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HEALTH POLICY AND SYSTEMS

The Relationships of Nurse Staffing Level and Work Environment With Patient Adverse Events

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Abstract

Purpose: The purpose of this study was to examine the relationships of nurse staffing level and work environment with patient adverse events.

Design: This cross-sectional study used a combination of nurse survey data ($N = 4,864$ nurses), facility data ($N = 58$ hospitals), and patient hospital discharge data ($N = 113,426$ patients) in South Korea.

Methods: The three most commonly nurse-reported adverse events included administration of the wrong medication or dose to a patient, pressure ulcers, and injury from a fall after admission. Multilevel ordinal logistic regression was employed to explore the relationships of nurse staffing level (number of patients assigned to a nurse) and work environment (Practice Environment Scale of the Nursing Work Index) with patient adverse events after controlling for nurse, hospital, and patient characteristics.

Findings: A larger number of patients per nurse was significantly associated with a greater incidence of administration of the wrong medication or dose (odds ratio [OR] = 1.01, 95% confidence interval [CI] = 1.007–1.016), pressure ulcer (OR = 1.01, 95% CI = 1.007–1.016), and patient falls with injury (OR = 1.02, 95% CI = 1.013–1.022). A better work environment had a significant inverse relationship with adverse events; the odds of reporting a higher incidence of adverse events were 45% lower for administration of the wrong medication or dose (OR = 0.55, 95% CI = 0.400–0.758), followed by 39% lower for pressure ulcer (OR = 0.61, 95% CI = 0.449–0.834) and 32% lower for falls with injury after admission (OR = 0.68, 95% CI = 0.490–0.939).

Conclusions: This study found that a larger number of patients per nurse and poor work environment increase the incidence of patient adverse events, such as administration of the wrong medication or dose to a patient, pressure ulcers, and injury from falling after admission. The findings suggest that South Korean hospitals could prevent patient adverse events by improving nurse staffing and work environment.

Clinical Relevance: Healthcare strategies and efforts to modify adequate nurse staffing levels and better work environments for nurses are needed to improve patient outcomes.

South Korea is experiencing an increase in the incidence of chronic diseases due to the rapid growth of its aging population and higher rates of risky health behaviors, such as smoking and alcohol consumption (Organization for Economic Cooperation and Development [OECD], 2012). According to the OECD's Health Care Quality

Review, despite increased investments in hospitals, greater accessibility to hospital care, and advanced medical technologies, the Korean health system continues to deliver a relatively lower quality of health care than other OECD countries (OECD, 2012). For example, a study by Aiken, Sloane, et al. (2011) that used data from nearly 100,000 nurses in nine countries between 1999 and 2009 found that nurses in South Korea (68%) were more likely to report that the quality of patient care on their unit was only fair or poor (as opposed to good or excellent) than nurses in other countries (only 11% of nurses in Canada). Therefore, the quality of care in South Korea remains a considerable public health challenge.

The quality of health care is often evaluated using patient outcomes. Patient adverse events (including medication error, fall, urinary tract infection, pneumonia, and pressure ulcer) and patient mortality are frequently used to assess patient outcomes (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Lang, Hodge, Olson, Romano, & Kravitz, 2004; Stalpers, de Brouwer, Kaljouw, & Schuurmans, 2015). Because nurses represent the largest group of hospital employees who deliver most of the direct patient care, nurse care is one of the most important areas of quality of health care and patient safety (Institute of Medicine [IOM], 2011). Nurse staffing level (e.g., patient-to-nurse ratio) plays a significant role in the outcomes of hospital patients (Aiken et al., 2014). Much of the literature published in connection with studies conducted in the United States and Europe and reviews of the literature and meta-analyses have demonstrated the relationship among the level of nurse staffing in hospitals, patient mortality, and adverse patient events. Better patient-to-nurse staffing ratios have been significantly associated with lower rates of hospital mortality, failure to rescue, cardiac arrest, hospital-acquired pneumonia, patient fall, pressure ulcer, or other adverse events (Aiken, Sloane, et al., 2011; Cho et al., 2015; Kane et al., 2007; Needleman, Buerhaus, Stewart, Zelevinsky, & Mattke, 2006; Rafferty et al., 2007; Stalpers et al., 2015). Furthermore, previous studies suggest that a better nursing work environment is associated with higher levels of quality and patient safety and fewer patient adverse events (Aiken, Cimiotti, et al., 2011; Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Aiken, Sloane, et al., 2011; Cho et al., 2015; Friese, Lake, Aiken, Silber, & Sochalski, 2008; IOM, 2004). Better work environments often include ardent nurse participation in hospital affairs, a solid nursing foundation for quality of care, strong nurse leadership, adequate resources, and good working relationships between doctors and nurses (Aiken, Cimiotti, et al., 2011; Lake, 2002). Thus, nurse staffing level and nurse work environment should be considered critical factors that influence adverse patient events in South Korea.

