*Original Research Article*

# Rural Hospital Nursing Skill Mix and Work Environment Associated With Frequency of Adverse Events

SAGE Open Nursing
Volume 5: 1–13

DOI: 10.1177/2377960819848246
journals.sagepub.com/home/son
SAGE

**Jessica G. Smith, PhD, RN[1], Colin M. Plover, PhD, RN[2], Moira C. McChesney[3], and Eileen T. Lake, PhD, RN, FAAN[3]**

## Abstract

**Introduction:** Although rural hospitals serve about one fifth of the United States, few studies have investigated relationships among nursing resources and rural hospital adverse events.

**Objectives:** The purpose was to determine relationships among nursing skill mix (proportion of registered nurses [RNs] to all nursing staff), the work environment, and adverse events (medication errors, patient falls with injury, pressure ulcers, and urinary tract infections) in rural hospitals.

**Methods:** Using a cross-sectional design, nurse survey data from a large study examining nurse organizational factors, patient safety, and quality from four U.S. states were linked to the 2006 American Hospital Association data. The work environment was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI). Nurses reported adverse event frequency. Data analyses were descriptive and inferential.

**Results:** On average, 72% of nursing staff were RNs (range = 45%–100%). Adverse event frequency ranged from 0% to 67%, across 76 hospitals. In regression models, a 10-point increase in the proportion of RNs among all nursing staff and a one standard deviation increase in the PES-NWI score were significantly associated with decreased odds of frequent adverse events.

**Conclusion**: Rural hospitals that increase the nursing skill mix and improve the work environment may achieve reduced adverse event frequency.

## Keywords

health services research, hospitals, nursing, work environment, nursing skill mix

Date received: 28 January 2019; revised: 24 March 2019; accepted: 13 April 2019

## Introduction

Adverse events, defined by the Joint Commission as "patient safety event[s] that resulted in harm to a patient," are estimated to be the third leading cause of death in the United States (Joint Commission, 2016; Makary & Daniel, 2016). Improving nursing surveillance in hospitals is one promising approach to prevent adverse events (Henneman et al., 2010; Henneman, Gawlinski, & Giuliano, 2012; Kelly & Vincent, 2011; Lucero, Lake, & Aiken, 2010; Voepel-Lewis, Pechlavanidis, Burke, & Talsma, 2013). Global evidence from multiple countries supports that enriching the hospital nursing skill mix, which is antecedent to improving nursing surveillance, is associated with fewer adverse events in hospitals (Griffiths et al., 2018; Patrician et al., 2011; Twigg, Duffield, Bremner, Rapley, & Finn, 2012; Yang, Hung, Chen, Hu, & Shieh, 2012). Nursing skill mix refers the proportion of

[1]College of Nursing and Health Innovation, University of Texas at Arlington, Arlington, TX, USA
[2]College of Population Health, Thomas Jefferson University, Philadelphia, PA, USA
[3]Center for Health Outcomes and Policy Research, University of Pennsylvania School of Nursing, Philadelphia, PA, USA

**Corresponding Author:**
Jessica G. Smith, College of Nursing and Health Innovation, University of Texas at Arlington, 411 South Nedderman Drive, Pickard Hall, Arlington, TX 76019, USA.
Email: jessica.smith2@uta.edu

registered nurses (RNs) to all nursing staff (Duffield et al., 2011).

The work environment, also antecedent to nursing surveillance effectiveness (Kelly & Vincent, 2011), is "the organizational characteristics of a work setting that facilitate or constrain professional nursing practice" (Lake, 2002, p. 178). Plentiful literature has identified associations between better nursing work environments and better patient outcomes (Aiken et al., 2011; Duffield et al., 2011; Kang, Kim, & Lee, 2014; Kelly, Kutney-Lee, Lake, & Aiken, 2013; Kirwan, Matthews, & Scott, 2013; Stalpers, de Brouwer, Kaljouw, & Schuurmans, 2015; Wei, Sewell, Woody, & Rose, 2018). However, few studies have investigated the influence of modifiable hospital characteristics, such as the proportion of RNs to all nursing staff and the work environment on adverse event frequency, at the same time in rural hospitals.

Using multistate nurse survey data, the study aims were to evaluate how the proportion of RNs to all nursing staff and work environments are associated with the occurrence of nurse-reported adverse events in rural hospitals. The theoretical basis for this study is that the proportion of RNs to all nursing staff and work environments, both structural components of the Quality Health Outcomes Model which guided this study (Mitchell, Ferketich, & Jennings, 1998), might have an important role in predicting rural patient outcomes. Evidence about how nursing skill mix and work environments influence adverse events in rural hospitals is relevant given existing evidence that there are fewer RNs to all nursing staff in rural as compared to urban hospitals (Baernholdt & Mark, 2009). Findings of this study inform how hospital nursing resources can be modified to improve the quality of acute care services for rural residents.

## Review of Literature

Rural hospitals, though fewer in number, serve about one fifth of the U.S. population (L. G. Hart, Larson, & Lishner, 2005) and have unique cultures (Baernholdt, Jennings, Merwin, & Thornlow, 2010) and population-based needs (Bolin et al., 2015). Rural nurses must be prepared to offer essential lifesaving care with fewer human and material resources (Baernholdt & Mark, 2009; The Council of State Governments, 2011) to serve a population that is older, poorer, more ill, and more frequently uninsured compared to urban residents (Bolin et al., 2015; Havens, Warshawsky, & Vasey, 2012). Unlike nurses in large urban hospitals who more commonly practice in health-care specialties, nurses who work in rural hospitals must be expert generalists to care for patients across the lifespan. Rural nurses need to facilitate timely transfers of patients (Baernholdt et al., 2010) who experience rapid condition changes to urban facilities with specialists and advanced technological capabilities. Ensuring that rural hospitals are equipped with enough RNs to all nursing staff and better work environments might help improve nurse surveillance and decision-making (Aiken, Clarke, Cheung, Sloane, & Silber, 2003), and therefore might reduce adverse event frequency.

Increasing the proportion of RNs to all nursing staff in rural hospitals is an evidence-based (International Council of Nurses [ICN], 2018) long-term management plan associated with decreased adverse events (Dall, Chen, Seifert, Maddox, & Hogan, 2009). Hospital-level nursing care strategies associated with decreased adverse events are sought after in today's era of value-based purchasing, which requires better outcomes for full hospital reimbursement (Ryan, Krinsky, Maurer, & Dimick, 2017). The ICN position statement on evidence-based nurse staffing (ICN, 2018) supports cultivating a sufficient nursing skill mix in consideration of patient needs and for improved patient care outcomes. In general, large medical centers tend to have a higher proportion of RNs to all nurses than community hospitals; however, critical care units, which have the highest proportion of RNs, tend to have the same proportion of RNs regardless of hospital type (Welton, Unruh, & Halloran, 2006). Nurses working in hospitals with a higher proportion of RNs to all nurses are less likely to report poorer quality care and lower patient safety (Aiken et al., 2017). One study found that the strongest predictor of nurse turnover, an expensive cost for hospitals, was the proportion of RNs to all nurses (Staggs, Olds, Cramer, & Shorr, 2017).

