

# Nurse-Physician Collaboration and Hospital-Acquired Infections in Critical Care

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**BACKGROUND** Nurse-physician collaboration may be related to outcomes in health care–associated infections.

**OBJECTIVE** To examine the relationship between nurse-physician collaboration and health care–associated infections in critically ill adults.

**METHODS** A secondary analysis was done of 5 years of nurses' perception data from 671 surveys from 4 intensive care units. Ventilator-associated pneumonia and central catheter–associated bloodstream infections were examined. Multilevel modeling was used to examine relationships between nurse-physician collaboration and the 2 infections.

**RESULTS** Nurse-physician collaboration was significantly related to both infections. For every 0.5 unit increase in collaboration, the rate of the bloodstream infections decreased by 2.98 ( $P = .005$ ) and that of pneumonia by 1.13 ( $P = .005$ ). Intensive care units with a higher proportion of certified nurses were associated with a 0.43 lower incidence of bloodstream infections ( $P = .02$ ) and a 0.17 lower rate of the pneumonia ( $P = .01$ ). With nursing hours per patient day as a covariate, units with more nursing hours per patient day were associated with a 0.42 decrease in the rate of bloodstream infections ( $P = .05$ ).

**CONCLUSION** Nurse-physician collaboration was significantly related to health care–associated infections. (*Critical Care Nurse*. 2015;35[2]:66-72)

**I**mproving patient safety is a top priority of all health care institutions. Of particular concern is the incidence of health care–associated infections (HAIs). In critical care, 2 common HAIs are ventilator-associated pneumonia (VAP) and central line (central catheter)–associated bloodstream infections (CLABSIs).<sup>1</sup> Estimates of the costs of these HAIs are tremendous; VAPs contribute to 35 967 deaths per year and CLABSIs to 30 665 deaths.<sup>2</sup>

Many factors in nurses' work environment have been linked to patient safety. One important aspect of that environment is nurse-physician collaboration. Nurse-physician collaboration is defined as "nurses and physicians working together, sharing responsibilities for solving problems and making decisions to formulate and carry out plans for patient care."<sup>3</sup> In *The Future of Nursing*,<sup>4</sup> the Institute of Medicine identified nurse-physician collaboration as 1 of 4 key priorities. According to the publication,<sup>4</sup> nurses should strive to be full partners with physicians in redesigning health care in the United States.

Several barriers to achieving a full partnership with physicians have been recognized. First, nurses view collaboration as more positive and important than do physicians.<sup>5-7</sup> Second, physicians do not seem to understand the role and scope of practice of nurses.<sup>8</sup> To achieve full partnership, both nurses and physicians must recognize the unique contribution of each profession. Third, a disconnect exists in the perception of the quality of collaboration. Physicians rate the quality of collaboration significantly higher than do nurses.<sup>9-11</sup> If members of both professions do not identify a problem, they will have little motivation to work toward a solution.

Nurses working in intensive care units (ICUs) with effective nurse-physician collaboration report greater overall job satisfaction than do nurses in other units. In a meta-analysis<sup>12</sup> of nurses' job satisfaction, nurse-physician collaboration was 1 of the top 3 most commonly noted variables predictive of job satisfaction, second only to job stress. Critical care nurses reported greater satisfaction with nurse-physician communication than did those nurses working in general care areas<sup>13</sup>; however, disparities remain in relation to perception of communication.<sup>14</sup> Conflicts in the ICU are most often between nurses and physicians rather than between either nurses or physicians and members of other disciplines.<sup>15</sup>

Breakdown in communication and collaboration between nurses and physicians is related not only to unfavorable perceptions of the work environment<sup>16</sup> but also to adverse patient outcomes. In an early study,<sup>17</sup> researchers noted a significant inverse relationship between staff interaction and coordination and patient mortality: as staff interaction and coordination increased, patient mortality decreased. A similar relationship was noted between nurses' reports of collaboration and patients' outcomes. When adjustments were made for severity of illness, medical ICU nurses' reports of collaboration were significantly predictive of improvement in

patients' outcomes.<sup>18</sup> In another report,<sup>19</sup> nurse-physician communication was examined in relation to medication errors, VAP, and catheter-associated sepsis. Nurse-physician communication was a significant predictor of medication errors but not of any other patient outcomes.

