department of Health and Senior Services, and Pennsylvania Health Care Cost Containment Council. These databases cover all discharges from hospitals and include information on patient demographics, admission information, principal and secondary diagnosis and procedure codes (ICD-9-CM), and diagnosis-related group (DRG) assignment. Our patient sample included those aged 18–89 who underwent general surgical, vascular or orthopedic surgery from January 2006 to December 2007 (N=1,321,904).

Variables and Measures

Teamwork.—The level of nurse–physician teamwork in the hospital was the main explanatory variable of interest. It was measured using the nurse–physician relations, a validated subscale of the Practice Environment Scale of the Nursing Work Index, a National Quality Forum endorsed measure that was included in the nurse survey (Lake, 2002). The component items of this subscale focused on: (a) teamwork between nurses and doctors, (b) quality of relationships between physicians and nurses, and (c) degree of functional collaboration between nurses and physicians. Each item was measured on a 4-point Likert scale ranging from “strongly disagree” to “strongly agree.” The subscale score for each individual nurse respondent was a mean of the items comprising the teamwork subscale. Exploratory factor analysis demonstrated that each item loaded on a single factor >0.6 (range: 0.76–0.83). Additionally, the average interclass correlation (ICC) was also robust along with the ICC (1,k) of greater than 0.6 (range 0.66–0.68). The individual nurse–physician relations subscale scores were then aggregated to the hospital level. For descriptive purposes, the aggregated measurement of nurse–physician relations was categorized based on the bottom quartile, the middle 50%, and the top quartile representing poor, mixed, and good nurse–physician teamwork respectively.

Nurse staffing.—Survey responses from nurses included answers to the questions “On the most recent shift/day you worked, how many patients were on your unit?” and “On the most recent shift/day you worked, counting yourself, how many RNs provided direct patient care?” Utilizing these questions, nurse staffing was calculated for each nurse respondent as

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the number of patients divided by number of nurses on the unit and aggregated to the hospital level. This measure has demonstrated good predictive validity for patient outcomes (Aiken et al., 2002, 2011).

Nurse education.—Nurses also reported their highest nursing degree attained. The proportion of nurses with BSN degrees was aggregated to the hospital level. Previous studies have shown that the hospital proportion of baccalaureate prepared nurses is associated with patient outcomes (Aiken et al., 2003; Kutney-Lee et al., 2013).

Hospital characteristics.—Hospital characteristics were derived from the AHA Annual Survey. Hospital size based on the number of beds was classified as small (≤100 beds), medium (101 – 250 beds), and large (>250 beds). Teaching status based on the physician resident/fellow trainee-to-bed ratio was categorized as non-teaching (no postgraduate trainees), minor teaching (≤1:4 trainee-to-bed ratio) or major teaching (>1:4 trainee-to-bed ratio). Hospitals capable of supporting open-heart surgery and/or major transplants were classified as high-technology hospitals.

Patient outcomes.—*30-day mortality*. Patient discharge files linked with vital statistics data indicated if patients died within 30 days of admission and whether patients died inside or outside the hospital. The 30-day mortality measure has the benefit over inpatient mortality of capturing delayed effects of poor care during hospitalization that manifest after discharge. *Failure-to-rescue* (FTR) is defined as death within 30 days of hospital admission among those patients who suffered a complication while in the hospital (Clarke & Aiken, 2003; Needleman & Buerhaus, 2007; Silber, Williams, Krakauer, & Schwartz, 1992). Failure-to-rescue is calculated using the same numerator as mortality rates, but the denominator includes only those patients who experienced a complication (Silber, Rosenbaum, Zhang, & Even-Shoshan, 2007). Both 30-day mortality and FTR were represented as binary variables indicating whether the outcome occurred or not.

Covariates and Risk Adjustment

We used an established risk adjustment approach to account for the contribution of patient characteristics to the outcomes. In addition to including a set of 48 dummy variables indicating the specific surgical procedure, we adjusted for patient demographics including age and gender (Aiken et al., 2002, 2008, 2011), whether the patient was transferred into the hospital, and 27 of the 29 comorbidities identified by Elixhauser and colleagues (Elixhauser, Steiner, Harris, & Coffey, 1998). Fluid and electrolyte disorders and coagulopathy were excluded from the comorbidity adjustment as they have been shown to be miscalculated for complications (Glance, Dick, Osler, & Mukamel, 2006). A 180-day look-back period to previous hospitalizations was used to further distinguish between comorbidities and complications (Aiken et al., 2002, 2011).