Despite plentiful empirical evidence about how an increased proportion of RNs to all nurses is associated with lower odds of adverse events in larger populations (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007), the association between the proportion of RNs among nursing staff and rural hospital adverse events remains understudied. Rural hospitals continue to be staffed with a lower proportion of RNs to all nursing staff (Baernholdt & Mark, 2009) without sufficient evidence to inform this practice. Rural hospitals might continue to be staffed with a lower proportion of RNs to all nursing staff because of a lack of employer incentives to hire more RNs (Jones, Yoder, & Baernholdt, 2019). One incentive, for example, might be a mandate to provide better reimbursement rates for hospitals that have a higher proportion of RNs to all nursing staff (Jones et al., 2019). In other populations, increasing the proportion of RNs to all nursing staff has been associated with decreased physical restraint use (P. Hart & Davis, 2011; Staggs et al., 2017), lower odds of mortality in medical and surgical patients (Aiken et al., 2017; Kane et al., 2007), decreased pressure ulcers, falls with injuries, urinary tract infections (UTIs) (Aiken et al., 2017;

P. Hart & Davis, 2011), decreased rates of hospital-acquired pneumonia (Kane et al., 2007), and decreased rates of sepsis (Kane et al., 2007; Twigg et al., 2012). Better patient outcomes that might be achieved through staffing higher proportions of RNs to all other nurses are important to ensure long-term financial solvency for hospitals in the current era of value-based care, which requires optimal patient outcomes for reimbursement (Blumenthal & Jena, 2013).

Cost-effective nursing resource modifications, such as improving the work environment, are not discussed enough in the rural health literature as having a potential positive influence on patient outcomes in rural hospitals. Factors of the work environment to which we refer in this article, as measured in prior studies (Kirwan et al., 2013; Warshawsky & Havens, 2011), include nurse manager leadership, staffing and resource adequacy, nurse–physician collegial relations, nursing foundations for quality of care, and involvement in hospital affairs (Lake, 2002). Extensive evidence demonstrates that more favorably rated work environments are associated with better patient outcomes, including decreased mortality (Aiken et al., 2011; Warshawsky & Havens, 2011), decreased adverse events (Kelly et al., 2013; Warshawsky & Havens, 2011), decreased failure to rescue (McHugh, Berez, & Small, 2013; Warshawsky & Havens, 2011), and improved patient safety (Kirwan et al., 2013; Warshawsky & Havens, 2011). More favorable work environments have been associated with better patient care quality outcomes, and with improved nurses' outcomes, at the same time (Copanitsanou, Fotos, & Brokalaki, 2017). However, few studies have examined the rural work environment at the hospital level (Baernholdt & Mark, 2009), despite the fact that it is noted to differ from urban hospitals work environments in qualitative data and among small samples with quantitative data (Cline et al., 2014).

Studies that have examined nurse work environments in rural settings have not included the proportion of RNs to all nursing staff as an additional variable influential to adverse events (Baernholdt & Mark, 2009; Cline et al., 2014; Krebs, Madigan, & Tullai-McGuinness, 2008; MacPhee & Scott, 2002; Meraviglia et al., 2009; Newhouse, Morlock, Pronovost, Colantuoni, & Johantgen, 2009; Newhouse, Morlock, Pronovost, & Sproat, 2011; Sullivan Havens, Warshawsky, & Vasey, 2013). Although past studies have examined the effect of nurse work environments on nursing outcomes, such as job satisfaction, turnover rate (Baernholdt & Mark, 2009), and the prevalence of patient falls in different geographic regions (Baernholdt, 2018), little research exists about how nursing work environments, inclusive of the proportion of RNs to all nursing staff, affects the frequency of adverse events in rural hospitals.

### *Theoretical Framework*

The Quality Health Outcomes Model (Mitchell et al., 1998) was used to guide this study. This model suggests reciprocal influence between interventions, system characteristics, patient outcomes, and population characteristics with no proposed direct influence of interventions on patient outcomes, meaning that interventions influence outcomes through system and population characteristics (Mitchell et al., 1998). Modification of the health-care system might mediate effects of interventions on patient outcomes (Mitchell et al., 1998) and is therefore critical to understand. Nursing surveillance is a theoretical intervention mediated by system characteristics and population characteristics to influence outcomes. The Nursing Interventions Classification definition of nursing surveillance is "purposeful and ongoing acquisition, interpretation, and synthesis of patient data for clinical decision-making" (Butcher, Bulechek, Dochterman, & Wagner, 2018, p. 6650). Nursing surveillance requires analytic decision-making that surpasses the act of monitoring or assessment (Kelly & Vincent, 2011). This decision-making and analytic process might be enhanced with nurses who are trained to think through clinical situations using the nursing process.

Modifications to the health-care system to influence nursing surveillance might include increasing nursing skill mix and improving the nurse work environment and might be required to have a positive effect on patient outcomes such as decreased adverse event frequency. The ICN (2018) defines safe nurse staffing as having "an appropriate number of nurses [. . .] available at all times across the continuum of care, with a suitable mix of education, skills and experience to ensure that patient care needs are met and that the working environment and conditions support staff to deliver quality care" (p. 1). That a richer nursing skill mix and the work environment might be associated with reduced adverse event frequency in rural hospitals is a hypothesis based on the Quality Health Outcomes Model theoretical principles (Mitchell et al., 1998). Therefore, there is conceptual support for the hypotheses of this study.

## Purpose

The purpose of this study was to determine how the proportion of RNs to all nursing staff and nurse work environments, two modifiable features of rural hospitals, influence nurse sensitive adverse events. There were two research hypotheses: (a) more favorably rated nurse work environments will be associated with decreased odds of frequent nurse-reported adverse events such as falls with injury, pressure ulcers, medication errors, and UTIs and (b) higher proportions of RNs to other nursing personnel will be associated with decreased odds of frequent nurse-reported adverse events.

## Methods

### Design and Data Collection

This study was cross-sectional. Two data sources were linked for analyses: (a) nurse survey data from the 2005–2008 Multi-State Nursing Care and Patient Safety Study Survey and (2) the American Hospital Association (AHA) data from 2006 to describe hospital characteristics. Although over a decade old, these nurse survey data are unique in providing valid hospital-level measures of nursing organizational features recognized internationally. More recent nurse survey data were not otherwise available. Rural hospitals ($n = 76$) were identified by the AHA variable for Core-Based Statistical Area type, which has three categories: metropolitan, micropolitan, and rural. Hospitals classified as micropolitan and rural were classified as "rural."

In the 2005–2008 Multi-State Nursing Care and Patient Safety Study Survey (e.g., the parent study), nurses reported about the hospitals in which they worked. Data were collected through mail surveys sent to random samples of licensed nurses in four large states: California, Florida, New Jersey, and Pennsylvania. These four states account for over 20% of hospitalizations per year in the United States (Aiken et al., 2011). This approach was designed to yield a representative sample of nurses and resulted in a 39% response rate (Aiken et al., 2011). Evidence from a nonresponse survey (91% response rate) revealed no significant difference between original responders and nonresponders (Aiken et al., 2011). Only three of the four states were included, as there were no rural hospitals in our sample from New Jersey.

Rural hospitals with fewer than five nurse respondents were excluded to ensure that there was an acceptable interrater reliability among nurses for the work environment variable, which is a psychometric instrument aggregated to the hospital level. In our sample, the average number of nurse respondents per rural hospital was 17. The intraclass correlation (ICC(1,$k$)) value for measuring the nurse work environment at the hospital level was satisfactory at above 0.60, which exceeds the minimum established value of 0.60 needed for estimating aggregate reliability measures for measuring organizational characteristics (Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005).

