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RESEARCH ARTICLE

Impact of Performance Obstacles on Intensive Care Nurses' Workload, Perceived Quality and Safety of Care, and Quality of Working Life

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Objectives. To study the impact of performance obstacles on intensive care nurses' workload, quality and safety of care, and quality of working life (QWL). Performance obstacles are factors that hinder nurses' capacity to perform their job and that are closely associated with their immediate work system.

Data Sources/Study Setting. Data were collected from 265 nurses in 17 intensive care units (ICUs) between February and August 2004 via a structured questionnaire, yielding a response rate of 80 percent.

Study Design. A cross-sectional study design was used. Data were analyzed by correlation analyses and structural equation modeling.

Principal Findings. Performance obstacles were found to affect perceived quality and safety of care and QWL of ICU nurses. Workload mediated the impact of performance obstacles with the exception of equipment-related issues on perceived quality and safety of care as well as QWL.

Conclusions. Performance obstacles in ICUs are a major determinant of nursing workload, perceived quality and safety of care, and QWL. In general, performance obstacles increase nursing workload, which in turn negatively affect perceived quality and safety of care and QWL. Redesigning the ICU work system to reduce performance obstacles may improve nurses' work.

Key Words. Intensive care nurses, workload, quality of care, patient safety, stress

A major challenge for intensive care units (ICUs) is improving quality and safety of nursing care. For example, a recent study found that there was one error for every five medication doses administered in a medical–surgical ICU. The medication administration stage was especially susceptible for errors (Kopp et al. 2006). Nurses play a substantial role in the care provided in ICUs (McSteen and Peden-McAlpine 2006; Rogers et al. 2008). Another related challenge for ICUs is to improve nursing quality of working life (QWL). QWL

is nurses' reactions to the outcome of complex interactions between work system components described in seminal work by Smith and Carayon (Smith and Carayon-Sainfort 1989; Carayon and Smith 2000; Smith and Carayon 2000). Improving nursing QWL is critical because poor QWL leads to high nursing turnover (Hayes et al. 2006)—a significant problem for ICUs in the United States (Stone et al. 2007b).

Poor ICU work system design may negatively affect the quality and safety of nursing care as well as nursing QWL (Institute of Medicine 2004). In this paper, the term "ICU work system design" refers to the design of all ICU work system tasks, technologies, physical environment, and organization, as well as the interactions among them, which eventually affect care providers, processes, and outcomes (Carayon et al. 2006). Interruptions, overworking, illegible writing, ineffective communication, and equipment problems, among others, result from poor ICU work system design. Such hazards can increase nursing errors (Institute of Medicine 2004; Suresh et al. 2004; Baggs 2007; Stone et al. 2007a) and also negatively affect QWL (Gurses and Xiao 2006; Poncet et al. 2007; Schmalenberg and Kramer 2007).

Work system design characteristics may affect quality and safety of care and QWL through workload (Carayon, Alvarado, and Hundt 2007). We tested whether workload mediates the relationships between work system design characteristics and nursing QWL, as well as between work system design characteristics and nurses' perceived quality and safety of care. Literature supports that high nursing workload adversely affects quality and safety of care (e.g., Lang et al. 2004) and QWL (McVicar 2003). Furthermore, some work system design characteristics such as understaffing (Dimick et al. 2001) and inadequate collaboration among care providers (Spence et al. 2006) can increase ICU nursing workload.

The concept of performance obstacles can be used to study ICU work system design. Performance obstacles are "the work system design characteristics that inhibit performance and are closely associated with the immediate work setting" (Peters and O'Connor 1988). Performance obstacles can

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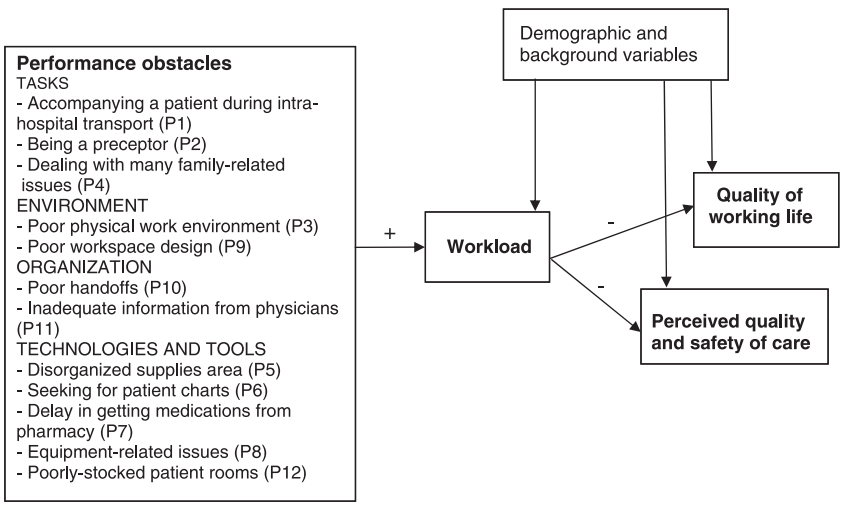
negatively impact employees' QWL (Peters and O'Connor 1980; O'Connor et al. 1982). However, conflicting results are reported on the impact of obstacles on performance, with some studies indicating a negative impact (O'Connor et al. 1984a; Steel and Mento 1986), and others indicating no impact (Pooyan et al. 1982; O'Connor et al. 1984b). It is plausible to claim that performance obstacles negatively affect quality and safety of care and QWL.

Research Objective and Hypotheses

The overall study objective was to investigate the relationships between performance obstacles, workload, perceived quality and safety of care, and QWL among ICU nurses. More specifically, we aimed at (1) identifying performance obstacles that affect nursing workload, perceived quality and safety of care, and QWL in ICUs, and (2) understanding the role of workload as a mediator in the relationships between performance obstacles and perceived quality and safety of care as well as between performance obstacles and QWL. A conceptual model (Figure 1) was developed and empirically tested.