Although there is strong empirical evidence from several studies in the United States and Europe (Kane et al., 2007; Lang et al., 2004; Stalpers et al., 2015), little is known about whether the significant associations of patient outcome with nurse staffing and nurse work environment are also present in South Korean hospitals. Therefore, the purpose of this study was to examine the relationships of nurse staffing level and nurse work environment with patient adverse events. Numerous previous studies conducted in the United States (Aiken, Cimiotti, et al., 2011; Blegen, Goode, Park, Vaughn, & Spetz, 2013; Blegen, Goode, Spetz, Vaughn, & Park, 2011; Cho, Ketefian, Barkauskas, & Smith, 2003) and recently in nine European countries (Belgium, England, Finland, Ireland, the Netherlands, Norway, Spain, Sweden, and Switzerland; Aiken et al., 2014) have identified several nurse (e.g., nursing education, unit type), hospital (e.g., hospital size, teaching status), and patient characteristics (e.g., age, comorbidities) that affect patient outcomes, which were included here as covariates. Based on previous research evidence, the theoretical perspective for this study is that appropriate nurse staffing level and nurse work environment in hospitals may ensure the quality of health care they provide, and in turn affect the health outcomes of hospital patients. Patient outcomes in this study are measured by patient adverse events, including administration of the wrong medication or dose, pressure ulcer, and injury from falling after admission. We adjusted for other covariates, including nurse, hospital, and patient characteristics that are correlated with patient adverse events. We hypothesized positive relationships among a larger number of patients per nurse, poor work environment, and incidence of patient adverse events, after controlling for nurse, hospital, and patient characteristics.

Methods

Setting and Sample

This study was conducted with a combination of nurse survey data, facility data, and hospital discharge data from South Korea using a common research protocol and instruments established by Aiken and colleagues in the United States and other countries (Aiken, Cimiotti, et al., 2011; Aiken et al., 2014; Aiken, Sloane, et al., 2011). The nurse survey data were collected from 60 randomly selected hospitals out of all 295 acute hospitals with 100 or more beds in all seven metropolitan cities and all nine provinces in South Korea. In order to assure the representativeness of hospitals selected, these 60 hospitals were selected by a stratified random sampling method based on location (Seoul, other metropolitan areas, and

provinces) and bed size (100–399, 400–699, 700–799, and 1,000 or above). Units were also randomly selected from the list of units at each hospital by using a random table. The number of nurses varied based on the number of beds of hospitals and types of units. Thus, we selected units in different proportions based on the number of beds of hospitals and types of units. Namely, in the hospitals with 100 to 699 beds, all units were included, while 50% from all general wards and one from each type of special unit (e.g., intensive care unit, perioperative unit, and emergency room) in hospitals with 700 to 999 beds were randomly selected, and 20% from all general wards and one from each type of special unit of units in hospitals with 1,000 or more beds were randomly selected. All nurses working in the selected units on the date of data collection were invited to complete the survey. The surveys were distributed to nurses at each hospital. Once the participating nurses completed the survey in private, the completed questionnaires were placed in sealed envelopes and dropped in locked boxes located in each unit at each participating hospital to ensure anonymity. The staff of the department of nursing at each participating hospital mailed the unopened boxes to the principal investigator.