## Measurement

### Outcome Variables

Nurses indicated the frequencies of the following adverse events: medication administration errors, pressure ulcers, falls with injury, and UTIs, using multiple choice questions. Nurses responded to the question, "How often would you say each of the following incidents occurs involving you or your patients?" Response categories were *never* (1), *a few times a year or less* (2), *once a month or less* (3), *a few times a month* (4), *once a week* (5), *a few times a week* (6), and *every day* (7). Nurse survey responses were checked for missing values and possible coding errors. Adverse event data were missing ranging from 5.5% to 13%, likely due to the sensitive nature of adverse event reporting frequency. Paper survey response scanning errors might have also contributed to the rate of missing data. Missing data might contribute to selection bias. In this case, missing data for adverse events were distributed evenly across the sample hospitals, which indicate that there was not a pattern among nurses from specific hospitals not answering about adverse events.

Although benchmarking quality and safety measures is often difficult in rural hospitals due to lower patient census and frequent fluctuations in patient volume and acuity (Newhouse, 2005), nurses are some of the best informants of hospital quality and safety (Aiken, 2002). Previous studies have demonstrated that nurse-reported care quality measures are highly correlated with objective patient outcomes such as mortality and failure-to-rescue (McHugh & Stimpfel, 2012).

For regression analyses, we coded responses for each of the four adverse events that occurred once a month or less up to as frequent as to every day as *frequent* (1). Conversely, adverse event responses for each that occurred a few times a year or less or never were coded as *infrequent* (0).

### Predictor Variables

Nursing skill mix was defined as the proportion of RNs compared to the number of total nursing staff, which includes other licensed and unlicensed nursing personnel (Jacob, McKenna, & D'Amore, 2015). From this point forward until the discussion, we will refer to the proportion of RNs to all nurses as "nursing skill mix" to be consistent with other literature and our measurement approach. In the discussion, we will return to referring to nursing skill mix as the proportion of RNs to all nurses to provide a practical discussion.

Nursing skill mix was measured with a fill in question that stated, "Counting yourself, how many of each of the following provided direct patient care on your unit the most recent shift/day you worked?" Nursing skill mix was calculated as the proportion of RNs to RNs, licensed vocational nurses or licensed practical nurses (LVNs or LPNs) and unlicensed assistive personnel (UAPs) (i.e., RNs / [RNs + LVNs or LPNs + UAPs]). The theoretical range for nursing skill mix proportion is 0 to 1 and is interpreted as a percentage. The nursing skill mix variable was multiplied by 10 for interpretation

of logistic regression results as a 10-point increase in the proportion of RNs among all nursing staff. Details about how missing data were managed to create this variable are available upon request.

The nurse work environment was measured with the validated, reliable, National Quality Forum-endorsed Practice Environment Scale of the Nursing Work Index (PES-NWI), which consists of Likert items that range from *strongly disagree* (1) to *strongly agree* (4) (Lake, 2002). The PES-NWI consists of five subscales, including nurse manager leadership, staffing and resource adequacy, nurse–physician collegial relations, nursing foundations for quality of care, and involvement in hospital affairs (Lake, 2002). The PES-NWI has been validated for use to measure aspects of the rural acute care nurse practice environments (Havens et al., 2012). Data missing for the nurse work environment were minimal at less than 2%, and PES-NWI items that were missing responses were replaced with the row mean when scores were aggregated for hospital level analyses, as described in a prior report using this sample (Smith, Plover, McChesney, & Lake, 2019). The nurse work environment composite scores, which are comprised of all five subscales, were standardized for interpretation of logistic regression results. Standardizing the work environment composite scores rescales the scores to fit a normal distribution where the distribution mean is 0 and 1 standard deviation (*SD*) change is used to describe the associated change in the adverse events in each model.

Because the staffing and resource adequacy subscale is a broader measure of nurse staffing and resources as part of the nurse work environment (Olds, Aiken, Cimiotti, & Lake, 2017), we used a direct measure to estimate nursing skill mix. The PES-NWI subscale entitled "Staffing and Resource Adequacy" contains four items: (a) enough staff to get the work done, (b) enough RNs to provide quality patient care, (c) adequate support services allow me to spend time with my patients, and (d) enough time and opportunity to discuss patient care problems with other nurses (Lake, 2002). One of these items asks about having enough RNs to provide quality patient care. To support our reasoning to keep the staffing and resource adequacy subscale as part of our PES-NWI measure, we ran sensitivity analyses using a four-subscale PES-NWI in the final logistic regression models to compare with our results. Final logistic regression model results using the four-subscale composite for the work environment were almost identical to using the five-subscale composite, which supports our decision to use all five subscales of the PES-NWI to measure the work environment.

### *Descriptive Variables*

Hospitals were coded as Critical Access Hospitals (CAHs) if listed as having that designation on the Flex Monitoring Team website (last updated July 27, 2018) (Flex Monitoring Team, 2018). The Flex Monitoring Team is a consortium of three rural health research centers in Minnesota, North Carolina, and Maine (Flex Monitoring Team, 2018). Hospitals were coded as being Swing Bed Providers if identified as having that designation on the National Provider Identifier Database (2018). Swing Bed Providers include rural hospitals that participate in Medicare and are permitted through the Centers for Medicare and Medicaid Services to use rural hospital beds for either acute or skilled nursing care as needed (Centers for Medicare and Medicaid Services, 2017).

Hospitals were considered to be nonteaching status if not noted in the AHA data as having any residents or fellows. Teaching hospitals would have at least a 1:4 trainee-to-bed ratio. Technology status was measured according to the presence of open heart and or transplant surgery hospitals.

## Data Analyses

After management of missing data and variable generation, descriptive analyses were performed, hospital-level distributions were assessed, and logistic regression analyses were performed to generate main results. Independent variables were the work environment and nursing skill mix. Dependent variables were the four adverse events and were measured and analyzed independently. Bivariate logistic regression models at the nurse level were estimated to understand how the nurse work environment and nursing skill mix might influence adverse events independently, which required estimating eight bivariate models. Joint logistic regression models were estimated to test how the work environment and skill mix influence each adverse event when both independent variables are accounted for in a single model, which resulted in four joint models. In regression models, we controlled for rural hospitals that were critical access and had swing beds because nurses' reports of frequent adverse events differed in these hospitals.

## Results

Of the 76 rural hospitals, 30% were in California, 14% were in Florida, and 55% were in Pennsylvania. Over half of rural hospitals (58%) had fewer than 100 beds and 3% of rural hospitals had more than 250 beds. Only 4% of rural hospitals were classified as high technology. Most rural hospitals (88%) were nonteaching. Rural hospitals with CAH designation comprised 29% of the hospital sample, and almost half (47%) of hospitals were Swing Bed Providers (22% were both CAH and Swing Bed Providers). There were 1,165 rural nurses across the 76 hospitals, whose job statuses ranged from full time

(68%), part time (22%), and per-diem (10%). The mean age of nurses in the sample was 45.8 years and on average, the nurses had 17.5 years of experience. In addition, 94% of nurses were female.

At least three quarters of nurses reported that all adverse events occurred infrequently (i.e., at most a few times a year). The most frequent adverse event reported was UTIs; 25% of nurses reported these as occurring from ''once a month or less'' to ''every day.'' Falls with injury and medication errors were reported as next most frequent after UTIs, followed last by pressure ulcers, which occurred least frequently. Very few nurses reported any adverse event as happening ''once a week'' or more often; the highest was UTI at 3.1% of nurses (Table 1).