Data Analysis

First, we described the characteristics of the hospitals and patients in our sample. Differences in hospital characteristics by level of teamwork were assessed using chi-square for categorical and ANOVA for continuous variables. To test for an association between

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nurse–physician teamwork, staffing, education, and patient outcomes (30-day mortality and FTR) several logistic regression models were fit. To facilitate the interpretation of the interactive effects of the explanatory variables on outcomes, nurse–physician teamwork was treated as a continuous variable and in standard deviation units, staffing was centered on the mean, and nurse education was also standardized to reflect a 10% increase in proportion of BSN nurses by standard deviations for all models. The outcome variables (30-day-mortality and FTR) were measured at the patient level. We first fit unadjusted models to examine the effect of nurse–physician teamwork on each outcome (separately). Subsequent models adjusted for patient and hospital characteristics, and finally adjusted for nurse staffing and education.

The second aim was to test whether any association detected between teamwork and patient outcomes was conditional on the level of other modifiable characteristics of hospital nursing (i.e., nurse staffing and education levels). We estimated logistic regression models adjusted for patient and hospital characteristics that included terms for the direct effect of teamwork and staffing as well as an interaction term, and (separately) the direct effect of teamwork and education along with their interaction. In these models, the interactions of teamwork and staffing and teamwork and education were evaluated at the mean and one and two standard deviations above and below the mean for each predictor. In all models clustering of patients in hospitals was accounted for using the Huber-White sandwich estimator (Huber, 1967; White, 1980). All analyses were conducted in STATA 15 and significance level set at *p-value* < .05.

Results

Table 1 displays descriptive characteristics of the hospitals in the sample overall and by level of nurse–physician teamwork (“poor” representing the bottom 25%, “mixed” the middle 50% and “good” the top 25%). The 665 hospitals in the study varied with regards to their nursing characteristics, with a quarter of hospitals having on average four or fewer patients per nurse and around 20% having seven or more patients per nurse on average. The mean teamwork score across all hospitals was 2.9 (SD=0.2). Hospitals in the top 25% with regards to teamwork had significantly fewer patients per nurse (4.9, SD=1.4) compared to the bottom 25% of hospitals (6.0, SD=1.8; $p < .001$). Hospitals in the top 25% of teamwork also had significantly more RNs with BSNs (41.1%; SD=15.0%) versus the bottom 25% of hospitals (33.6%, SD=14.8%; $p < .001$). Hospitals with less than 100 beds were twice as likely to be represented in the top quartile (41.0%) as compared to the bottom quartile of teamwork scores (22.0%, $p < .001$%). The majority of high technology hospitals were in the middle 50% of teamwork and the majority of hospitals were non-teaching.

Patients in the sample (N=1,321,904) were on average 60.2 years old (SD=17.5). Over half (52.3%) underwent an orthopedic surgical procedure (Table 2). Hypertension was the most common comorbidity (48.4%) and the average number of comorbidities was 1.3 (SD=2.2). 30-day mortality for the sample was 1.9% (n=25,514) and 34.0% of all patients experienced a complication (n=454,564). Patients who experienced a complication were more likely to be female (53.4%), older (mean=64.2 years, SD=16.7), and to experience 30-day mortality

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(4.8%). All the Elixhauser comorbidities were present significantly less for patients without complications than patients with complications except for obesity.

Table 3 displays the odds of 30-day mortality (top panel) and FTR (bottom panel) based on several models. The first column displays the bivariate effects of teamwork on each outcome. The second column displays the effects of teamwork on each outcome while adjusting for patient and hospital characteristics, including nurse staffing and education. In unadjusted and adjusted models, teamwork is significantly associated with the odds of both outcomes. Better nurse–physician teamwork, lower patient-to-nurse ratios, and higher percentages of BSN nurses were associated with lower odds of mortality and FTR. In the fully adjusted model, for each standard deviation unit increase in nurse–physician teamwork the odds of 30-day mortality and FTR both decreased by 5% ($p < .001$). In the final two columns of Table 3 when the interaction of teamwork and staffing or teamwork and education is added to the model, both interaction terms are significant for each outcome, indicating that the effects of nurse–physician teamwork are conditional upon nurse staffing and nurse education.