The total of 5,103 registered nurses (RNs) from 60 hospitals were invited to participate in the study, and 4,910 completed the survey, a response rate of 96.2%. This study was able to achieve the high response rate because the design involved recruiting hospitals first and then sampling nurses directly from participating hospitals, which tends to achieve a higher response rate than recruiting individual nurses (Aiken et al., 2012; Aiken, Sloane, et al., 2011). In addition, as demonstrated in an earlier study (Aiken, Sloane, et al., 2011), a high response rate is often found in Asian countries. More detailed information on the nurse survey is published elsewhere (Aiken, Sloane, et al., 2011; Cho et al., 2013). The facility data and hospital discharge data were collected by the Health Insurance Review Agency (HIRA) in South Korea. The hospital discharge data of patients who underwent general, orthopedic, or vascular surgery in 2008 and who were between the ages of 19 and 89 years were included in the analysis. The hospital discharge data were aggregated to the hospital level in order to adjust the case mix of patients, which represents the difference in severity of illness and the characteristics of patients across hospitals. The hospital discharge data of 2 of the total 60 hospitals were not available. Therefore, this study analyzed the combined data of 58 hospitals, 113,426 patients, and 4,864 nurses. The study protocol was approved by the institutional review board of the authors' affiliated university.

Measures

Adverse events. Three nurse-reported adverse events were examined as outcome variables. Nurses were asked how often patients received the wrong medication or dose and how frequently patients experienced pressure ulcer or fall with injury after admission. Nurses rated the frequency of each adverse event on a 7-point Likert scale that ranged from never to every day. These nurse-reported adverse events have been used in many international studies and reported as reliable and valid measures (Aiken, Sloane, Bruyneel, Van den Heede, & Sermeus, 2013; Ausserhofer et al., 2013; Cina-Tschumi, Schubert, Kressig, De Geest, & Schwendimann, 2009; Kelly, Kutney-Lee, Lake, & Aiken, 2013; Lucero, Lake, & Aiken, 2010; Van Bogaert et al., 2014).

Nurse staffing level and work environment. The nurse staffing level was assessed using a single self-report questionnaire regarding the number of patients each participating nurse had cared for on his or her last shift. The nurse work environment was measured using the Korean version of the Practice Environment Scale of the Nursing Work Index (PES-NWI), which has demonstrated good validity and reliability (Cho, Choi, Kim, Yoo, & Lee, 2011). The Korean version of the PES-NWI has 29 items with five subscales consisting of nine items regarding nurse participation in hospital affairs (e.g., opportunity for staff nurses to participate in policy decisions); nine items to assess nursing foundations for quality of care (e.g., written, up-to-date nursing care plans for all patients); four items for nurse manager ability, leadership, and support of nurses (e.g., a nurse manager who is a good manager and leader); four items that investigate the staffing and resource adequacy of a facility (e.g., enough RNs to provide quality patient care); and three items for collegial nurse–physician relations (e.g., physicians and nurses have a good working relationship). Each item was rated on a 4-point Likert scale, ranging from "1 = *strongly disagree*" to "4 = *strongly agree*," and a higher score indicated a more supportive work environment. Cronbach's alphas for the five subscales of the Korean version of the PES-NWI ranged from 0.80 to 0.93. To calculate the composite score, the subscale scores of individual nurses were aggregated to the hospital level mean, and the distance of the hospital level mean from the median for all hospitals on five subscales was determined; these values ranged from 0 to 5. Hospitals were categorized into three groups based upon these differences: zero or one subscale above the median were "poor," two or three subscales above the median were "mixed," and four or five subscales above the median were classified as "better" care environments (Lake, 2002).

Nurse, hospital, and patient characteristics.
Nurse, hospital, and patient characteristics were included as covariates. Nurse characteristics collected from the nurse survey included education (3 years of nursing college vs. Bachelor of Science in Nursing [BSN] or higher), age, years worked as a nurse, gender, job status (part-time vs. full-time), job security (temporary vs. permanent job), unit type (medical and surgical, intensive care, operating and recovery room, or other), and the most recent shift or day worked (day, evening, night, or other). Each work shift of nurses in South Korea is usually 8 hr. Hospital characteristics included bed size (100–399, 400–699, 700–999, or ≥ 1,000), location (capital city of Seoul, other metropolitan area, or province), teaching hospital status (yes vs. no), and high-technology status (yes vs. no). Hospitals with postgraduate residents or interns were considered teaching hospitals, while hospitals that regularly conducted open-heart surgery or major organ transplantation were classified as high-technology hospitals. To control for differences in severity of illness and characteristics of patients across hospitals, the characteristics of patients who underwent common surgical procedures were controlled for. Common surgical procedures were selected because they are carried out in all hospitals and risk adjustment techniques have been well validated for these procedures (Aiken, Cimiotti, et al., 2011; Aiken et al., 2008; Aiken et al., 2014). The patient characteristics include the percentage of patients 65 years of age or over, transferred patients, emergency admissions, male patients, patients with major diagnostic categories (MDCs), and those with comorbidities (Elixhauser, Steiner, Harris, & Coffey, 1998). The percentage of patients with MDCs included diseases and disorders of the circulatory system (MDC 5); the digestive system (MDC 6); the hepatobiliary system (MDC 7); the musculoskeletal system (MDC 8); the skin, subcutaneous tissue, or breast (MDC 9); and endocrine, nutritional, or metabolic diseases and disorders (MDC 10). The risk adjustment of Elixhauser et al. (1998) was used, and HIV/AIDS, obesity, and drug abuse were excluded because they were extremely uncommon ($n \leq 10$ in all cases). In addition, three different types of cancer (lymphoma, metastatic cancer, and solid tumors without metastasis) were combined into one category.