Across rural hospitals, nurse reports of adverse event frequency varied considerably. For all adverse events, at least one hospital had all nurses reporting the adverse event never happened. Among the four adverse events, frequent UTIs were reported by the highest percentage of nurses, 22% on average. This percentage ranged substantially across hospitals from 0% to 60%. Frequent pressure ulcers were reported by the lowest percentage of nurses, 12% on average, ranging from 0% to 50%. Frequent medication errors and falls with injury were reported by 17% and 15% of nurses on average, respectively (Table 2). The prevalence of nurses reporting frequent adverse pressure ulcers and falls with injury was significantly lower in CAHs. The prevalence of nurses reporting frequent falls with injury and UTIs was significantly lower in hospitals that were also Swing Bed Providers.

On average, rural hospital nursing skill mix was 72% and ranged from 45% to 100% (Table 3). Skill mix across hospitals was approximately normally distributed (Figure 1). On average, the nurse work environment composite score of 2.68 reflected between neutral (2.5) and favorable (3.0). Most aspects of the work environment were, on average, favorable—that is, nursing foundations for quality care (2.84), nurse manager ability, leadership, and support of nurses (2.60), staffing and resource adequacy (2.60), and collegial nurse–physician relations (2.89)—except for nurse participation in hospital affairs, which was 2.46 on average and ranged from 1.65 (unfavorable) to 3.15 (favorable). The two subscales that exhibited the greatest variation were nurse manager ability, leadership, and support of nurses and staffing and resource adequacy, with *SD*s of about .375 (Table 1). Refer to Figure 2 to see box and whisker plots displaying the variation in the work environment subscales in the rural hospital sample, arrayed from most to least favorable.

## Regression Results

In the adjusted bivariate logistic regression model, an increase of one *SD* in the work environment score, that is, a standard variation in scores for this sample, was associated with a reduction of 42% ($p < .01$) in the odds that a nurse reported medication errors as occurring frequently. Each 10-point increase in the proportion of RNs among all nursing personnel was associated with a 21% ($p < .01$) decrease in these odds. In a joint regression model, these coefficients did not change (Table 4).

An increase of one SD in the work environment score was associated with a reduction of 46% ($p < .01$) in the odds that a nurse reported pressure ulcers as occurring frequently. Each 10-point increase in the proportion of RNs among all nursing personnel was associated with a 20% ($p < .01$) decrease in these odds. In a joint logistic

**Table 2.** Percent of Nurses Reporting Frequent Adverse Events ($n = 76$ Hospitals).

| Dependent variables | Mean (%) | *SD* (%) | Min | Max (%) |
|---|---|---|---|---|
| Medication errors | 17 | 14 | 0 | 67 |
| Pressure ulcers | 12 | 12 | 0 | 50 |
| Fall with injury | 15 | 13 | 0 | 50 |
| Urinary tract infection | 22 | 15 | 0 | 60 |

**Table 1.** Nurse Reported Frequency of Adverse Events on Their Unit (Nurse Level).

| Infrequent (%) | | | Frequent (%) | | | | |
|---|---|---|---|---|---|---|---|
| | Never | A few times a year or less | Once a month or less | A few times a month | Once a week | A few times a week | Every day |
| Medication error ($n = 1,265$) | 28.5 | 55.7 | 9.0 | 5.0 | 1.0 | 0.8 | 0.1 |
| Pressure ulcer ($n = 1,199$) | 48.2 | 38.8 | 7.8 | 4.1 | 0.6 | 0.5 | 0.1 |
| Fall with injury ($n = 1,218$) | 38.6 | 46.1 | 9.0 | 4.8 | 1.1 | 0.4 | 0.2 |
| Urinary tract infection ($n = 1,165$) | 30.6 | 44.8 | 14.1 | 7.5 | 2.0 | 0.8 | 0.3 |

*Note*. Percentages might not add to 100 due to rounding.

**Table 3.** Rural Hospital Nurse Skill Mix and Work Environment ($n = 76$ Hospitals).

| Independent variables | Mean | *SD* | Min | Max |
|---|---|---|---|---|
| Nurse skill mix | .72 | .11 | .45 | 1.0 |
| Nurse participation in hospital affairs | 2.46 | .31 | 1.65 | 3.15 |
| Nursing foundations for quality of care | 2.84 | .23 | 2.27 | 3.35 |
| Nurse manager ability, leadership, and support of nurses | 2.60 | .37 | 1.75 | 3.50 |
| Staffing and resource adequacy | 2.60e | .38 | 1.80 | 3.60 |
| Collegial nurse–physician relations | 2.89 | .26 | 2.20 | 3.67 |
| Nurse work environment composite | 2.68 | .26 | 2.15 | 3.35 |

*Note*. Minimum values refer to hospitals with the lowest PES-NWI subscale and composite scores in sample. Maximum values refer to hospitals with the highest PES-NWI subscale and composite scores in sample.

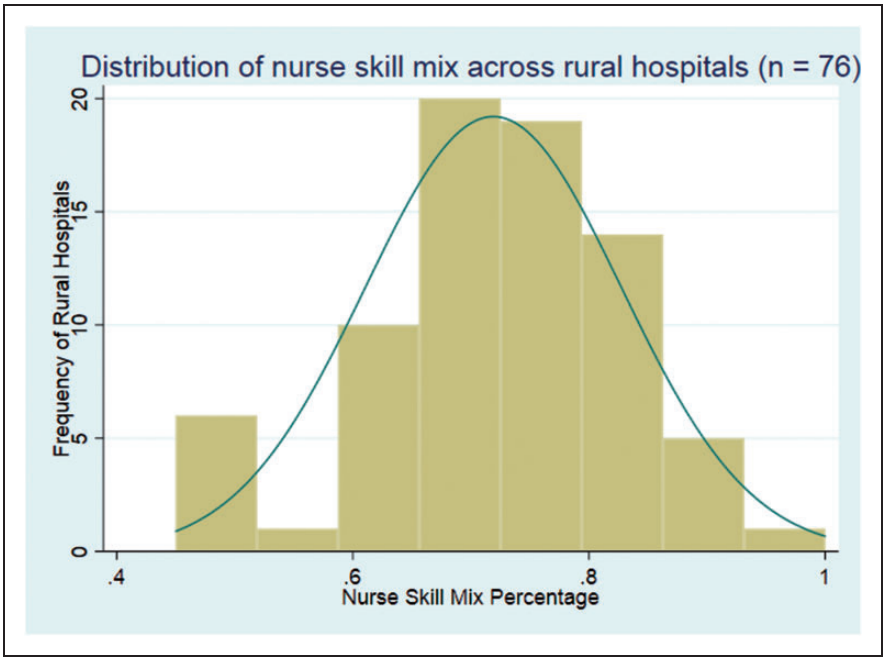


**Figure 1.** Distribution of skill mix across rural hospitals.

regression model, these coefficients did not change (Table 4).

An increase of one SD in the work environment score was associated with a reduction of 50% ($p < .01$) in the odds that a nurse reported falls with injury as occurring frequently. Each 10-point increase in the proportion of RNs among all nursing personnel was associated with a 27% ($p < .01$) decrease in falls with injury. In a joint logistic regression model, these coefficients did not change (Table 4).

An increase of one *SD* in the work environment score was associated with a reduction of 40% ($p < .01$) in the odds that a nurse reported UTIs as occurring frequently. Each 10-point increase in the proportion of RNs among all nursing personnel was associated with a 12% ($p < .01$) decrease in the odds of a UTI. In a joint logistic regression model, these coefficients did not change (Table 4).