In this study, we address an important topic related to nurse-physician collaboration and adverse patient outcomes. The research question was as follows: What is the relationship between nurse-physician collaboration and 2 of the most common elements of patient care directly affected by nursing practice in critical care: VAPs and CLABSIs? On the basis of a comprehensive review of the literature, we hypothesized that nurse-physician collaboration is inversely related to VAP and CLABSI.

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## Methods

The theoretical framework for this study was Kanter's theory of structural empowerment.<sup>20</sup> In this theory, Kanter suggests that hierarchical structures contribute to behaviors and attitudes. Both the formal and the informal processes in place within a critical care setting and perceived power disparities may contribute to ineffective nurse-physician collaboration.

## Design

This longitudinal study was a secondary analysis of nurse perception data. In the original study,<sup>21</sup> the Nurse Perception Survey was used once a year to measure nurses' perception of the work environment during the 4.25-year study period. The survey was a compilation of 5 instruments used to measure various aspects of the work environment. During the study period, interventions to streamline nurses' orientation and provide more staff education were implemented. Bundling practices recommended by the Institute for Healthcare Improvement<sup>22,23</sup> were not fully implemented until the present study was completed.

## Sample and Setting

The original study<sup>21</sup> was conducted in a 750-bed university-affiliated Magnet hospital in western New York. Four specialized ICUs (surgical, medical, burn-trauma, and cardiovascular) with 10 to 22 beds each were included in the study. The units were geographically isolated

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from each other. The research reported in this secondary analysis of data was approved by the appropriate university research review board.

Data on all nurses who participated in the original study were included in the secondary analysis. The Collaboration and Satisfaction About Care Decisions (CSACD)<sup>24</sup> was 1 instrument embedded within the Nurse Perception Survey. A total of 671 nurse perception surveys were collected. The mean response rate for the entire study period was 96%.

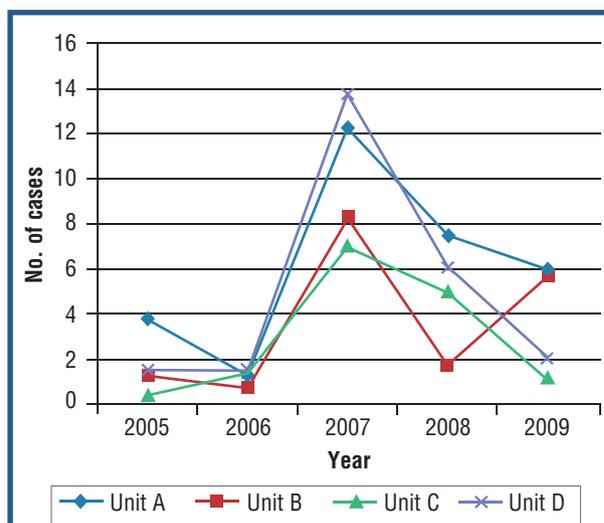
Patient outcome data were collected on all patients (n = 3610) discharged from each of the 4 ICUs during the 4.25-year study period (January 1, 2005, to March 31, 2009). Discharge was defined as transfer to an alternative level of care, discharge home, or death. Demographic information was also obtained, including age, sex, length of stay, and comorbid conditions. This information was used to compute a Charlson Comorbidity Index to control for severity of illness.<sup>25</sup> Specifically, data for all patients with CLABSI, VAP, or both were examined in the secondary analysis of data because these HAIs are the most common in critical care and contribute to marked morbidity and mortality.<sup>1</sup>