Nurse staffing and education had a modifying effect on nurse–physician teamwork. Table 4 shows that while high nurse–physician teamwork scores lowered the odds of 30-day mortality and FTR in hospitals, the effect is most pronounced in better staffed hospitals. The effect of nurse–physician teamwork was virtually nil in hospitals with poor staffing, or those hospitals with 2 patients per nurse above the mean (mean=5.3). The effect of nurse–physician teamwork in the best staffed hospitals at 2 patients per nurse below the mean decreased the odds of 30-day mortality and FTR by 9% ($p < .001$). Nurse education had similar effects, as shown in Table 5. Teamwork was not associated with 30-day mortality or FTR in hospitals with 20% fewer BSN educated nurses below the mean. Whereas, in hospitals with 20% more BSN educated nurses above the mean, nurse–physician teamwork decreased the odds of 30-day mortality and FTR by approximately 9% ($p < .001$). Higher proportions of BSN educated nurses at the hospital-level improved the impact of nurse–physician teamwork on 30-day mortality and FTR.

Discussion

Nurse–physician teamwork, nurse staffing, and nurse education levels are associated with 30-day mortality and FTR for surgical patients. In this study, we found a trend of decreased odds of 30-day mortality and FTR for hospitals with both higher nurse–physician teamwork scores and lower patient per nurse ratios and for hospitals with higher nurse–physician teamwork scores and higher proportions of nurses with BSNs.

These results support previous research findings where higher teamwork levels were associated with lower patient mortality rates in hospitals (Baggs et al., 1999; Knaus et al., 1986; Wheelan, Burchill, & Tilin, 2003). Our analysis builds upon these prior studies, which were conducted only at the intensive care unit level (Baggs et al., 1999; Wheelan et al., 2003) whereas ours was conducted at the hospital level and included 665 hospitals across four states. The impact of an increased percentage of nurses with BSNs on nurse–physician teamwork found here is contrary to an older study that found no statistically significant

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relationship between nurse–physician teamwork and educational preparation of the nursing staff (Alt-White, Charns, & Strayer, 1983). However, their sample was a single hospital and the contribution of baccalaureate nursing education to improved teamwork may not have been present in that specific hospital. Subsequent studies have found educational preparation of nurses to be an important indicator of quality outcomes (Aiken et al., 2003, 2011; Kutney-Lee et al., 2013).

Over the past decade there has been a heightened awareness of the importance of interprofessional teamwork among policy makers, educators and health care leaders. As a result, numerous initiatives and programs have been implemented to improve teamwork. The 2010 Affordable Care Act (ACA) created several mechanisms to improve coordination of patient care across the health care system including Accountable Care Organizations (ACOs) and Patient-Centered Medical Homes (PCMHs). The environments within ACOs and PCMHs strongly encourages teamwork among interprofessional providers in order to improve patient outcomes (Nester, 2016). Over the past decade, national IPE organizations have emphasized increasing complexity of health care requiring providers to evolve towards a more team-based approach (Health Professions Accreditors Collaborative, 2019).

Despite these initiatives and financial investments, teamwork continues to vary across hospitals (Kalisch & Lee, 2012; O'Leary et al., 2012) and the results among ACOs and PCMHs has been mixed (Kaufman, Spivack, Stearns, Song, & O'Brien, 2019; Kern, Edwards, & Kaushal, 2016). Missing from many of these initiatives is the inclusion of other nursing factors, such as staffing and education (Institute of Medicine, 2011). Health policy makers should continue to prioritize interprofessional teamwork as a means to improving patient outcomes, while also considering nursing resources needed to enhance teamwork's effects in order to maximize these investments.

This study adds to the evidence of the value of investing resources into the contributing factors of better nurse staffing and employing nurses with BSN education (Kutney-Lee et al., 2013). Health care policy makers, educators and hospital administrators looking for improvements in nurse–physician collaborative teamwork and ultimately patient care and safety should consider better nursing resources as systematic strategies (Stone et al., 2007; Yanchus, Ohler, Crowe, Teclaw, & Osatuke, 2017).

There were some limitations to our study. First, the cross-sectional study design limits our ability to make causal inferences about relationships between nurse–physician teamwork and 30-day mortality and FTR. We are using data from 2006–2007, however, previous studies describe a persistent relationship between measures of hospital nursing, including the work environment, staffing, and patient outcomes across countries over a large span of time (Aiken et al., 2002, 2011, 2014). Furthermore, a recent study demonstrated that in the cross-section the association between hospital nurse resources and patient quality and safety are essentially the same as those found in a longitudinal panel study of hospitals (Sloane, Smith, McHugh, & Aiken, 2018). Lastly, though we accounted for patient and hospital characteristics in our adjusted models, there may be some confounding variables that were unmeasured.