## Discussion

We were motivated to understand how the proportion of RNs to all nursing staff and work environments in rural hospitals are associated with the frequency of nurse-reported adverse events, such as falls, pressure ulcers, medication errors, and UTIs. Rural hospitals with a higher proportion of RNs to all nursing staff, on average, were associated with a 19% reduced odds for medication errors, pressure ulcers, falls with injury, and UTIs. On average, better work environment ratings were associated with a 44% reduced odds of medication errors,

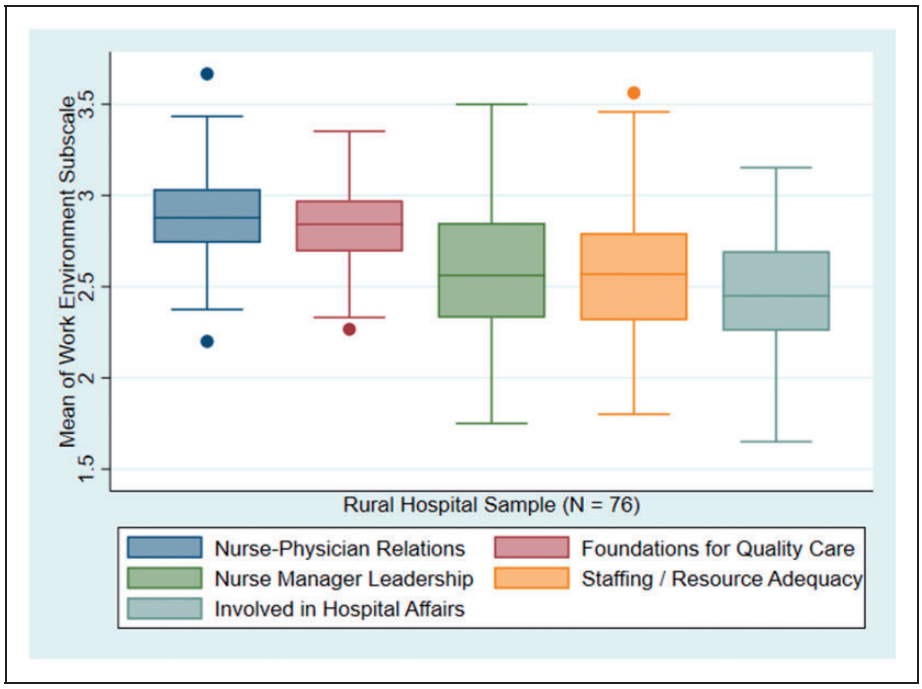


**Figure 2.** Distribution of work environment scores across rural hospitals.

pressure ulcers, falls with injury, and UTIs. In all models, the work environment had a stronger association than nursing skill mix with the occurrence of nurse-reported adverse events. Our evidence supports both improving the work environment and increasing the proportion of RNs to all nursing staff in rural hospitals as an avenue for improving outcomes.

The effects of an increased proportion of RNs to all nursing staff and better nurse work environments were almost identical across models to predict the four nurse-reported adverse events whether considered as single or joint predictors. Because the odds for adverse events did not change with both the proportion of RNs to all nursing staff and work environment were included as predictors in the same models, it is possible that these two organizational features contribute as independent factors to influence adverse event frequency in rural hospitals. This means that rural hospitals could benefit from decreased odds of adverse events through either making improvements to the nurse work environment or increasing the proportion of RNs to all licensed and unlicensed bedside nursing care staff.

Although work environments and an increased proportion of RNs to all nursing staff were both associated with significant reduced odds in adverse events in all models, the work environment had a stronger association with reduced odds of adverse events. This might be due to greater variation in work environments across rural hospitals. Given that increasing the number of RNs in relation to all licensed and unlicensed nursing staff might not be feasible in the short term, it may be reasonable to focus efforts on improving the work environment as a first step to reducing odds of adverse events. Supporting LVNs or LPNs to become RNs, or recruiting more RNs to work at rural hospitals, might be a multi-year effort. In contrast, improving the work environment over a period of months could be a more feasible first step to lowering the odds of adverse events. Although efforts to improve both of these organizational features may serve to reduce adverse events even more, logistical and financial limitations may necessitate a phased approach to the implementation. In addition, increasing the proportion of RNs to all nursing staff might affect hospital finances given the higher cost of RNs as compared to LPNs; therefore, work environment interventions may provide rural hospitals with a plan to begin addressing adverse events without further exacerbating financial challenges.

Nevertheless, our findings reveal that increasing the proportion of RNs to all nursing staff is a promising avenue for reducing the odds of nurse-reported adverse events. One standard increase in nursing skill mix was associated with a 19% average decrease in the odds of all nurse-reported events. This consistent pattern for all four adverse events supports improving the work environment and increasing the proportion of RNs to all nursing staff would be beneficial changes in efforts to reduce a wide range of adverse events. To illustrate this finding, consider a medical surgical nursing unit with 20 patients requiring 7 nursing personnel for bedside care: 5 licensed

**Table 4.** Odds Ratios Indicating the Effects of Nursing Skill Mix and Work Environments on Adverse Event Frequency in Rural Hospitals.

| | Adjusted bivariate models | | Adjusted joint models | |
|---|---|---|---|---|
| Rural hospital outcome | OR | 95% CI | OR | 95% CI |
| *Nurse-reported adverse events* | | | | |
| Medication error | | | | |
| Nurse work environment | 0.58** | 0.49–0.67 | 0.61** | 0.52–0.73 |
| Nurse skill mix | 0.79** | 0.72–0.87 | 0.80** | 0.73–0.88 |
| Pressure ulcer | | | | |
| Nurse work environment | 0.54** | 0.43–0.68 | 0.54** | 0.43–0.67 |
| Nurse skill mix | 0.80** | 0.74–0.87 | 0.81** | 0.75–0.88 |
| Fall with injury | | | | |
| Nurse work environment | 0.50** | 0.41–0.60 | 0.50** | 0.41–0.61 |
| Nurse skill mix | 0.73** | 0.67–0.79 | 0.74** | 0.68–0.80 |
| Urinary tract infection | | | | |
| Nurse work environment | 0.60** | 0.49–0.72 | 0.61** | 0.51–0.73 |
| Nurse skill mix | 0.88** | 0.81–0.94 | 0.89** | 0.82–0.96 |

*Note.* Adjusted models control for the effect of reports from critical access hospitals and hospitals that were also swing bed providers. The nurse work environment is standardized. The number of nurse respondents for all adverse event reports used in regression analyses ranged from 1,078–1,248. OR = odds ratio; CI = confidence interval.
**$p < .01$.

nurses and 2 UAPs. If the charge nurse and two bedside nurses are RNs, and two bedside nurses are LVNs or LPNs, then the unit skill mix is 43% RNs to all bedside nursing staff (i.e., 3 RNs/7 nurses = .43). In the same scenario, if an LVN or LPN were to have obtained RN licensure, the nursing skill mix would be 57% instead of 43%, a 14% increase in skill mix. Our findings support that such a 14% increase in nursing skill mix would be associated with an estimated 19% decrease in the odds of all nurse-reported adverse events, a practical and useful implication of this research.