The model includes four constructs: performance obstacles, workload, QWL, and perceived quality and safety of care. Workload is nurses' subjective

Figure 1: The Conceptual Research Model



experiences reflecting the combined effects of both task demands while performing direct and indirect care activities and demands imposed on them by the obstacles in the work system (Carayon and Gurses 2005). The multidimensional workload concept covers issues of the amount of work and the physical, mental, emotional, and temporal demands of the work (Carayon and Alvarado 2007; Carayon and Gurses 2008). In this study, we focused on quantitative workload attributed to time pressure. QWL corresponds to nurses' stress, fatigue, and job satisfaction. Perceived quality and safety of care is nurses' perception regarding both performance and satisfaction with the quality and safety of the care they provide. The conceptual model asserts that performance obstacles affect perceived quality and safety of care as well as QWL through workload. In other words, performance obstacles increase nurses' workload, which, in turn, can negatively affect their QWL and perceived quality and safety of care.

The conceptual model was based on job design and occupational stress theories (Herzberg 1966; Smith 1987), specifically the Balance Theory (Smith and Carayon-Sainfort 1989; Carayon and Smith 2000; Smith and Carayon 2000). The Balance Theory can guide efforts in assessing and designing work systems that produce the right level of workload, high quality and safety of care, and QWL from a systems perspective (Carayon et al. 2006). According to this theory, a work system such as an ICU can be characterized by five components: task, organization, environment, technology, and individual. These five interact with and influence one another. Flaws in the design of these components and interactions are the underlying sources of performance obstacles (Carayon et al. 2005). If performance obstacles can be identified, it may be possible to redesign the work system and processes to eliminate or "balance out" their impact.

To accomplish the research objectives, the following hypotheses were tested:

H_1. Performance obstacles increase nurses' workload.

H_{2a}. Workload has a negative impact on quality and safety of care as perceived by nurses.

H_{2b}. Workload has a negative impact on nurses' QWL. It leads to increased stress and fatigue and decreased job satisfaction among nurses.

H_{3a}. Performance obstacles, mediated by workload, negatively affect perceived quality and safety of care.

H_{3b}. Performance obstacles, mediated by workload, negatively affect QWL.

METHODOLOGY

Overall Study Design

A cross-sectional study design was used. The unit of analysis was the nurse over a shift. A structured questionnaire was used to collect data from ICU nurses regarding the shift they just completed.

Participating Organizations and Sample

Questionnaires were distributed to nurses in 17 ICUs of seven hospitals in Wisconsin between February and August 2004. One hospital was rural and nonacademic, five were urban and nonacademic, and one was urban and academic. The participating ICUs had different sizes and specialties, including medical, surgical, trauma, burn, cardiothoracic, cardiac, neurosurgery, adult, pediatric, and neonatal. Each nurse could fill out the questionnaire only once. The inclusion criteria were as follows:

(1) Being a staff nurse: Typically, nonstaff nurses have limited knowledge of a particular unit and may therefore experience additional obstacles that staff nurses do not.
(2) Having been assigned ICU-level patient(s): Rarely, patients who do not need ICU-level care stay in the ICU due to bed unavailability in other hospital units. Nurses who attended such patients were excluded.

A total of 364 questionnaires were distributed. Three hundred were filled out and returned, out of which only 265 were eligible to participate as 22 were not staff nurses and 13 were not assigned ICU-level patients in the shift just worked. Hence the response rate was 80 percent (265/329), ranging between 40 and 100 percent across ICUs. Six questionnaires were excluded, reducing the sample size to 259: Two were <50 percent complete, and four were identified as outliers.

Study Procedures

Institutional Review Board approvals were obtained from Human Subjects Committees of all involved institutions. Participation in the study was voluntary. Methods used to inform nurses about the study included presentations at unit nursing meetings, meetings with ICU representatives, and e-mails or memos from nurse managers.

Data collection started two and a half hours before the end of the shift. The first author went to the units at randomly chosen shifts, distributed the

questionnaire, and asked nurses to complete it based only on their experiences of that particular shift any time during the last two and a half hours of their shift or right after the shift. We believe that this flexibility ensured a high response rate while capturing most of the nurses' experiences during the shift. The first author waited outside the units during the majority of the data collection period, going inside the units every 30–45 minutes to answer questions.

Measures

To collect data, we used 61 items from a 98-item questionnaire (Appendix), which was developed and pilot-tested (Gurses 2005). The questionnaire was designed to measure performance obstacles, workload, perceived quality and safety of care, and QWL constructs as well as the demographic and background variables. Whenever appropriate, interitem reliability was assessed by Cronbach's α (Table 1).

Performance Obstacles. Twenty-six items were included in the questionnaire to measure performance obstacles; 21 had a dichotomous scale, and 5 had a semantic differential response format. A semantic differential response format measures respondents' reactions to a concept in terms of ratings on bipolar scales defined with contrasting adjectives at each end (Heise 1970). Accompanying a patient during intrahospital transport was an obstacle because a primary nurse cannot complete any tasks in her unit while accompanying a patient for transport. Upon her return, she may have an accumulated workload because the filling nurses typically concentrate only on the most critical patient tasks. Additionally, most hospitals do not have a formal, standardized handoff process for the primary nurse to give and receive information on the patient that did not go to an intrahospital transport, which may negatively affect quality and safety of care.

Through exploratory principal components factor analysis with promax rotation (Dillon and Goldstein 1984) and face validity decision making, the 26 items were combined to create measures for the 12 dimensions of the performance obstacles construct. For the dimensions indicated by the factor analysis, scales were created by summing items, and interitem reliability was assessed. For the dimensions involving items not necessarily correlated but that together defined a meaningful construct, an index was created by summing up the items (Diamantopoulos and Winklhofer 2002). Some single items were used alone to represent their own dimension (Table 1).

Table 1: Measures of Performance Obstacles and Outcome Variables Included in the Questionnaire (Abbreviations for Performance Obstacles Presented Preceding the Construct Name)