Data Analysis

Analysis of descriptive statistics was conducted to examine the incidence of adverse events, nurse staffing level and work environment, and characteristics of nurses and hospitals including patient characteristics to represent the case mix of hospitals. The incidences of each

Table 1. Nurse Characteristics ($N = 4,864$)

Variables	Mean ± SD
Age (years)	28.7 ± 5.7
Years worked as a nurse	6.2 ± 5.4
	n (%)
Gender	
Male	234 (4.8)
Female	4,617 (95.2)
Highest education level	
Three years of college	2,721 (56.2)
BSN or higher	2,124 (43.8)
Job status	
Part-time	24 (0.5)
Full-time	4,825 (99.5)
Job security	
Temporary job	185 (3.8)
Permanent job	4,663 (96.2)
Unit type	
Medical and surgical	1,401 (30.3)
Intensive care	625 (13.5)
Operating/recovery room	912 (19.7)
Other	1,689 (36.5)
Last shift/day worked	
Day	2,099 (44.1)
Evening	1,283 (27.0)
Night	1,291 (27.1)
Other	83 (1.7)

Note. BSN = Bachelor of Science in Nursing.

adverse event (wrong medication or dose, pressure ulcers, and falls with injury after admission) were ordered from never to every day. Nurses were clustered at the hospital level. Thus, the structure of data in this study had two levels: the individual nurse level and hospital level. Patient characteristics were aggregated at the hospital level as the case mix of the hospitals. Multilevel ordinal logistic regression was employed to explore the relationships of nurse staffing level and work environment with adverse events while controlling for nurse and hospital characteristics including patient characteristics represented by the case mix at the hospital level. STATA version 13.1 software (StataCorp LP, College Station, TX, USA) was used for data analysis, and statistically significant findings were considered when $p < .05$.

Results

Characteristics of Nurses, Hospitals, and Patients

A total of 4,864 RNs participated in this study. Nurse characteristics are summarized in **Table 1**. The participants were young (mean age 28.7 years), with an

Table 2. Hospital Characteristics (N = 58)

Variables	n (%)
Bed size (number of beds)	
100–399	29 (50.0)
400–699	15 (25.9)
700–999	7 (12.1)
≥1,000	7 (12.1)
Location	
Seoul (capital)	14 (24.1)
Other metropolitan area	17 (29.3)
Province	27 (46.6)
Teaching status	
No	16 (27.6)
Yes	42 (72.4)
High-technology status	
No	14 (24.1)
Yes	44 (75.9)

Table 3. Patient Characteristics (N = 113,426)

Variables	N (%)
Age, mean years ± SD	53.9±16.1
Gender	
Male	56,934 (50.2)
Transfer status (transferred)	5,843(5.5)
Emergency admissions (yes)	26,145 (24.7)
MDCs	
General surgery	
Diseases and disorders of the digestive system (MDC 6)	18,563 (16.4)
Diseases and disorders of the hepatobiliary system (MDC 7)	16,495 (14.5)
Diseases and disorders of the skin, subcutaneous tissue, or breast (MDC 9)	13,334 (11.8)
Endocrine, nutritional, or metabolic diseases and disorders (MDC 10)	8,466 (7.5)
Orthopedic surgery	
Diseases and disorders of the musculoskeletal system (MDC 8)	37,297 (32.9)
Vascular surgery	
Diseases and disorders of the circulatory system (MDC 5)	19,271(17.0)
Comorbidities[a]	
Hypertension	24,833 (21.9)
Diabetes mellitus	17,630 (15.5)
Liver disease	10,729 (9.5)
Cancer	6,916 (6.1)
Peptic ulcer disease, no bleeding	7,880 (6.9)
Arrhythmia	6,312 (5.6)
Chronic obstructive pulmonary disease	6,168 (5.4)
Weight loss	3,681 (3.2)
Coagulopathy	2,417 (2.1)
Deficiency anemia	3,007 (2.7)
Fluid and electrolyte disorders	2,624 (2.3)
Hypothyroidism	2,441 (2.2)
Congestive heart failure	1,766 (1.6)
Peripheral vascular disorders	1,347 (1.2)
Aortic stenosis	1,106 (1.0)
Renal failure	998 (0.9)
Depression	1,128 (1.0)
Paralysis	387 (0.3)
Other neurodegenerative disorders	662 (0.6)
Alcohol abuse	411 (0.4)
Pulmonary circulation disorders	330 (0.3)
Rheumatoid arthritis/collagen vascular diseases	766 (0.7)
Psychoses	264 (0.2)
Blood loss anemia	200 (0.2)