Rural nurses rated involvement in hospital affairs as being unfavorable on average (mean = 2.46), with substantial variation between the lowest rating of 1.65 (unfavorable) and the highest rating of 3.15 (favorable). These score differences suggest that some rural hospitals provide more opportunities for nurses to participate in hospital affairs than other rural hospitals. Nurse involvement in hospital affairs were measured through determining the following as either favorable or unfavorable: staff nurse involvement in internal hospital governance (i.e., unit-based committees), staff nurse involvement in hospital policy decisions, staff nurse opportunities for advancement within the hospital, and staff nurse awareness if the chief nursing officer was equivalent in power to other hospital executives (Lake, 2002). To improve nurse involvement in hospital affairs, rural hospital administrators could invite bedside nurses to be members of joint decision-making groups composed of administration staff and direct care providers in the hospital. Such an effort would validate the important role of nurses, as continuous direct care providers, as health-care team members aware of threats to patient safety that need intervention for better patient safety and care quality. Our finding that nurse participation in hospital affairs is the lowest rated work environment subscale in rural hospitals differs from results found from a systematic review of studies that used the PES-NWI, as most settings rate staffing and resource adequacy as lowest across all settings globally (Warshawsky & Havens, 2011). This highlights the unique nursing resource needs of rural hospitals in the United States.

The variation between hospitals for nursing skill mix (range = 45%–72%) was notable. The hospital in our sample with a nursing skill mix of 45% is 27 percentage points lower than the hospital with nursing skill mix of 72%. This indicates a maldistribution of RNs across rural areas consistent with other studies (Jones et al., 2019) and raises a new question about how variations in nursing skill mix across rural hospitals might or might not be satisfactory given unique geographic area population-based needs. Future studies should examine potential associations between hospitals with different proportions of RNs to all other nursing staff and rural-relevant hospital patient outcomes, such as timely transfer to a higher level of care, to determine the significance of nursing skill mix variations in recent data. In addition, the effect of rural hospital nursing skill mix in consideration of patient-to-nurse ratios on rural patient outcomes needs to be studied.

The hospital average for prevalence of nurse-reported frequent fall rates with injury within our rural U.S.

hospital sample (15%) was lower than in other samples, though measurement methods might contribute to these differences. For example, researchers found a nurse-reported patient fall prevalence of 60.5% in Korean hospitals using a dichotomous "frequent" or "infrequent" variable created from a 4-point Likert-type scale to measure adverse events (Kang et al., 2014), whereas we used a 6-point Likert-type scale to create a dichotomous "frequent" or "infrequent" variable. Using the same 6-point Likert-type scale in this study, nurse survey data from 1998 and 1999 indicate that patient falls with injury were reported as frequent by 20.4% of nurses in the United States, 27.9% in Canada, and 15% in Germany (Aiken et al., 2001). Although the nurse-reported prevalence of frequent falls with injury within our sample of rural U.S. hospitals from three states (15%) was lower than a general U.S. sample (27.9%) from 1998 and 1999 nurse survey data, it is unclear how comparable these rates are given the time differences for when data were collected. Similar patterns were observed for the comparisons with the Korean sample (Kang et al., 2014) and the U.S. data from the late 1990s for pressures ulcers, nosocomial infections, and medication errors (Aiken et al., 2001).

## Strengths and Limitations

This study has limitations. The cross-sectional design limits causal inference. The sample of 76 hospitals is from three U.S. states; however, these three states are in three of the major geographic regions of the United States. We relied on nurse-reported adverse events, which are easier to obtain than from health records. Nurse estimates of quality have been shown to be valid and liked to mortality (McHugh & Stimpfel, 2012). Future studies could confirm these results using health record data. Once confirmed, studies could introduce work environment improvements to potentially reduce adverse events. Consistent with the Quality Health Outcomes Model, our emphasis was on understanding structural factors of the nurses' work environment rather on psychological and individual factors. Using a systems framework without accounting for the potential influence of psychological and individual factors might be another limitation.

The nurse survey data we used were collected from 2005 to 2008, representing a major limitation. Health care is a fast-growing area. Policies and procedures are constantly changing. Although AHA Annual Survey data and AHA Hospital Statistics™ data are available annually, more recent hospital-level data on rural nursing skill mix, work environments, and nurse-reported adverse events from this many rural hospitals across four large states were not available. The age of the nurse survey data required the use of AHA data from 2006 to link the data sets for determining which hospitals were rural. Despite the data being over a decade old, our findings using these data are novel because the joint influence of rural nursing skill mix and work environments has not been published elsewhere in the literature to our knowledge. Our results using data from 2005 to 2008 inform a need to determine the extent to which rural work environments and nursing skill mix might be associated with adverse events in a more recent multihospital data set. It is important to determine if changes have occurred over time in rural nursing skill mix and work environments, possibly due to changes in the health-care system over the past decade (i.e., health-care reform), to inform evidence-based health policy recommendations for improving patient outcomes.

In addition, we also acknowledge that the nurse survey data from 2005 to 2008 do not provide information about the rural hospital nursing resources after the implementation of the Affordable Care Act. However, rural health-care research experts continue to acknowledge that the under-resourced nature of rural health care, and continued difficulties that rural residents face in accessing health care today, remain a significant challenge (Bolin et al., 2015). These persistent challenges point to the need to consider this evidence that improving nurse work environments and increasing the proportion of RNs to all nursing staff might be beneficial modifications to improve rural patient care. This evidence will also provide rural health researchers with baseline evidence to determine if these relationships are persistent in data sets that are more recent.

## Implications for Practice

Although nurses are one of the most expensive costs for hospitals (Aiken et al., 2017), the immediate costs associated with increasing the proportion of RNs to all nursing staff might be buffered by long-term savings in health-care dollars through the prevention of adverse events. One immediate solution to increased health-care costs that might be attractive to hospital administrators would be to decrease the largest costs of the hospital budget, wages of nurses (Aiken et al., 2017). For example, in an effort to contain costs, hospitals might hire fewer RNs, which thus lowers the proportion of RNs to all nursing staff, and increases the number of nursing assistants. This approach, however, may not be in the best interest for hospitals interested in optimizing value because of the potential consequences of poorer quality that may result from a skill mix with fewer nurse. It might be possible that hiring fewer RNs to total nursing staff decreases immediate, short-term costs, but this approach omits an intangible but important theoretical and empirical premise that highly skilled nursing staff are associated with better health outcomes and might prevent costly medical errors that could spiral out of control far beyond the cost of base nurse wages.

## Conclusion

Hospitals that serve rural populations must contend with financial and epidemiological challenges unique from their urban counterparts. These challenges relate to the financial viability of their operation, the acquisition of well-trained experienced human resources, and providing high value care to populations that can be disproportionately vulnerable. To overcome these challenges, it is imperative that these hospitals invest in resources that will optimize their efficiency and quality of care. Investments to increase the proportion of RNs to all nursing staff and improve the work environment in rural settings can serve as strategies to reduce adverse events. Our findings add to similar studies with samples from more sizable population centers thus further supporting these as promising strategies. This article provides a clear opportunity for rural health system administrators and policy to improve the work environment and increase the proportion of RNs to all nursing staff as a means to improve the health and safety of rural populations.

### Acknowledgments

The authors would like to acknowledge Jesse Chittams, data analysist at the University of Pennsylvania's Center for Health Outcomes and Research Policy, for statistical analyses consultation.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study received funding from the National Institute of Nursing Research, National Institutes of Health (T32-NR-007104 and R01NR014855, L. Aiken, PI). This study was also supported by the Inaugural Nursing Policy Research Grant from the Texas Nurses Foundation, and the Virginia S. Cleland Scholar, Joyce J. Fitzpatrick Endowed Leadership Research Fund from the American Nurses Foundation.

### ORCID iD

Jessica G. Smith https://orcid.org/0000-0003-4769-1905

### References

Aiken, L. H. (2002). Superior outcomes for magnet hospitals: The evidence base. In M. L. McClure & A. S. Hinshaw (Eds.), *Magnet hospitals revisited: Attraction and retention of professional nurses* (pp. 61–81). Washington, DC: American Nurses Publishing.