## Measures

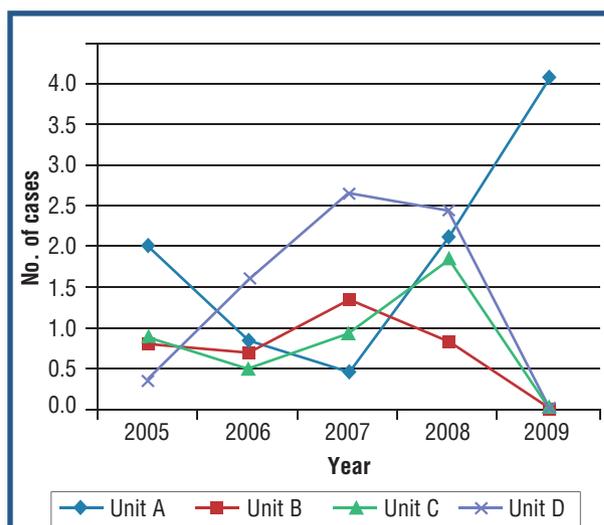
Nurse-physician collaboration was measured in the original study by using the CSACD,<sup>24</sup> which is both reliable and valid. The Likert scale was adjusted from a 7-point scale to a 6-point scale when incorporated into the Nurse Perception Survey, with values of 1 (strongly disagree) to 6 (strongly agree). A mean collaboration score was calculated for all nurses. The CSACD has been used in many studies<sup>18,26-28</sup> on nurse-physician collaboration and was created specifically for critical care units.

## Dependent Variables

VAP was defined as pneumonia that occurred in a patient who had been treated with mechanical ventilation for more than 2 calendar days on the day the infection was diagnosed<sup>29</sup> and was calculated as the number of VAPs times 1000 divided by the number of ventilator days for ICU patients per month. CLABSI was defined as laboratory confirmed bloodstream infection in which the central catheter had been in place for more than 2 calendar days on the day the infection was diagnosed and was calculated as the number of CLABSI times 1000 divided by number of central catheter days per month.<sup>30</sup> Figures 1 and 2 illustrate CLABSI and VAP rates by unit



**Figure 1** Central catheter-associated bloodstream infection rates by intensive care unit by year for the entire study period.



**Figure 2** Ventilator-associated pneumonia rates by intensive care unit by year for the entire study period.

for the entire period of the original study. Also included in the analysis were 3 unit-level variables related to patient outcomes in critical care. Nurses' skill mix, nursing hours per patient day, and voluntary turnover were examined as covariates in the modeling procedures. These data were obtained from the nursing administrative database. Data on all variables were collected monthly and were aggregated at the unit level. Patient outcome data were obtained from the ICU clinical outcomes specialist.

## Data Analysis

Data were cleaned and checked for errors and missing data before any analyses. SAS, version 9.3, software (SAS

Institute Inc) was used for data analysis. Data were expressed as mean and standard deviation. All statistical tests were 2-sided. *P* values less than .05 were considered significant. Evaluation of the nurse-physician collaboration was completed by examining data collected by using the CSACD from January 1, 2005, to March 31, 2009. Descriptive statistics were used.

The observations and analysis were at the unit level. In order to ensure a sufficient number of rare outcomes and a sufficient level of variability in patient outcomes, data were aggregated by unit by month except for nurse-level data, which were aggregated to the unit level by year. The total observations for these variables were 204 (4 units × 12 months × 4.25 years). Nurse-physician collaboration per unit was treated as constant within a year. As a result, the mean (per unit by year) was used as a proxy for job satisfaction for each month for each unit.