Note. MDC = major diagnostic category.

[a] The comorbidities listed are from Elixhauser et al. (1998). HIV/AIDS, obesity, and drug abuse were excluded from our analyses and also from the table because they were extremely uncommon (n ≤ 10 in all cases); Elixhauser's three cancer types (lymphoma, metastatic cancer, and solid tumors without metastasis) were combined into the category of cancer.

average of 6.2 years of work experience as an RN. The majority of participants were female (n = 4,617, 95.2%), and 43.8% (n = 2,124) had a bachelor's degree or higher in nursing. Almost all (n = 4,825, 99.5%) were full-time, while only 3.8% of RNs (n = 185) were in temporary positions. The most recent shift worked was day shift (n = 2,099, 44.1%), followed by evening shift (n = 1,283, 27.0%), night shift (n = 1,291, 27.1%), and other shifts (n = 83, 1.7%; see **Table 1**). Other shifts included pro re nata (PRN), double duty, or 24-hr shifts.

Table 2 provides information on the characteristics of the 58 participating hospitals. Half of the hospitals (n = 29) had 100 to 399 beds, while 12.1% (n = 7) had 1,000 beds or more. About 24.1% (n = 14) of the hospitals were located in Seoul (the capital city), and 46.6% (n = 27) were located in a province; 72.4% (n = 42) and 75.9% (n = 44) were teaching hospitals and high-technology hospitals, respectively.

The characteristics of patients (N = 113,426) are presented in **Table 3**. The mean age of patients was 53.9 years (SD = 16.1), and the percentage of male patients was 50.2%. A total of 5.5% of patients were transferred from other healthcare facilities, while approximately 24.7% were admitted through the emergency department. With regard to the distribution of MDCs, the two largest proportions of patient types were those with diseases and disorders of the musculoskeletal system (MDC 8; 32.9%) and diseases and disorders of the circulatory system (MDC 5; 17.0%). Among the patient comorbidities listed by Elixhauser et al. (1998), hypertension (21.9%) and diabetes mellitus (15.5%) were the most common.

Nurse Staffing Level, Work Environment, and Patient Adverse Events

The nurse staffing level, work environment, and adverse events are presented in **Table 4**. On average, nurses reported that they had cared for more than 17 patients on their most recent shift. Approximately 40% ($n = 1,966$) of nurses worked in hospitals with better nursing practice environments (four or five subscales above the median on the PES-NWI), whereas 23.2% ($n = 1,127$) of nurses worked in hospitals with poor nursing practice environments (zero or one subscale above the median of PES-NWI). In terms of adverse events, 3.2% ($n = 149$) of nurses reported administering the wrong medication or dose a few times a month or more. Pressure ulcers and falls with injuries were reported to occur a few times a month or more by 4.7% ($n = 216$) and 2.3% ($n = 103$) of the nurses, respectively.