Construct	*No. of Items*	*Mean (Standard Deviation) or % for Dichotomous Variables, Range and Interitem Reliability (Where Applicable)*
		Performance Obstacles
Tasks		
P1—Accompanying a patient during intrahospital transport	1	14.3%, $R = 0–1$, Cronbach's α not applicable
P2—Being a preceptor	1	15.1%, $R = 0–1$, Cronbach's α not applicable
P4—Dealing with many family—related issues	4	1.34 (1.39), $R = 0–4$, Cronbach's $\alpha = 0.73$
Environment		
P3—Poor physical work environment	3	1.22 (1.18), $R = 0–3$, Cronbach's $\alpha = 0.72$
P9—Poor workspace design	2	0.37 (0.60), $R = 0–2$. An index summing the two items. Cronbach's α not applicable
Organization		
P10—Poor handoffs	4	0.54 (0.79), $R = 0–4$. An index summing the first three items with two response categories of *Yes* or *No* and a dichotomized fourth item with a semantic differential response format. Cronbach's α not applicable
P11—Inadequate information from physicians	1	18.9%, $R = 0–1$, Cronbach's α not applicable
Technologies and tools		
P5—Disorganized supplies area	2	0.16 (0.44), $R = 0–2$. An index summing the two items. Cronbach's α not applicable
P6—Seeking for patient charts	2	0.45 (0.70), $R = 0–2$. An index summing the two items. Cronbach's α not applicable
P7—Delay in getting medications from pharmacy	1	37.1%, $R = 0–1$, Cronbach's α not applicable
P8—Equipment-related issues	3	0.62 (0.80), $R = 0–3$. An index summing the three items. Cronbach's α not applicable
P12—Poorly stocked patient rooms	2	44.4%, $R = 0–1$. A dichotomous variable derived from the two items indicating yes to either item. Cronbach's α not applicable
		Workload
Workload	4	3.48 (0.82), $R = 1–5$, Cronbach's $\alpha = 0.92$
		Perceived Quality and Safety of Care
Overall quality of care	2	8.13 (1.34), $R = 2–10$, Cronbach's $\alpha = 0.89$
Detailed nursing care	3	6.54 (2.10), $R = 0–10$, Cronbach's $\alpha = 0.80$
Safety of care	2	3.34 (0.71), $R = 0.5–4.5$, Cronbach's $\alpha = 0.62$
		Quality of Working Life
Fatigue	2	2.43 (0.95), $R = 1–5$, Cronbach's $\alpha = 0.88$
Overall stress	6	2.32 (0.82), $R = 1–4.3$, Cronbach's $\alpha = 0.89$

Workload. Workload was measured by a validated adaptation of a well-known scale (Caplan et al. 1975) measuring quantitative workload. The scale had four items, measuring the amount and pace of nurses' work assignments and had adequate interitem reliability (Table1) (Nunnally 1978).

Perceived Quality and Safety of Care. This construct was measured by three scales. The first one measured nurses' own assessments of the overall quality of care they provided, the second measured the level of detailed nursing care provided (Bertram, Hershey, Opila, and Quirin 1990), and the third measured the perceived safety of care nurses provided (Nieva and Sorra 2003; Singer et al. 2003). All but the perceived safety of care scale had adequate interitem reliability (Table 1) (Nunnally 1978).

QWL. Nine items were used to measure QWL. Eight were developed based on the Profile of Mood States (McNair, Lorr, and Droppleman 1971) and the pilot study of the questionnaire (Gurses 2005). The ninth was a single item on job satisfaction (Quinn et al. 1971), which was not included in further analyses due to its low variance. A principal component factor analysis with promax rotation of the remaining eight items resulted in a correlated two-factor solution (fatigue and overall stress) that explained 72 percent of the total variance. Scales associated with each factor were created by averaging out the items loading on respective factors and both had satisfactory interitem reliability (Table 1) (Nunnally 1978).

Demographic and Background Variables. Participants' gender, age (29 or younger, 30–39, 40–49, 50–59, 60+), ethnicity, education (ADN, BSN, MSN, or above), experience (number of years worked as an ICU nurse), and tenure (number of years worked in a particular hospital) were the demographic variables measured. Due to low variability, ethnicity and education were not included in further analyses. Several background variables (e.g., total number of patients assigned to a nurse over a shift—maximum two patients are allowed in ICUs) were also measured.

Statistical Analysis

Univariate statistical analyses were conducted to obtain descriptive data on the variables. The five hypotheses were tested using correlation analyses and structural equation modeling (SEM). Correlation analyses were conducted to

test the bivariate relationships. Although several variables are dichotomous, the Pearson correlation is still used for describing the relationship between a binary and a continuous variable because it is equivalent to the regression effect found for the simple regression of a continuous outcome on a binary predictor. SEM was conducted to test the conceptual model (Figure 1) using the Mplus version 4.2 software (Muthén and Muthén 2006). The focus of the SEM was two-fold: (1) To determine the effect of the performance obstacles on perceived quality and safety of care and QWL directly as well as indirectly, in the latter case as mediated by workload; and (2) to determine the amount of variation in workload, perceived quality and safety of care, and QWL that could be explained by the full model. The model fit was evaluated with three traditional SEM measures: The ratio of the χ^2 estimate and degrees of freedom, recommended to be <2 (Carmines and Mclver 1981; Akaike 1987); the root mean square error of approximation (RMSEA), recommended to be <0.1 for adequate fit or <0.06 for good fit (Hu and Bentler 1999); and the comparative fit index (CFI), recommended to be at least 0.90 (Hu and Bentler 1999).

Paths in the SEM estimated as standardized regression coefficients were considered significant at 0.05 α level. The effect of performance obstacles on outcome variables was determined to be mediated by workload when the following two conditions were met simultaneously: 1—performance obstacles having significant direct effects on workload but no significant effect on the other outcome variables controlling for workload, and 2—workload having a significant effect on the other outcome variables. Finally, the proportion of variance in the outcome variables (R^2) explained by the model was calculated. A separate analysis including ICU as a random effect, hence accounting for clustering of nurses within ICU unit, produced very similar fixed effect estimates as the analysis without it. In addition to the ICU level, there was also a nonsignificant variance estimate at the hospital level, indicating no significant clustering effects at either level. Therefore, results without the additional random effects are presented.

RESULTS

Sample Characteristics

Table 2 provides data on the demographics and background variables. Compared to the 2007 American Association of Critical Care Nurses (AACN) members' demographics (available at http://www.aacn.org/WD/Memberships/

Table 2: Demographics of the Participants and Background Information

	Mean (Std. Dev.)	*N (%)*
Gender		
Female		222 (86%)
Male		37 (14%)
Age		
29 or younger		33 (13%)
30–39		105 (41%)
40–49		71 (27%)
50–59		43 (17%)
60+		7 (3%)
Ethnicity/race		
Caucasian		254 (99%)
Other		3 (1%)
Education		
Associate degree (ADN) or equivalent		69 (27%)
Bachelors' (BSN) or equivalent		185 (72%)
Masters (MSN) or above		4 (2%)
Experience (years)	6.49 (7.40)	
Tenure (years)	7.16 (7.63)	
Nursing assistant available over the shift just worked		
Yes		165 (64%)
No		94 (36%)
Shift type when questionnaire was filled out		
Day		133 (51%)
Night		126 (49%)
Admissions by the nurse over the shift		
Yes		68 (26%)
No		189 (74%)
Transfers out of the unit that a nurse facilitated over the shift		
Yes		44 (17%)
No		215 (83%)
Any isolation patients assigned to a nurse over the shift		
Yes		72 (28%)
No		186 (72%)
Shift type the questionnaire was filled out		
Day shift		133 (51%)
Night shift		126 (49%)