Mixed linear modeling with PROC MIXED (SAS, version 9.3) was used to examine the potential relationship between nurse-physician collaboration and HAIs. The intraclass correlation coefficient was calculated because of the hierarchical structure in the data. The coefficient is used to determine the degree to which observations within groups may be dependent because of the phenomenon of nesting.<sup>31</sup> Intraclass correlation coefficients for VAP and CLABSI were 0.20 and 0.04, respectively. These moderately high values indicate that rates of VAP and CLABSI were unit dependent. Multilevel modeling<sup>31</sup> was used to control for variability attributed to the effect of nesting of monthly data within units.

After confirmation that all assumptions of mixed linear modeling were met, multicollinearity among the independent variables was investigated. In order to choose the optimal predictors, the model was selected before the modeling was done. First, the primary predictor mean

collaboration and the entire relevant nurse and patient levels' covariates were included in the model, and the backward step was used to select the optimal variables for the final model. The following variables were chosen as in the final models: mean collaboration, unit, year, Charlson Comorbidity Index, nursing certification (CCRN), nurses skill mix, turnover, and nursing hours per patient day. Bias-corrected bootstrap methods were used to generate 95% CIs and *P* values for model parameters. These methods produce more accurate estimates in multilevel modeling when level 2 sample size is small or distributions deviate from normal.<sup>32</sup>

## Results

Tables 1 and 2 give the demographics associated with data on both the nurses and the patients used in this secondary analysis. Included in Table 1 are the mean rates for both CLABSI and VAP for the study period along with mean Charlson Comorbidity Index. This sample of nurses reported favorable perception of nurse-physician collaboration as measured by the CSACD instrument. Unit C consistently reported the highest satisfaction with nurse-physician collaboration, and unit D reported the lowest satisfaction. The 4 ICUs differed significantly in perception of nurse-physician collaboration (Table 3).

**Table 1** Aggregated patient demographics by unit for entire study period (N=3610)

Characteristic	Intensive care unit			
	A	B	C	D
	<b>Percentage of patients in unit</b>			
Patient's age, mean, y				
<21	6.8	0.3	1.4	0.5
21-30	14.8	2.3	3.5	3.6
31-40	14.3	5.3	6.7	3.7
41-50	17.0	11.0	15	13.8
51-60	17.3	17.4	18.8	31.0
61-70	12.0	25.3	18.6	23.8
71-80	9.6	23.6	20.5	12.9
>80	8.2	14.8	15.5	10.7
	<b>Mean (range)</b>			
Charlson Comorbidity Index	0.88 (0.33-2.08)	2.3 (0.5-4.22)	2.9 (1.6-4.9)	3.2 (1.5-5.0)
No. of CLABSIs per month	2.4 (0-12)	1.3 (0-10)	1.1 (0-5)	2.2 (0-8)
CLABSI rate	5.7 (0-25.6)	3.0 (0-29.7)	3.3 (0-15.4)	5.9 (0-25.2)
No. of VAPs per month	1.1 (0-8)	0.4 (0-3)	0.3 (0-2)	0.6 (0-3)
VAP rate	3.7 (0-27.2)	1.6 (0-17.14)	1.0 (0-7.8)	1.6 (0-9.1)

Abbreviations: CLABSI, central catheter-associated bloodstream infection; VAP, ventilator-associated pneumonia.

**Table 2** Aggregated nursing demographics by unit for entire study period

Characteristic	Intensive care unit			
	A	B	C	D
	Percentage of nurses in unit <sup>a</sup>			
Age, y				
20-30	40.0	25.6	21.9	24.5
31-40	32.6	42.6	29.7	45.5
41-50	18.6	27.9	21.9	28.2
>50	10.9	3.9	26.5	1.8
Race				
Native American	0.8	2.3	0.8	0.9
Asian	0.0	3.1	0.0	2.8
Native Hawaiian	0.0	0.0	0.8	0.0
Black	1.6	0.0	0.0	0.8
White	95.3	93.8	96.0	96.3
Education				
Diploma	4.7	5.5	7.8	3.6
Associate's degree	15.5	5.5	23.3	17.1
Bachelor's and higher	79.8	89.0	68.0	79.3
Certification	26.6	22.6	25.4	21.7

<sup>a</sup> Percentages may not total 100 because of rounding.