Relationships of Nurse Staffing Level and Work Environment With Patient Adverse Events

Table 5 reports the results of multilevel ordinal logistic regression for adverse events, which included administration of the wrong medication or dose, pressure ulcer, and falls with injury while controlling for nurse, hospital, and patient characteristics. The models separately examined the effect of each nurse staffing level and work environment on wrong medication or dose, pressure ulcer, and fall with injury separately. The results showed that both nurse staffing level and work environment are significantly associated with all three adverse events. A larger number of patients per RN was significantly associated with higher incidence of administration of the wrong medication or dose (odds ratio [OR] = 1.01, 95% confidence interval [CI] = 1.007–1.016), pressure ulcer (OR = 1.01, 95% CI = 1.007–1.016), and patient falls with injury (OR = 1.02, 95% CI = 1.013–1.022). In addition, compared with nurses in a poor work environment, those who had a better work environment reported that the incidence of adverse events was 45% lower for administration of the wrong medication or dose (OR = 0.55, 95% CI = 0.400–0.758), 39% lower for pressure ulcer (OR = 0.61, 95% CI = 0.449–0.834), and 32% lower for falls with injury after admission (OR = 0.68, 95% CI = 0.490–0.939).

Discussion

To our knowledge, this study is one of the first in South Korea to explore the relationships of nurse staffing level or nurse work environment with patient adverse events using 58 randomly selected hospitals. Our findings indicate that both nurse staffing level and nurse work

Table 4. Nurse Staffing Level, Work Environment, and Adverse Events

Variables	Mean $\pm$ SD
Nurse staffing level	17.4 $\pm$ 18.3
	n (%)
Work environment	
Poor	1,127 (23.2)
Mixed	1,771 (36.4)
Better	1,966 (40.4)
Adverse events	
Administration of the wrong medication or dose	
Never	1,524 (33.1)
A few times a year or less	2,487 (53.9)
Once a month or less	451 (9.8)
A few times a month	91 (2.0)
Once a week	41 (0.9)
A few times a week	15 (0.3)
Every day	2 (0.0)
Pressure ulcer	
Never	1,817 (39.8)
A few times a year or less	1,949 (42.7)
Once a month or less	579 (12.7)
A few times a month	160 (3.5)
Once a week	47 (1.0)
A few times a week	9 (0.2)
Every day	0 (0.0)
Fall with injury	
Never	2,052 (45.4)
A few times a year or less	2,067 (45.8)
Once a month or less	293 (6.5)
A few times a month	71 (1.6)
Once a week	26 (0.6)
A few times a week	5 (0.1)
Every day	1 (0.0)

environment are significantly associated with all three patient adverse events (administration of the wrong medication or dose, pressure ulcer, and falls with injury). The present study revealed a significant positive relationship between higher nurse workload and patient adverse events after controlling for nurse, hospital, and patient characteristics. Each increase of one patient per nurse on shift was associated with a 1% increase in likelihood of administering the wrong medication or dose, a 1% increase in pressure ulcer, and a 2% increase in falls with injury.

These findings were consistent with previous studies that reported an association between inadequate nurse staffing level and nurse-sensitive patient adverse events, such as medication errors, hospital-acquired pressure ulcers, and patient falls and injuries (Blegen, Goode, & Reed, 1998; Cho et al., 2003; Frith, Anderson, Tseng, & Fong, 2012; Kane et al., 2007; Lake, Shang, Klaus, & Dunton, 2010; Lucero et al., 2010). Maintaining an adequate nursing workforce to provide a good quality of patient outcome is a challenge for hospitals in South

Table 5. Multilevel Ordinal Logistic Regression of Nurse Staffing Level and Work Environment on Wrong Medication or Dose, Pressure Ulcer, and Fall With Injury ($N = 4{,}864$)

	Wrong medication or dose Adjusted OR[a] (95% CI)	Pressure ulcer Adjusted OR[a] (95% CI)	Fall with injury Adjusted OR[a] (95% CI)
Nurse staffing level	1.01*** (1.007–1.016)	1.01*** (1.007–1.016)	1.02*** (1.013–1.022)
Work environment (ref. Poor)			
Mixed	0.71* (0.552–0.924)	0.98 (0.762–1.258)	0.90 (0.693–1.168)
Better	0.55*** (0.400–0.758)	0.61** (0.449–0.834)	0.68* (0.490–0.939)

Note. CI = confidence interval; OR = odds ratio; ref. = reference.

[a]The models examined each predictor variable (nurse staffing level and work environment) separately while controlling for nurse characteristics (education, age, years worked as a nurse, gender, job status, job security, unit type, and last shift/day worked) and hospital characteristics (bed size, location, teaching status, high-technology status, and case mix of patients).