Aiken, L. H., Cimiotti, J. P., Sloane, D. M., Smith, H. L., Flynn, L., & Neff, D. F. (2011). Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Medical Care*, *49*(12), 1047–1053. doi:10.1097/MLR.0b013e3182330b6e

Aiken, L. H., Clarke, S. P., Cheung, R. B., Sloane, D. M., & Silber, J. H. (2003). Educational levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association*, *290*(12), 1617–1623. doi:10.1001/jama.290.12.1617

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J. A., Busse, R., Clarke, H., . . . Shamian, J. (2001). Nurses' reports on hospital care in five countries. *Health Affairs*, *20*(3), 43–53. doi:10.1377/hlthaff.20.3.43

Aiken, L. H., Sloane, D., Griffiths, P., Rafferty, A. M., Bruyneel, L., McHugh, M., . . . Sermeus, W. (2017). Nursing skill mix in European hospitals: Cross-sectional study of the association with mortality, patient ratings, and quality of care. *British Medical Journal of Quality and Safety*, *26*(7), 559–568. doi:10.1136/bmjqs-2016-005567

Baernholdt, M. (2018). Fall rates in urban and rural nursing units: Does location matter? *Journal of Nursing Care Quality*, *33*(4), 326–333. doi:10.1097/NCQ.0000000000000319

Baernholdt, M., Jennings, B. M., Merwin, E., & Thornlow, D. (2010). What does quality care mean to nurses in rural hospitals? *Journal of Advanced Nursing*, *66*(6), 1346–1355. doi:10.1111/j.1365-2648.2010.05290.x

Baernholdt, M., & Mark, B. A. (2009). The nurse work environment, job satisfaction and turnover rates in rural and urban nursing units. *Journal of Nursing Management*, *17*(8), 994–1001. doi:10.1111/j.1365-2834.2009.01027.x

Blumenthal, D., & Jena, A. B. (2013). Hospital value-based purchasing. *Journal of Hospital Medicine*, *8*(5), 271–277.

Bolin, J. N., Bellamy, G. R., Ferdinand, A. O., Vuong, A. M., Kash, B. A., Schulze, A., & Helduser, J. W. (2015). Rural healthy people 2020: New decade, same challenges. *The Journal of Rural Health*, *31*(3), 326–333. doi:10.1111/jrh.12116

Butcher, H. K., Bulechek, G. M., Dochterman, J. M. M., & Wagner, C. (2018). *Nursing interventions classification* (7th ed.). St. Louis, MO: Elsevier.

Centers for Medicare and Medicaid Services. (2017). *Swing bed providers*. Retrieved from https://www.cms.gov/medicare/medicare-fee-for-service-payment/snfpps/swingbed.html

Cline, D. D., Dickson, V. V., Kovner, C., Boltz, M., Kolanowski, A., & Capezuti, E. (2014). Factors influencing RNs' perceptions of quality geriatric care in rural hospitals. *Western Journal of Nursing Research*, *36*(6), 748–768. doi:10.1177/0193945913513505

Copanitsanou, P., Fotos, N., & Brokalaki, H. (2017). Effects of work environment on patient and nurse outcomes. *British Journal of Nursing*, *26*(3), 172–176. doi:10.12968/bjon.2017.26.3.172

Dall, T. M., Chen, Y. J., Seifert, R. F., Maddox, P. J., & Hogan, P. F. (2009). The economic value of professional nursing. *Medical Care*, *47*(1), 97–104. doi:10.1097/MLR.0b013e3181844da8

Duffield, C., Diers, D., O'Brien-Pallas, L., Aisbett, C., Roche, M., King, M., & Aisbett, K. (2011). Nursing staffing, nursing workload, the work environment and patient outcomes.

*Applied Nursing Research*, *24*(4), 244–255. doi:10.1016/j.apnr.2009.12.004

Estabrooks, C. A., Midodzi, W. K., Cummings, G. G., Ricker, K. L., & Giovannetti, P. (2005). The impact of hospital nursing characteristics on 30-day mortality. *Journal of Nursing Research*, *54*(2), 74–84.

Flex Monitoring Team. (2018). *Critical access hospital locations*. Retrieved from http://www.flexmonitoring.org/data/critical-access-hospital-locations/

Griffiths, P., Ball, J., Bloor, K., Bohning, D., Briggs, J., Dall'Ora, C.,... Smith, G. (2018). Nurse staffing levels, missed vital signs and mortality in hospitals: Retrospective longitudinal observational study. *Health Services and Delivery Research* (vol. 6). Southampton, UK: NIHR Journals Library.

Hart, L. G., Larson, E. H., & Lishner, D. M. (2005). Rural definitions for health policy and research. *American Journal of Public Health*, *95*(7), 1149–1155. doi:10.2105/AJPH.2004.042432

Hart, P., & Davis, N. (2011). Effects of nursing care and staff skill mix on patient outcomes within acute care nursing units. *Journal of Nursing Care Quality*, *26*(2), 161–168. doi:10.1097/NCQ.0b013e3181efc9cb

Havens, D. S., Warshawsky, N., & Vasey, J. (2012). The nursing practice environment in rural hospitals: Practice Environment Scale of the Nursing Work Index assessment. *Journal of Nursing Administration*, *42*(11), 519–525. doi:10.1097/NNA.0b013e3182714506

Henneman, E. A., Gawlinski, A., Blank, F. S., Henneman, P. L., Jordan, D., & McKenzie, J. B. (2010). Strategies used by critical care nurses to identify, interrupt, and correct medical errors. *American Journal of Critical Care*, *19*(6), 500–509. doi:10.4037/ajcc2010167

Henneman, E. A., Gawlinski, A., & Giuliano, K. K. (2012). Surveillance: A strategy for improving patient safety in acute and critical care units. *Critical Care Nurse*, *32*(2), e9–e18. doi:10.4037/ccn2012166

International Council of Nurses. (2018). *Position statement: Evidence-based safe nurse staffing*. Geneva, Switzerland: International Council of Nurses.

Jacob, E. R., McKenna, L., & D'Amore, A. (2015). The changing skill mix in nursing: Considerations for and against different levels of nurse. *Journal of Nursing Management*, *23*(4), 421–426. doi:10.1111/jonm.12162

Joint Commission. (2016). *Sentinel events*. Retrieved from https://www.jointcommission.org/assets/1/6/camh_24_se_all_current.pdf

Jones, T. L., Yoder, L. H., & Baernholdt, M. (2019). Variation in academic preparation and progression of nurses across the continuum of care. *Nursing Outlook*. doi:10.1016/j.outlook.2019.02.008

Kane, R. L., Shamliyan, T. A., Mueller, C., Duval, S., & Wilt, T. J. (2007). The association of registered nurse staffing levels and patient outcomes: Systematic review and meta-analysis. *Medical Care*, *45*(12), 1195–1204. doi:10.1097/MLR.0b013e3181468ca3

Kang, J. H., Kim, C. W., & Lee, S. Y. (2014). Nurse-perceived patient adverse events and nursing practice environment. *Journal of Preventive Medicine and Public Health. Yebang Uihakhoe Chi*, *47*(5), 273–280. doi:10.3961/jpmph.14.019

Kelly, D., Kutney-Lee, A., Lake, E. T., & Aiken, L. H. (2013). The critical care work environment and nurse-reported health care-associated infections. *American Journal of Critical Care*, *22*(6), 482–488. doi:10.4037/ajcc2013298