Units with favorable perception of nurse-physician collaboration were associated with lower rates of both CLABSI and VAP. Table 4 illustrates the results of the 2-level model for CLABSI with controls for patient severity of illness. For every 0.5 unit increase in nurse-physician collaboration, the rate of CLABSI decreased by 2.98 ( $P = .005$ ). Additionally, those units with a higher proportion of certified nurses were associated with a 0.44 lower incidence of CLABSI ( $P = .02$ ). Neither nurses' skill mix nor voluntary turnover was related to CLABSI, but nursing hours per patient day was a significant predictor of CLABSI for this sample. ICUs with increased nursing hours per patient day were associated with a 0.42 decrease in the rate of CLABSI ( $P = .05$ ).

Table 5 illustrates the results of the 2-level model for VAP with controls for severity of illness. For every 0.5 unit increase in nurse-physician collaboration, the rate of VAP decreased by 1.13 ( $P = .005$ ). Units with a higher proportion of certified nurses were associated with a 0.17 decrease in the rate of VAP ( $P = .01$ ). However, none of the unit-level variables (nurses' skill mix, voluntary turnover, or nursing hours per patient day) was a significant predictor of VAP.

**Table 3** Mean (SD) scores on the Collaboration and Satisfaction About Care Decisions by unit by year

Time	Intensive care unit				<i>P</i> <sup>a</sup>
	A	B	C	D	
2005-2006	4.45 (0.56)	4.14 (0.69)	4.46 (0.66)	4.30 (0.76)	.21
2006-2007	4.29 (0.56)	4.24 (0.79)	4.55 (0.73)	3.82 (1.13)	.004
2007-2008	4.06 (0.78)	4.07 (0.69)	4.63 (0.71)	4.04 (1.06)	.06
2008-2009	4.04 (0.70)	4.23 (1.55)	4.97 (0.65)	4.23 (1.05)	.02
Entire study period	4.21	4.17	4.65	4.09	<.001

<sup>a</sup> Analysis of variance used to determine differences between units.

**Table 4** Two-level model of nurse-physician collaboration and central catheter-associated bloodstream infections

Variable	Estimate	95% CI	<i>P</i>
Intercept	56.56	8.52 to 104.60	.02
Mean collaboration	-5.96	-10.08 to -1.83	.005
Certification	-0.44	-0.79 to -0.08	.02
Nurses' skill mix	-22.48	-63.59 to 18.64	.28
Voluntary turnover	-12.29	-42.36 to 17.77	.42
Nursing hours per patient day	-0.42	-0.84 to 0.00	.05

**Table 5** Two-level model of nurse-physician collaboration and ventilator-associated pneumonia

Variable	Estimate	95% CI	<i>P</i>
Intercept	22.54	4.73 to 40.36	.01
Mean collaboration	-2.25	-3.80 to -0.71	.005
Certification	-0.17	-0.30 to -0.04	.01
Nurses' skill mix	-12.56	-27.72 to 2.60	.10
Voluntary turnover	-3.14	-14.30 to 8.03	.58
Nursing hours per patient day	-0.02	-0.18 to 0.13	.79

## Discussion

Our findings support existing research that links nurse-physician collaboration and patient outcomes. Our results also add to the existing literature on nurse-physician collaboration and patient outcomes in 2 important ways. First, in many studies, only patient mortality was examined as an outcome measure. With recent policy changes by the Centers for Medicare and Medicaid Services related to nonreimbursement for HAIs,<sup>33</sup> preventable conditions are now carefully scrutinized. Both CLABSI and VAP are associated with increased patient morbidity and mortality, and as health care providers, nurses need to better understand all aspects of the work environment that may affect HAIs. Second, the longitudinal data collection allowed us to examine trends over time, a situation that improves the validity of the findings. Additionally, we used mixed linear modeling for the data analysis, a step that allowed us to control for observations within groups that may be dependent because of the phenomenon of nesting.<sup>31</sup> For example, patients in the cardiovascular ICU would have lower rates of VAP because they are typically not intubated for long periods postoperatively. Controlling for nesting in the data analysis is important to decrease error.