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Nurses and physicians share the common goal of providing high quality health care and ensuring patient safety. Teamwork among nurses and physicians is an essential key to providing effective and safe patient care (Manser, 2009). We confirm the importance of nurse–physician collaboration in this study by demonstrating an association between better teamwork and improved patient outcomes. We also show that this association is conditional on the levels of nurse staffing and nurse education. The analysis of the interaction of nursing factors with nurse–physician teamwork is a first step in examining conditions that may improve the returns on investments in interprofessional teamwork and in turn, quality and safety for health care systems in the future. Organizations seeking to improve patient outcomes through systematic changes must not only focus on interprofessional teamwork but should also consider other nursing resources in order to have the greatest impact.

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Table 1

Hospital Characteristics by Level of Nurse–Physician Teamwork

Characteristic	All (N=665)		Poor (n=167)		Mixed (n=332)		Good (n=166)		*p*-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Nurse–physician teamwork	2.9	0.2	2.6	0.1	2.9	0.1	3.1	0.1	< .001
Nurse staffing (patients/nurse)	5.5	1.6	6.0	1.8	5.5	1.5	4.9	1.4	< .001
Nurse education (% BSN)	37.2	14.4	33.6	14.8	37.0	13.4	41.1	15.0	< .001
	%	n	%	n	%	n	%	n	
Bed size									< .001
Small (<100)	15.1	100	22.0	22	37.0	37	41.0	41	
Medium (101–250)	45.3	300	29.3	88	48.0	144	22.7	68	
Large (>250)	39.6	264	21.6	57	57.2	151	21.2	56	
High Technology	39.3	261	21.5	56	56.3	147	22.2	58	.031
Teaching status									.033
Non-teaching	53.0	352	25.9	91	48.6	171	33.5	90	
Minor	40.1	266	27.5	73	50.3	134	22.2	59	
Major	6.9	46	6.5	3	58.7	27	34.8	16	

Note. Poor teamwork represents the bottom 25%, mixed represents the middle 50% and good the top 25%. Totals may not add up due to missing values. SD=standard deviation, BSN=bachelors prepared

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Table 2

Surgical Patient Characteristics

Characteristic	All patients (N=1,321,904) %	n
Male	43.2	570,846
Transferred status	1.2	15,890
Experienced a complication	34	454,564
Death within 30 days of admission	1.9	25,514
Major Surgical Category		
General Surgery (MDC 6,7,9,10)		
Digestive System disease and disorders (6)	21.9	279,503
Hepatobiliary System diseases and disorders (7)	11.2	143,411
Diseases and disorders of the skin, subcutaneous tissue & breast (9)	3.6	45,457
Endocrine, Nutritional, Metabolic Diseases & Disorders (10)	5.6	71,031
Orthopedic Surgery (MDC 8)		
Musculoskeletal System & Connective Tissue	52.3	668,639
Vascular Surgery (MDC 5)		
Circulatory system diseases and disorders	5.5	70,021
Comorbid Conditions *		
Congestive heart failure	5.3	69,700
Valvular disease	4.7	61,830
Peripheral vascular disorders	4.5	59,563
Hypertension	48.4	639,698
Other neurological disorders	4.21	55,704
Chronic pulmonary disease	14.6	193,499
Diabetes, uncomplicated	15.0	198,805
Diabetes, complicated	3.4	44,600
Hypothyroidism	9.5	124,916
Renal failure	4.9	64,749
Liver disease	2.3	30,500
Metastatic cancer	3.2	42,227
Rheumatoid arthritis/collagen vascular diseases	2.4	31,296
Obesity	8.7	114,295
Weight loss	1.8	23,565
Deficiency anemias	13.9	183,412
Alcohol abuse	2.4	31,499
Depression	7.3	96,261

Note.

* Other comorbidities used to risk-adjust in our models: pulmonary circulation disorders, paralysis, solid tumor without metastasis, blood loss anemias, drug abuse, psychoses, peptic ulcer disease, AIDS, and lymphoma. All of these conditions were exhibited by fewer than 2% of all patients and fewer than 3% of patients with complications.