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

Korea due to the relatively high nurse workloads. The present study found that nurses in South Korea reported caring for an average of 17.4 patients on their last shift, which is almost three times higher than number of patients per nurse in the United States (5.7 patients per nurse) and twice as high as the rate reported in European countries (8.3 patients per nurse; Aiken et al., 2013, 2014). Due to inadequate nurse staffing levels in South Korea, nurses might have more physically and psychologically demanding workdays that can result in errors in medication or dose and that also provide less time for meticulous patient care, the lack of which can lead to an increased rate of pressure ulcers. This study highlights the importance of improving inadequate patient-to-nurse staffing ratios in order to reduce patient adverse events in South Korea. A policy in South Korean hospitals to modify nurse staffing levels is needed to improve preventable patient outcomes.

The present study also revealed a significant association between nurse work environment and patient adverse events. Even after controlling for the effects of nurse, hospital, and patient characteristics, nurses in hospitals with better nurse work environments reported significantly (45%) lower rates of medication or dose error, 39% fewer pressure ulcer, and 32% fewer falls with injury after admission compared to nurses in poor work environments. Similarly, previous studies have found that healthy and better nurse work environments were also associated with lower patient adverse events (Flynn, Liang, Dickson, & Aiken, 2010; Flynn, Liang, Dickson, Xie, & Suh, 2012; Friese et al., 2008; Lucero et al., 2010). Employment in a hospital with a better work environment was also associated with positive nurse outcomes, such as lower rates of nurse burnout and job dissatisfaction (Aiken, Sloane, et al., 2011; Gabriel, Erickson, Moran, Diefendorff, & Bromley, 2013). In a study of 1,406 hospitals in nine countries, 60% of the nurses in South Korea reported high burnout, 36% were dissatisfied with their current job, and only a low

percentage (28.8%) were employed in better work environments (Aiken, Sloane, et al., 2011). Additionally, the present study included predominantly younger (mean 28.7 years) and less experienced (mean 6.2 years) nurses, which may be due to high nurse turnover rates in South Korea. It is important to increase the retention of more experienced nurses in order to provide higher quality patient care. Therefore, the present study's findings suggest the need to improve the number of good nursing work environments, which could help decrease patient adverse outcomes and improve the quality of patient care. It is important to continue current efforts to develop healthcare strategies and policies to modify more supportive nursing practice environments.

Strengths and Limitations

The strengths of this study included its randomly selected data set with large sample sizes and a high response rate (96.2%). In addition, this study improved on previous evidence by controlling for nurse (education, age, years worked as a nurse, gender, job status, job security, unit type, and shift), hospital (bed size, location, teaching hospital status, and high-technology hospital status), and patient characteristics (age, gender, transfer and admission status, major diagnostic categories, and comorbidities) to reduce possible effects on patient adverse events.

Several limitations should be considered when interpreting these findings. First, the results of the present study were based on cross-sectional data; therefore, a causal relationship among patient adverse events, nursing staffing level, and nurse work environment cannot be determined. Second, this study included the use of a self-report survey for both outcomes and covariates. In particular, because adverse patient events were reported by nurses, there may have been a recall or reporting bias. Thus, compared to the actual incidence rates, the incidence rates of adverse events reported in this study might have been underestimated or overestimated. Further

research will be needed to objectively measure patient adverse outcomes (patient medical records) and to confirm the findings in the present study. Third, adjustment for patient characteristics was based on hospital discharge data of surgical patents only. This adjustment therefore limits the generalizability of the study findings. Finally, this study did not consider other nurse characteristics, such as stress (burnout), fatigue, or poor sleep quality due to shift work, which might be significantly related to patient adverse events and could increase the possibility of confounding effects by unmeasured or unknown factors.

Conclusions

The present study found significant associations between nurse staffing level and work environment with patient adverse events. Specifically, our findings suggest that an adequate nurse staffing level (reducing the number of patients per nurse on each shift) and better nurse work environments can improve preventable patient outcomes. Further longitudinal research is needed to better understand the causal relationships among nurse staffing level, nurse work environments, and patient outcome. This study suggests the importance of the development of effective strategies and policies to improve the quality of health care and patient safety in South Korean hospitals and provides empirical evidence to further these efforts.

Acknowledgments

Clinical Resources

- Agency for Healthcare Research and Quality, Patient Safety & Medical Errors:
  http://www.ahrq.gov/professionals/quality-patient-safety/index.html
- U.S. Department of Health and Human Services, Hospital Compare:
  http://www.hospitalcompare.hhs.gov

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