Docs/membdemographics.pdf), nurses in our sample were younger (54 percent compared with 26 percent under 40 years old, p-value $< .001$), had less experience as an ICU nurse (6.5 compared with 13 years, p-value $< .001$), had less advanced degrees (2 percent compared with 16 percent with a Masters degree or beyond, p-value $< .001$), and were mostly white (99 percent compared with 89 percent, p-value $< .001$). The sample was comparable to AACN 2007

members' demographics with respect to gender (86 percent compared with 89 percent female, p-value = .09) and with respect to having at least a Bachelors degree (74 percent compared with 76 percent, p-value = .30).

Correlation Analyses

Ten of the twelve performance obstacles were significantly correlated with workload (*H1 supported*): poor physical work environment, dealing with many family-related issues (e.g., many phone calls for nurses from patients' families and no policy or system is in place on how and when to return these phone calls), disorganized supplies area, seeking for patient charts, delay in getting medications from pharmacy, equipment-related issues, poor workspace design, poor handoffs, inadequate information from physicians, and poorly stocked patient rooms (Table 3). Nurses who encountered these obstacles over a shift reported experiencing higher workload than those who did not. Accompanying a patient during intrahospital transport and being a preceptor were the only obstacles not related to workload. Besides these, each obstacle was also significantly correlated with at least one measure of perceived quality and safety of care and QWL.

Workload was negatively correlated with both perceived quality and safety of care and QWL (Table 3). Nurses who experienced higher workload reported providing lower levels of overall quality of care, detailed nursing care, and safe care *(H2a supported)*, and experiencing higher fatigue and stress *(H2b supported)*.

Few demographic and background variables were significantly correlated to any of the outcome variables (Table 3). For example, nurses who were assigned two patients, who admitted a patient, and who worked on day shifts reported experiencing higher workload.

Structural Equation Modeling (SEM)

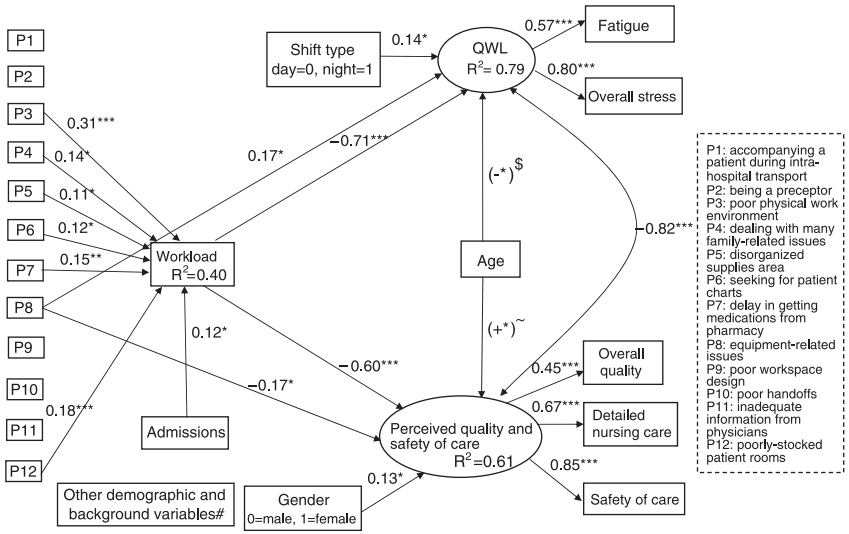
SEM was used to test all of the hypotheses. The model included 12 observed measures of performance obstacles, one observed measure of workload, and latent variables for perceived quality and safety of care and QWL (Figure 2). The model controlled for 13 demographic and background variables, which were treated as predictors of workload, perceived quality and safety, and QWL, and were allowed to correlate freely with performance obstacles. Finally, the equation errors for the perceived quality and safety of care and QWL latent outcome variables were allowed to correlate, acknowledging that

Table 3: Results of Correlation Analyses (Abbreviations for Performance Obstacles Presented Preceding the Construct Name)

	Workload	*Fatigue*	*Overall Stress*	*Overall Quality of Care*	*Detailed Nursing Care*	*Safety of Care*
Performance obstacles						
P1—Accompanying a patient during intra-hospital transport	0.12	0.00	0.08	0.02	– 0.05	– 0.06
P2—Being a preceptor	– 0.01	– 0.08	– 0.07	– 0.01	0.02	– 0.05
P3—Poor physical work environment	0.43***	0.19**	0.32***	– 0.13*	– 0.30***	– 0.33***
P4—Dealing with many family-related issues	0.37***	0.26	0.33***	– 0.02	– 0.20**	– 0.33***
P5—Disorganized supplies area	0.20**	0.16*	0.20***	– 0.10	– 0.12*	– 0.18**
P6—Seeking for patient charts	0.37***	0.14*	0.24***	– 0.13*	– 0.26***	– 0.25***
P7—Delay in getting medications from pharmacy	0.26***	0.19**	0.13*	– 0.05	– 0.19**	– 0.21***
P8—Equipment-related issues	0.20**	0.29***	0.24***	– 0.13*	– 0.16**	– 0.29***
P9—Poor workspace design	0.26***	0.19**	0.27***	– 0.22***	– 0.18**	– 0.19**
P10—Poor handoffs	0.20***	0.26***	0.20***	– 0.07	– 0.13**	– 0.25***
P11—Inadequate information from physicians	0.18**	0.14*	0.17**	– 0.15*	– 0.14*	– 0.18**
P12—Poorly stocked patient rooms	0.28***	0.17**	0.13*	– 0.07	– 0.13*	– 0.26***
Demographic and background variables						
Gender (male = 0, female = 1)	0.08	0.00	– 0.04	0.08	– 0.02	0.12*
Age	– 0.02	– 0.15*	– 0.08	0.04	0.10	– 0.05
Experience (number of years worked as an ICU nurse)	– 0.05	– 0.10	– 0.15*	0.12	0.07	0.00
Tenure (number of years worked in the particular hospital)	– 0.06	– 0.10	– 0.16**	0.15*	0.07	0.03
Number of patients assigned to a nurse (one or two)	0.19**	0.05	0.17**	– 0.18**	– 0.13*	– 0.12
Number of isolation patients assigned to a nurse	0.01	– 0.05	– 0.04	0.02	– 0.02	0.08
Admissions	0.19**	0.01	0.14*	0.07	– 0.04	– 0.08
Transfers	0.06	– 0.08	0.05	0.04	– 0.02	– 0.08
Hours worked in the last week	0.00	0.17**	0.07	0.03	– 0.01	0
Hours worked in the last 24 hours	0.14*	0.24***	0.05	– 0.04	– 0.08	– 0.1
Shift type (day = 0, night = 1)	– 0.21***	0.05	– 0.06	– 0.04	0.12	0.09
Availability of nursing assistant	0.04	0.03	0.06	– 0.02	– 0.06	0.05
Workload						
Workload	1	0.45***	0.64***	– 0.17**	– 0.50***	– 0.61***