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Table 3

Effects of Nurse–Physician Teamwork on Surgical Patient Mortality and Failure-to-Rescue

	Unadjusted	Patient, hospital characteristics	Fully adjusted with interaction of teamwork and staffing	Fully adjusted with interaction of teamwork and education
			Odds Ratios from Models for Patient Mortality	
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Teamwork	0.90***	0.95***	0.95***	0.95***
	(0.89–0.91)	(0.94–0.97)	(0.94–0.97)	(0.93–0.96)
Staffing		1.03**	1.04***	1.03**
		(1.02–1.04)	(1.03–1.05)	(1.02–1.04)
Nurse education		0.94***	0.94***	0.93***
		(0.92–0.95)	(0.92–0.95)	(0.91–0.94)
Teamwork x Staffing			1.02***	
			(1.01–1.03)	
Teamwork x Education				0.98*
				(0.96–0.99)
			Odds Ratios from Models for Failure-To-Rescue	
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Teamwork	0.91***	0.95***	0.94***	0.94***
	(0.89–0.92)	(0.94–0.96)	(0.93–0.96)	(0.93–0.96)
Staffing		1.03***	1.04***	1.03**
		(1.02–1.04)	(1.03–1.06)	(1.02–1.04)
Nurse education		0.93***	0.93***	0.93***
		(0.92–0.95)	(0.92–0.95)	(0.91–0.94)
Teamwork x Staffing			1.03***	
			(1.02–1.04)	
Teamwork x Education				0.98*
				(0.96–0.99)

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Note. OR = odds ratio, CI = confidence interval. Nurse–physician teamwork is standardized in standard deviation units, staffing is centered on the mean, and education reflects a 10% increase in BSN nurses by standard deviation. Control variables in the adjusted models include patient (age, gender, comorbidities, type of surgery, and whether they were transferred), nurse characteristics (whether they worked in the ICU), and hospital characteristics (bed size, technology level, teaching status, and state).

* $p < .05$

** $p < .01$

*** $p < .001$.

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Table 4

Effect of Staffing at Level of Nurse–physician Teamwork and the Effect of Nurse–Physician Teamwork at Level of Staffing on 30-Day Mortality and Failure-to-Rescue

	Effect of Staffing			
	On Mortality		On Failure-to-Rescue	
	OR	95% CI	OR	95% CI
Interaction of staffing and teamwork, when teamwork is:				
2 SD < mean	0.99	0.96–1.02	0.99	0.96–1.02
1 SD < mean	1.02	0.99–1.04	1.02	0.99–1.04
At mean (2.9)	1.02***	1.01–1.04	1.03***	1.01–1.04
1 SD > mean	1.07***	1.04–1.10	1.07***	1.04–1.10
2 SD > mean	1.09***	1.05–1.13	1.10***	1.06–1.15
	Effect of the Nurse–physician Teamwork			
	On Mortality		On Failure-to-Rescue	
	OR	95% CI	OR	95% CI
Interaction of staffing and teamwork, when staffing is:				
2 patients/nurse > mean	1.00	0.97–1.03	1.00	0.96–1.03
1 patient/nurse > mean	0.97*	0.95–0.998	0.97*	0.95–1.00
At mean (5.3)	0.95***	0.93–0.97	0.94***	0.92–0.97
1 patient/nurse < mean	0.93***	0.90–0.95	0.92***	0.89–0.95
2 patients/nurse < mean	0.91***	0.87–0.94	0.89***	0.86–0.93

Note. SD = standard deviation, OR = odds ratio, CI = confidence interval.

* $p < .05$

** $p < .01$

*** $p < .001$.

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Table 5

Effect of Nursing Education at Level of Nurse–Physician Teamwork and the Effect of the Nurse–Physician Teamwork at Level of Nursing Education

	Effect of BSN education			
	On Mortality		On Failure-to-Rescue	
	OR	**95% CI**	**OR**	**95% CI**
Interaction of education and teamwork, when teamwork is:				
2 SD < mean	0.98	0.95–1.02	0.98	0.94–1.02
1 SD < mean	0.97**	0.94–0.99	0.96**	0.94–0.99
At mean (2.9)	0.98*	0.86–0.93	0.98*	0.96–0.998
1 SD > mean	0.93***	0.91–0.96	0.93***	0.90–0.95
2 SD > mean	0.91***	0.88–0.95	0.91***	0.87–0.95
	Effect of the Nurse–physician Teamwork			
	On Mortality		**On Failure-to-Rescue**	
	OR	**95% CI**	**OR**	**95% CI**
Interaction of education and teamwork, when education is:				
20% > mean	0.91***	0.87–0.96	0.91***	0.86–0.95
10% > mean	0.93***	0.90–0.96	0.93***	0.89–0.96
At mean (40%)	0.95***	0.93–0.97	0.94***	0.92–0.97
10% < mean	0.97**	0.94–0.99	0.96**	0.94–0.989
20% < mean	0.99	0.95–1.02	0.98	0.95–1.02

Note. SD = standard deviation, OR = odds ratio, CI = confidence interval.

* $p < .05$

** $p < .01$

*** $p < .001$