Another important finding is that units with a higher proportion of certified nurses were associated with lower incidences of both CLABSI and VAP. Certified nurses included nurses who completed certification such as those for CCRN, oncology nurse, and Advanced Trauma Life Support. Each of these additional certifications is above and beyond what is required by the hospital. In most research on patient outcomes and certification, the investigators looked specifically at CCRN certification. In previous multisite studies,<sup>34,35</sup> no significant relationships were detected between certification and patient outcomes. Our findings are more consistent with expectations about the potential impact of certification on care delivery outcomes. For example, nurses who earn CCRN certification are held to a higher standard than are noncertified nurses: the CCRNs are required to earn more than 100 contact hours every 3 years, pass a difficult written examination, provide evidence of bedside nursing, and participate in disseminating evidence.<sup>36</sup> Because of the extra effort required for certification, these nurses are expected to provide superior care, although the relationship between this enhanced care and improved outcomes has not been established.

Fortunately, rates of both CLABSI and VAP are decreasing, and some investigators<sup>33,37</sup> have attributed this decrease to the implementation of new bundling practices. Embedded within the bundles is the need for effective communication. For example, during insertion of a central catheter, all members of the health care team must communicate effectively and collaborate with each other on sterile technique, use of personal protective equipment, and updates on the patient's response to the procedure. According to our analysis, nurses rated overall nurse-physician collaboration as favorable, with significant differences between the 4 ICUs. At the unit level, those units with favorable nurse-physician collaboration were associated with decreased rates of both CLABSI and VAP.

Our findings have important implications. The first implication is the potential to improve patient safety through improved collaboration and communication. Several interventions have successfully improved nurse-physician collaboration. Multidisciplinary daily patient rounds can improve nurse-physician collaboration and communication.<sup>11,38,39</sup> However, in 1 study,<sup>10</sup> the physicians reported an improvement in nurse-physician collaboration, whereas the nurses reported no difference. This discrepancy in perception of collaboration is well-documented.<sup>5,6,10,11</sup>

Kanter's theory of structural empowerment may help explain the disparities. The hierarchical structures within the health care environment could potentially inflate physicians' perceptions of collaboration because physicians administer the orders. Nurses, as the recipient of the orders, may find true collaboration difficult because of the inherent barriers related to the hierarchy within hospitals.<sup>20</sup>

Other interventions that have improved nurse-physician collaboration include interprofessional education via both educational programs and patient simulations. Collaborative relationships improved after medical residents and nurses participated in both simulation training<sup>27</sup> and formal education programs.<sup>39</sup>

## Limitations

Our study has several limitations. First, because the original study was conducted at a single institution,

generalizability of the findings is limited. Future research on nurse-physician collaboration and patient outcomes should be conducted at various institutions (with multiple units) to improve external validity. Additionally, we measured only nurses' perceptions related to nurse-physician collaboration. For a more complete picture of the phenomenon, physicians' perceptions should be included. Another limitation is that we did not include physician staffing in the models. The 4 ICUs varied in terms of use of midlevel providers, but the care of all ICU patients was managed by intensivists.

Despite these limitations, our results provide preliminary support for the relationship between nurse-physician collaboration and HAIs in critical care. **CCN**

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To learn more about nurse-physician collaboration, read "Professional Autonomy, Collaboration With Physicians, and Moral Distress Among European Intensive Care Nurses" by Papatthanassoglou et al in the *American Journal of Critical Care*, March 2012;21:e41-e52. Available at [www.ajconline.org](http://www.ajconline.org).

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