*$p < .05$.
**$p < .01$.
***$p < .001$.

Figure 2: Final Structural Equation Model (Paths with Coefficients That Are Not Statistically Significant Are Not Shown)



~ Nurses who are in the 60 and older age group reported providing significantly higher quality of care compared with other age groups (29 or younger, 30–39, 40–49, 50–59). Other age categories were not significantly different from each other in terms of the quality of care they reported to provide.

$ Nurses who are in the 60 and older age group reported experiencing significantly higher quality of working life (lower fatigue and stress) compared with other age groups. Other age categories were not significantly different from each other in terms of the stress they experienced. *$p < .05$; **$p < .01$; ***$p < .001$.

the predictors in the model would not explain all the potential correlations between these two latent variables.

The χ^2 to degrees of freedom ratio (= 1.77) (Carmines and Mclver 1981; Akaike 1987), the RMSEA (= 0.06, 90 percent CI = 0.04–0.07), and the CFI (= 0.90) measures were all within the recommended ranges (Hu and Bentler 1999), hence the proposed model had an adequate fit. Forty percent of workload was explained jointly by performance obstacles and demographic and background variables. Furthermore, a large amount of the variability in both perceived quality and safety of care and QWL were explained by the model ($R^2 = 0.61$ and 0.79, respectively), confirming that much of these variables are understood when workload is understood (Figure 2).

SEM analysis provided support for H1. Nurses who reported experiencing any of the following six obstacles also reported experiencing higher workload: poor physical work environment, dealing with many family-related issues, disorganized supplies area, seeking for patient charts, delay in getting medications from the pharmacy, and poorly stocked patient rooms. Furthermore, nurses who admitted a patient over the shift experienced higher workload, even after the effect of obstacles was taken into account. Workload was significantly related to both perceived quality and safety of care and QWL (*H2a and H2b supported*). As workload increased, nurses reported providing lower quality and less safe care and experiencing increased fatigue and stress.

Workload also mediated the relationships between the outcomes of perceived quality and safety of care and QWL and the following six obstacles: poor physical work environment, dealing with many family-related issues, disorganized supplies area, seeking for patient charts, delay in getting medications from pharmacy, and poorly stocked patient rooms. The effect of only the equipment-related issues obstacle on perceived quality and safety of care and QWL was not mediated by workload. Overall, Hypotheses 3a and 3b were supported.

Among the demographic and background variables, only gender, age, and shift type were significantly related to outcome variables (Figure 2). Female nurses reported providing higher quality and safety of care. Nurses 60 years or older reported providing higher quality and safety of care and experiencing lower fatigue and stress. Night shift nurses reported experiencing higher fatigue and stress. Total number of patients assigned to a nurse was not a significant predictor of workload once performance obstacles were taken into account; nor was it significantly related to perceived quality and safety of care and QWL once the workload variable was included in the model.

DISCUSSION

Our study showed that work system characteristics can play a significant role on nursing workload. Even without considering patient acuity, a large amount of variability in workload (40 percent) was explained by work system characteristics. This finding is significant because a majority of research studies on ICU nursing workload has focused on optimizing nurse/patient ratio primarily based on patient's clinical condition, and not on improving the ICU work system characteristics. Improvement solutions derived from these studies

would typically involve either increasing the number of nurses or decreasing the number of patients, which may not be feasible given the nursing shortage in United States (Buerhaus et al. 2008) and the dramatic increases in the number and severity of ICU patients (Kelley et al. 2004). Our study provides an alternative approach by focusing on potential changes to the design of ICU nurses' work system for reducing workload and improving quality and safety of care and QWL.

Predictors of high workload included poor physical work environment, effectiveness of supply chain management (delay in getting medications from pharmacy, poorly stocked patient rooms, and disorganized supplies area), seeking for patient charts, dealing with many family-related issues and patient admissions. Performance obstacles related to communication (e.g., poor handoffs, inadequate information from physicians) were not significant predictors of workload after taking into account other obstacles and demographic and background variables. This is interesting because a lot of patient safety research focuses on improving communication (Sutcliffe, Lewton, and Rosenthal 2004; Vazirani et al. 2005); however, very little research is conducted on the impact of physical work environment and supply chain management issues on quality and safety of care and QWL.

ICU nurses' workload can potentially be reduced through eliminating performance obstacles. For example, the obstacle of dealing with many family-related issues can potentially be reduced by (1) developing an effective policy on how and when nurses should return families' phone calls; (2) using technologies such as educational DVDs to improve interactions with families; and (3) clarifying physicians' and social workers' roles and responsibilities regarding family relations. Effectiveness of supply chain management can be improved by (1) reorganizing the supplies area by taking nurses' needs into consideration; (2) clarifying for ancillary personnel why nurses need a particular supply in a certain location and amount; and (3) developing guidelines on how frequently patient rooms should be restocked.

There is a need to conceptualize and measure workload in different ways to implement innovative strategies for reducing nursing workload (Carayon and Gurses 2005). Human factors engineers studied the concept of workload for decades and this knowledge base can be transferred to study and improve workload in the health care domain. Workload is a multidimensional concept that goes beyond patients' clinical conditions and nurse/patient ratio and includes work system characteristics (Carayon and Gurses 2005). Although studies have identified some of these work system characteristics that affect nursing workload (Ball and McElligot 2003; Spence et al. 2006), they do not

provide sufficient information to uncover the impact of these characteristics on workload nor do they identify them comprehensively. This paper has made a significant contribution by providing evidence for the impact of various work system characteristics (performance obstacles) on nursing workload.