Kelly, L., & Vincent, D. (2011). The dimensions of nursing surveillance: A concept analysis. *Journal of Advanced Nursing*, *67*(3), 652–661. doi:10.1111/j.1365-2648.2010.05525.x

Kirwan, M., Matthews, A., & Scott, P. A. (2013). The impact of the work environment of nurses on patient safety outcomes: A multi-level modelling approach. *International Journal of Nursing Studies*, *50*(2), 253–263. doi:10.1016/j.ijnurstu.2012.08.020

Krebs, J. P., Madigan, E. A., & Tullai-McGuinness, S. (2008). The rural nurse work environment and structural empowerment. *Policy, Politics, & Nursing Practice*, *9*(1), 28–39. doi:10.1177/1527154408316255

Lake, E. T. (2002). Development of the Practice Environment Scale of the Nursing Work Index. *Research in Nursing and Health*, *25*(3), 176–188. doi:10.1002/nur.10032

Lucero, R. J., Lake, E. T., & Aiken, L. H. (2010). Nursing care quality and adverse events in US hospitals. *Journal of Clinical Nursing*, *19*(15–16), 2185–2195. doi:10.1111/j.1365-2702.2010.03250.x

MacPhee, M., & Scott, J. (2002). The role of social support networks for rural hospital nurses: Supporting and sustaining the rural nursing work force. *Journal of Nursing Administration*, *32*(5), 264–272.

Makary, M. A., & Daniel, M. (2016). Medical error-the third leading cause of death in the US. *BMJ*, *353*, i2139doi:10.1136/bmj.i2139

McHugh, M. D., Berez, J., & Small, D. S. (2013). Hospitals with higher nurse staffing had lower odds of readmissions penalties than hospitals with lower staffing. *Health Affairs*, *32*(10), 1740–1747. doi:10.1377/hlthaff.2013.0613

McHugh, M. D., & Stimpfel, A. W. (2012). Nurse reported quality of care: A measure of hospital quality. *Research in Nursing and Health*, *35*(6), 566–575. doi:10.1002/nur.21503

Meraviglia, M., Grobe, S. J., Tabone, S., Wainwright, M., Shelton, S., Miner, H., & Jordan, C. (2009). Creating a positive work environment: Implementation of the nurse-friendly hospital criteria. *Journal of Nursing Administration*, *39*(2), 64–70. doi:10.1097/NNA.0b013e318195a82b

Mitchell, P. H., Ferketich, S., & Jennings, B. M. (1998). Quality health outcomes model. *Image: The Journal of Nursing Scholarship*, *30*(1), 43–46.

National Provider Identifier Database. (2018). *NPI Lookup Medicare defined swing bed unit*. Retrieved from https://npidb.org/organizations/hospital_units/medicare-defined-swing-bed-unit_275n00000x/

Newhouse, R. P. (2005). Exploring nursing issues in rural hospitals. *Journal of Nursing Administration*, *35*(7–8), 350–358.

Newhouse, R. P., Morlock, L., Pronovost, P., Colantuoni, E., & Johantgen, M. (2009). Rural hospital nursing: Better environments = shared vision and quality/safety engagement. *Journal of Nursing Administration*, *39*(4), 189–195. doi:10.1097/NNA.0b013e31819c9cd5

Newhouse, R. P., Morlock, L., Pronovost, P., & Sproat, S. B. (2011). Rural hospital nursing: Results of a national survey

of nurse executives. *Journal of Nursing Administration*, *41*(3), 129–137. doi:10.1097/NNA.0b013e31820c7212

Olds, D. M., Aiken, L. H., Cimiotti, J. P., & Lake, E. T. (2017). Association of nurse work environment and safety climate on patient mortality: A cross-sectional study. *International Journal of Nursing Studies*, *74*, 155–161. doi:10.1016/j.ijnurstu.2017.06.004

Patrician, P. A., Loan, L., McCarthy, M., Fridman, M., Donaldson, N., Bingham, M., & Brosch, L. R. (2011). The association of shift-level nurse staffing with adverse patient events. *Journal of Nursing Administration*, *41*(2), 64–70. doi:10.1097/NNA.0b013e31820594bf

Ryan, A. M., Krinsky, S., Maurer, K. A., & Dimick, J. B. (2017). Changes in hospital quality associated with hospital value-based purchasing. *New England Journal of Medicine*, *376*(24), 2358–2366. doi:10.1056/NEJMsa1613412

Smith, J. G., Plover, C. M., McChesney, M. C., & Lake, E. T. (2019). Isolated, small, and large hospitals have fewer nursing resources than urban hospitals: Implications for rural health policy. *Public Health Nursing*. Advance Online Publication. doi:10.1111/phn.12612

Staggs, V. S., Olds, D. M., Cramer, E., & Shorr, R. I. (2017). Nursing skill mix, nurse staffing level, and physical restraint use in US hospitals: A longitudinal study. *Journal of General Internal Medicine*, *32*(1), 35–41. doi:10.1007/s11606-016-3830-z

Stalpers, D., de Brouwer, B. J., Kaljouw, M. J., & Schuurmans, M. J. (2015). Associations between characteristics of the nurse work environment and five nurse-sensitive patient outcomes in hospitals: A systematic review of literature. *International Journal of Nursing Studies*, *52*(4), 817–835. doi:10.1016/j.ijnurstu.2015.01.005

Sullivan Havens, D., Warshawsky, N. E., & Vasey, J. (2013). RN work engagement in generational cohorts: The view from rural US hospitals. *Journal of Nursing Management*, *21*(7), 927–940. doi:10.1111/jonm.12171

The Council of State Governments. (2011). *Health care workforce shortages critical in rural America*. Retrieved from https://knowledgecenter.csg.org/kc/content/health-care-workforce-shortages-critical-rural-america

Twigg, D., Duffield, C., Bremner, A., Rapley, P., & Finn, J. (2012). Impact of skill mix variations on patient outcomes following implementation of nursing hours per patient day staffing: A retrospective study. *Journal of Advanced Nursing*, *68*(12), 2710–2718. doi:10.1111/j.1365-2648.2012.05971.x

Voepel-Lewis, T., Pechlavanidis, E., Burke, C., & Talsma, A. N. (2013). Nursing surveillance moderates the relationship between staffing levels and pediatric postoperative serious adverse events: A nested case-control study. *International Journal of Nursing Studies*, *50*(7), 905–913. doi:10.1016/j.ijnurstu.2012.11.014

Warshawsky, N. E., & Havens, D. S. (2011). Global use of the Practice Environment Scale of the Nursing Work Index. *Journal of Nursing Research*, *60*(1), 17–31. doi:10.1097/NNR.0b013e3181ffa79c

Wei, H., Sewell, K. A., Woody, G., & Rose, M. A. (2018). The state of the science of nurse work environments in the United States: A systematic review. *International Journal of Nursing Sciences*, *5*(3), 287–300. doi:10.1016/j.ijnss.2018.04.010

Welton, J. M., Unruh, L., & Halloran, E. J. (2006). Nurse staffing, nursing intensity, staff mix, and direct nursing care costs across Massachusetts hospitals. *Journal of Nursing Administration*, *36*(9), 416–425.

Yang, P. H., Hung, C. H., Chen, Y. M., Hu, C. Y., & Shieh, S. L. (2012). The impact of different nursing skill mix models on patient outcomes in a respiratory care center. *Worldviews on Evidence-Based Nursing*, *9*(4), 227–233. doi:10.1111/j.1741-6787.2012.00246.x