The conceptual model was supported, suggesting that workload mediated the impact of performance obstacles on perceived quality and safety of care and QWL, except for the equipment-related issues obstacle. This exception is plausible and can be explained by the following example. In a qualitative interview study (Gurses 2005; Gurses and Carayon 2008), one ICU nurse mentioned that the cardiac chairs in her unit were old and did not have a safety belt. Whenever these chairs were used, she was concerned about patient falls. However, she did not experience an increase in her workload due to the use of these chairs (Gurses and Carayon 2008). The conceptual framework focused on workload as a mechanism for explaining the relationships between work system characteristics and two outcomes: perceived quality and safety of care and QWL. Other mechanisms may explain how work system characteristics affect nursing and patient outcomes and deserve attention in future studies (Carayon, Alvarado, and Hundt 2007; Gurses et al. 2008).

As hypothesized, workload was found to negatively affect perceived quality and safety of care. This is consistent with previous research (Institute of Medicine 2004); however, it should be noted that we conceptualized and measured nursing workload differently than previous studies. Several mechanisms can explain this finding (Carayon and Gurses 2008). One is that nurses who had a high workload over a shift would be pressured for time. Consequently, they would focus mainly on major patient issues and would not be able to attend to minor issues such as giving bath to patient or brushing patient's teeth. Another one is based on Reason's (1997) argument about the traditional inclination of industries to focus on production at the expense of safety. For example, a nurse who had a high workload during a shift would probably use her time to complete major patient care tasks at the expense of complying with hand-washing guidelines (Pittet et al. 2000).

The hypothesis that high workload negatively affects ICU nurses' QWL was also supported. This finding is consistent with the existing literature (McVicar 2003). ICU nurses' QWL can potentially be improved through reducing workload by eliminating performance obstacles.

Few demographic and background variables were found to affect the variables of interest. Number of patients assigned to a nurse was not a significant predictor of any of the variables of interest once performance obstacles were taken into account. This is interesting given the extensive research

on the impact of nurse/patient ratio on outcomes (Kane et al. 2007; West et al. 2008). Perhaps it is the design of ICU work systems that affects nurses' work more than the number of patients assigned to a nurse over a shift. However, to our knowledge, no previous study investigated ICU work system characteristics as comprehensively as this study. We encourage researchers to study effects of various ICU work system design characteristics on nurses' work and outcomes.

Future research could extend this line of research and investigate the impact of performance obstacles on objective measures such as nursing-sensitive patient outcomes (e.g., occurrence of pressure ulcers). Performance obstacles concept can also be used to identify problems in other health care settings, for other types of care providers and patients. This line of research is likely to help with designing effective interventions that address important quality and safety of care and QWL issues.

Strengths and Limitations

High response rate was a major strength of our study. We attribute this to several factors, including the participatory nature of the study, methods used to inform nurses about the study, support from ICU nurse managers and medical directors, and the use of a questionnaire that can be easily and rapidly filled out.

One limitation of the study was its cross-sectional design. This design was appropriate because no previous research investigated the relationships between the constructs of interest. However, longitudinal studies and field experiments are needed to further improve the knowledge base on nursing working conditions and their effects on workload, QWL, and quality and safety of care. Another limitation was the potential bias due to use of a single and subjective data collection method. For example, quality and safety of care was not measured objectively (i.e., based on patient clinical outcomes); rather it was measured subjectively based on perceptions of nurses. For performance obstacles, we tried to reduce this bias by including questions that ask about them as objectively as possible. However, future research should test the hypotheses included in this study using objective measures. Nonresponse bias was another limitation, which can be a problem even with high response rates (Dillman 2000). The nonrespondents' demographic characteristics may have been different than respondents, and no information is available on nonrespondents' characteristics. Nonrespondents may have experienced higher workload, stress, or more of particular obstacles. The study was conducted in

seven hospitals in Wisconsin, which limited its generalizability. Furthermore, almost all nurses in our sample are white (99 percent), which do not closely represent ICU nurses' ethnicity in the United States (American Association of Critical Care Nurses 2007). Finally, the Cronbach's α for the perceived safety of care scale (Table 1), one of the three underlying the perceived quality and safety of care construct, was <0.70 (Nunnally 1978). However, by using a latent variable underlying these three, rather than just relying on a single scale, the reliability of the perceived quality and safety measure was improved.

CONCLUSIONS

Performance obstacles have significant impact on nursing workload, perceived quality and safety of care, and QWL. Workload mediates the effects of performance obstacles on perceived quality and safety of care and QWL. (Re)designing ICU work systems by reducing performance obstacles may be an effective strategy for reducing workload and improving quality and safety of care as well as QWL among nurses, thereby complementing the efforts on optimizing the nurse/patient ratio. Future research should investigate the impact of reducing performance obstacles on ICU nurses' workload and other outcomes.

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REFERENCES

Akaike, H. 1987. "Factor Analysis and AIC." *Psychometrika* 52: 317–32.

American Association of Critical Care Nurses. 2007. "Membership Demographics" [accessed on July 10, 2008]. Available at http://www.aacn.org/AACN/Membship.nsf/Files/MembDemographics/$file/MembDemographics.pdf

Baggs, J. G. 2007. "Nurse-Physician Collaboration in Intensive Care Units." *Critical Care Medicine* 35: 641–2.

Ball, C., and M. McElligot. 2003. "Realising the Potential of Critical Care Nurses": An Exploratory Study of the Factors That Affect and Comprise the Nursing Contribution to the Recovery of Critically Ill Patients." *Intensive and Critical Care Nursing*. 19: 226–38.

Bertram, D. A., C. D. Hershey, D. A. Opila, and O. Quirin. 1990. "A Measure of Physician Mental Workload in Internal Medicine Ambulatory Care Clinics." *Medical Care* 28 (5): 458–67.

Buerhaus, P. I., V. Potter, D. O. Staiger, and D. I. Auerbach. 2008. *The Future of the Nursing Workforce in the United States: Data, Trends and Implications*. Boston: Jones and Bartlett Publishers.

Caplan, R. D., S. Cobb, J. R. P. French, R. V. Harrison, and S. R. Pinneau. 1975. *Job Demands and Worker Health: Main Effects and Occupational Differences*. Ann Arbor, MI: Institute for Social Research.

Carayon, P., and C. Alvarado. 2007. "Workload and Patient Safety among Critical Care Nurses." *Critical Care Nursing Clinics* 8 (5): 395–428.

Carayon, P., C. Alvarado, and A. S. Hundt. 2007. "Work Design and Patient Safety." *Theoretical Issues in Ergonomics Science* 8: 395–428.

Carayon, P., and A. P. Gurses. 2005. "A Human Factors Engineering Conceptual Framework of Nursing Workload and Patient Safety in Intensive Care Units." *Intensive and Critical Care Nursing* 21: 284–301.

———. 2008. "Nursing Workload and Patient Safety—A Human Factors Engineering Perspective." In *Safety and Quality: An Evidence-Based Handbook for Nurses*, edited by R. Hughes, pp. 1–14. Rockville, MD: Agency for Healthcare Research and Quality. Electronically available at http://www.ahrq.gov/qual/nurseshdbk [accessed on July 10, 2008].

Carayon, P., A. P. Gürses, A. S. Hundt, P. Ayoub, and C. J. Alvarado. 2005. "Performance Obstacles and Facilitators of Health Care Providers." In *Change and Quality in Human Service Work*, edited by C. Korunka and P. Hoffmann, pp. 257–76. Munich, Germany: Hampp Publishers.

Carayon, P., A. Schoofs Hundt, B. T. Karsh, A. P. Gurses, C. J. Alvarado, M. Smith, and P. Flatley Brennan. 2006. "Work System Design for Patient Safety: The SEIPS Model." *Quality and Safety in Health Care* 15: i50–8.

Carayon, P., and M. Smith. 2000. "Work Organization and Ergonomics." *Applied Ergonomics* 31: 649–62.

Carmines, E. G., and J. P. Mclver. 1981. "Analyzing Models with Unobserved Variables: Analysis of Covariance Structures." In *Social Measurement: Current Issues*, edited by G. W. Bohrnstedt and E. F. Bogatta, pp. 65–115. Newbury Park, CA: Sage.

Diamantopoulos, A., and H. M. Winklhofer. 2002. "Index Construction with Formative Indicators: An Alternative to Scale Development." *Journal of Marketing Research* 36: 269–77.

Dillman, D. A. 2000. *Mail and Internet Surveys: The Tailored Design Method*. 2d edition. New York: John Wiley and Sons.

Dillon, W. R., and M. Goldstein. 1984. *Multivariate Analysis: Methods and Applications*. New York: John Wiley and Sons.

Dimick, J. B., S. M. Swoboda, P. J. Pronovost, and P. A. Lipsett. 2001. "Effect of Nurse-to-Patient Ratio in the Intensive Care Unit on Pulmonary Complications and Resource Use after Hepatectomy." *American Journal of Critical Care* 10: 376–82.

Gurses, A. P. 2005. "Performance Obstacles and Facilitators, Workload, Quality of Working Life and Quality and Safety of Care among Intensive Care Nurses." Doctoral dissertation. University of Wisconsin–Madison.

Gurses, A. P., and P. Carayon. 2008. "Exploring Performance Obstacles of Intensive Care Nurses." *Applied Ergonomics*, in press.

Gurses, A. P., K. Seidl, V. Vaidya, G. Bochicchio, A. Harris, J. Hebden, and Y. Xiao. 2008. "Systems Ambiguity and Guideline Compliance: A Qualitative Study of How Intensive Care Units Follow Evidence-Based Guidelines to Reduce Healthcare-Associated Infections." *Quality and Safety in Health Care* 17: 351–9.

Gurses, A. P., and Y. Xiao. 2006. "A Systematic Review of the Literature on Multidisciplinary Rounds to Design Information Technology." *Journal of the American Medical Informatics Association* 13: 267–76.

Hayes, L. J., L. O'Brien-Pallas, C. Duffield, J. Shamian, J. Buchan, F. Hughes, H. K. Spence Laschinger, N. North, and P. W. Stone. 2006. "Nurse Turnover: A Literature Review." *International Journal of Nursing Studies* 43: 237–63.

Heise, D. R. 1970. "The Semantic Differential and Attitude Research." In *Attitude Measurement*, edited by G. F. Summers, pp. 235–53. Chicago: Rand McNally.

Herzberg, F. 1966. *Work and the Nature of Man.* Cleveland, OH: World Publishing.

Hu, L., and P. M. Bentler. 1999. "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives." *Structural Equation Modeling* 6: 1–55.

Institute of Medicine. 2004. *Keeping Patients Safe: Transforming the Work Environment of Nurses.* Washington, DC: The National Academies Press.

Kane, R. L., T. A. Shamliyan, C. Mueller, S. Duval, and T. J. Wilt. 2007. "The Association of Registered Nurse Staffing Levels and Patient Outcomes: Systematic Review and Meta-Analysis." *Medical Care* 45: 1195–204.

Kelley, M. A., A. Derek, D. B. C. E. D. Chalfin, D. Ingbar, J. Wanda, J. Medina, C. N. Sessler, and J. S. Vender. 2004. "The Critical Care Crisis in the United States: A Report from the Profession." *Critical Care Medicine* 32: 1219–22.

Kopp, B. J., B. L. Erstad, M. E. Allen, A. A. Theodorou, and G. Priestley. 2006. "Medication Errors and Adverse Drug Events in an Intensive Care Unit: Direct Observation Approach for Detection." *Critical Care Medicine* 34: 415–25.

Lang, T. A., M. Hodge, V. Olson, P. S. Romano, and R. L. Kravitz. 2004. "Nurse-Patient Ratios: A Systematic Review on the Effects of Nurse Staffing on Patient, Nurse Employee, and Hospital Outcomes." *Journal of Nursing Administration* 34: 326–37.

Mc Nair, D. M., M. Lorr, and L. F. Droppleman. 1971. *Profile of Mood States Manual.* San Diego: Educational and Industrial Testing Service.

McSteen, K., and C. Peden-McAlpine. 2006. "The Role of the Nurse as Advocate in Ethically Difficult Care Situations with Dying Patients." *Journal of Hospice and Palliative Nursing* 8: 259–69.

McVicar, A. 2003. "Workplace Stress in Nursing: A Literature Review." *Journal of Advanced Nursing* 44: 633–42.

Muthén, B. O., and L. K. Muthén. 2006. *Mplus version 4.2 [Computer Software].* Los Angeles: Muthén & Muthén.

Nieva, V. F., and J. S. Sorra. 2003. "Safety Culture Assessment: A Tool for Improving Patient Safety in Healthcare Organizations." *Quality and Safety in Health Care* 12 (Suppl II): 17–23.

Nunnally, J. C. 1978. *Psychometric Theory.* 2d edition. New York: McGraw-Hill.

O'Connor, E. J., L. H. Peters, J. R. Eulberg, and T. W. Watson. 1984a. "Situational Constraints in Air Force Work Settings: Effects on Performance, Affective Reactions, and Reenlistment Plans." In *Proceedings of the Annual Meeting of Academy of Management.* Boston: Academy of Management.

O'Connor, E. J., L. H. Peters, A. Pooyan, J. Weekley, B. Frank, and B. Erenkrantz. 1984b. "Situational Constraint Effects on Performance, Affective Reactions and Turnover: A Field Replication and Extension." *Journal of Applied Psychology* 64: 663–72.

O'Connor, E. J., L. H. Peters, C. J. Rudolf, and A. Pooyan. 1982. "Situational Constraints and Employee Affective Reactions: A Field Replication." *Group and Organization Studies* 7: 418–28.

Peters, L. H., and E. J. O'Connor. 1980. "Situational Constraints and Work Outcomes: The Influences of a Frequently Overlooked Construct." *Academy of Management Review* 5: 391–7.

Peters, L., and E. O'Connor. 1988. "Measuring Work Obstacles: Procedures, Issues, and Implications." In *Facilitating Work Effectiveness*, edited by F. Schoorman and B. Schneider, pp. 105–24. Lexington: D.C. Heath and Company.

Pittet, D., S. Hugonnet, S. Harbarth, P. Mouroga, V. Sauvan, S. Touveneau, and T. Perneger. "Effectiveness of a Hospital-Wide Programme to Improve Compliance with Hand Hygiene." *Lancet* 356 (9238): 1307–12D.

Poncet, M. C., P. Toullic, L. Papazian, N. Kentish-Barnes, J. F. Timsit, F. Pochard, S. Chevret, B. Schlemmer, and E. Azoulay. 2007. "Burnout Syndrome in Critical Care Nursing Staff." *American Journal of Respiratory Critical Care Medicine* 175: 698–704.

Pooyan, A., E. J. O'Connor, L. H. Peters, J. C. Quick, N. D. Jones, and A. Kulisch. 1982. "Supervisory/Subordinate Differences in Perceptions of Performance Constraints: Barriers are in the Eye of the Beholder." Proceedings of the Annual Convention of the Southwest Academy of Management, pp. 170–4

Quinn, R., S. Seashore, R. Kahn, T. Mangion, D. Cambell, and G. M. M. Staines. 1971. *Survey of Working Conditions: Final Report on Univariate and Bivariate Tables.* Washington, DC: U.S. Government Printing Office.

Reason, J. 1997. *Managing the Risks of Organizational Accidents.* Aldershot, U.K.: Ashgate.

Rogers, A. E., G. E. Dean, W. T. Hwang, and L. D. Scott. 2008. "Role of Registered Nurses in Error Prevention, Discovery and Correction." *Quality and Safety in Health Care* 17: 117–121.

Schmalenberg, C., and M. Kramer. 2007. "Types of Intensive Care Units with the Healthiest, Most Productive Work Environments." *American Journal of Critical Care* 16: 458–68.

Singer, S. J., D. Gaba, J. J. Geppert, A. D. Sinaiko, S. K. Howard, and K. C. Park. 2003. "The Culture of Safety: Results of an Organization-Wide Survey in 15 California Hospitals." *Quality and Safety in Health Care* 12: 112–8.

Smith, M. J. 1987. "Occupational Stress." In *Handbook of Human Factors*, edited by G. Salvendy, pp. 844–60. New York: John Wiley and Sons.

Smith, M. J., and P. Carayon. 2000. "Balance Theory of Job Design." In *International Encyclopedia of Ergonomics and Human Factors*, edited by W. Karwowski, pp. 1181–1184. London: Taylor and Francis.

Smith, M. J., and P. Carayon-Sainfort. 1989. "A Balance Theory of Job Design for Stress Reduction." *International Journal of Industrial Ergonomics* 4: 67–79.

Spence, K., W. Tarnow-Mordi, G. Duncan, N. Jayasuryia, J. Elliott, J. King, and F. Kite. 2006. "Measuring Nursing Workload in Neonatal Intensive Care." *Journal of Nursing Management* 14: 227–34.

Steel, R. P., and A. J. Mento. 1986. "Opportunity Knocks: The Impact of Situational Constraints on Relationships between Job Performance Criteria." *Organizational Behavior and Human Decision Processes* 37: 254–65.

Stone, P. W., C. Mooney-Kane, E. L. Larson, T. Horan, L. G. Glance, J. Zwanziger, and A. W. Dick. 2007a. "Nurse Working Conditions and Patient Safety Outcomes." *Medical Care* 45: 571–8.

Stone, P. W., C. Mooney-Kane, E. L. Larson, D. K. Pastor, J. Zwanziger, and A. W. Dick. 2007b. "Nurse Working Conditions, Organizational Climate, and Intent to Leave in ICUs: An Instrumental Variable Approach." *Health Services Research* 42: 1085–104.

Suresh, G., J. D. Horbar, P. Plsek, J. Gray, W. H. Edwards, P. H. Shiono, R. Ursprung, J. Nickerson, J. F. Lucey, and D. Goldmann. 2004. "Voluntary Anonymous Reporting of Medical Errors for Neonatal Intensive Care." *Pediatrics* 113: 1609–18.

Sutcliffe, K. M., E. Lewton, and M. M. Rosenthal. 2004. "Communication Failures: An Insidious Contributor to Medical Mishaps." *Academic Medicine* 79: 186–94.

Vazirani, S., R. D. Hays, M. F. Shapiro, and M. Cowan. 2005. "Effect of a Multidisciplinary Intervention on Communication and Collaboration among Physicians and Nurses." *American Journal of Critical Care* 14: 71–7.

West, E., N. Mays, A. M. Rafferty, K. Rowan, and C. Sanderson. 2008. "Nursing Resources and Patient Outcomes in Intensive Care: A Systematic Review of the Literature." *International Journal of Nursing Studies*, in press.

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