Received: 20 October 2020 | Revised: 15 January 2021 | Accepted: 13 February 2021

DOI: 10.1002/nur.22121

RESEARCH ARTICLE

RESEARCH IN NURSING & HEALTH WILEY

Better nurse work environments associated with fewer readmissions and shorter length of stay among adults with ischemic stroke: A cross-sectional analysis of United States hospitals

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Funding information
National Institutes of Health, Grant/Award Numbers: MD011518, R01NR014855, R01NR016002, T32NR007104

Abstract

Stroke is among the most common reasons for disability and death. Avoiding readmissions and long lengths of stay among ischemic stroke patients has benefits for patients and health care systems alike. Although reduced readmission rates among a variety of medical patients have been associated with better nurse work environments, it is unknown how the work environment might influence readmissions and length of stay for ischemic stroke patients. Using linked data sources, we conducted a cross-sectional analysis of 543 hospitals to evaluate the association between the nurse work environment and readmissions and length of stay for 175,467 hospitalized adult ischemic stroke patients. We utilized logistic regression models for readmission to estimate odds ratios (OR) and zero-truncated negative binomial models for length of stay to estimate the incident-rate ratio (IRR). Final models accounted for hospital and patient characteristics. Seven and 30-day readmission rates were 3.9% and 10.1% respectively and the average length of stay was 4.9 days. In hospitals with better nurse work environments ischemic stroke patients experienced lower odds of 7- and 30-day readmission (7-day OR, 0.96; 95% confidence interval [CI]: 0.93–0.99 and 30-day OR, 0.97; 95% CI: 0.94–0.99) and lower length of stay (IRR, 0.97; 95% CI: 0.95–0.99). The work environment is a modifiable feature of hospitals that should be considered when providing comprehensive stroke care and improving post-stroke outcomes.

KEYWORDS

ischemic stroke, length of stay, nurse work environment, readmission

1 | INTRODUCTION

Globally, stroke is the second highest cause of death and third highest reason for disability (Benjamin et al., 2017; Gorelick, 2019). Despite acute stroke management being highly protocolized, variation still exists with regard to patient outcomes (Kaufman et al., 2019; Messé et al., 2016). For example, readmission rates among stroke patients are as high as 13% with most readmissions being unplanned and many avoidable (Bambhroliya et al., 2018; Vahidy et al., 2017). Variations in outcomes, including readmissions and length of stay, have been attributed to patient factors, including age and underlying general health (Doyle et al., 2013; Okere et al., 2016; Shkirkova et al., 2020; Thompson et al., 2017). Additionally, readmissions in the immediate post-discharge time period may reflect unresolved

problems in the hospital and poor discharge planning (Camicia & Lutz, 2016; Lichtman et al., 2013). In a recent report, the Centers for Disease Control called for further evaluation of system-level factors that may result in variation in stroke outcomes (Adeoye et al., 2019; Centers for Disease Control and Prevention, 2018). In the few studies examining system-level factors, investigators have focused on the availability of stroke physician specialists and stroke center status (Doyle et al., 2013; Okere et al., 2016; Shkirkova et al., 2020; Thompson et al., 2017). Nurses are an integral part of health care systems and provide around the clock monitoring and management to stroke patients, though few investigators have examined nursing's influence on stroke outcomes (Camicia & Lutz, 2016; Summers et al., 2009). In studies considering nursing's influence on stroke outcomes, investigators have focused on nurse staffing and post-stroke mortality and found that in settings with richer staffing resources, patient mortality was lower (Bray et al., 2014; Cho & Yun, 2009). However, results from these studies suggest that even with optimal staffing, nurses may be unable to assess or appropriately intervene without adequate organizational supports, such as the work environment (Aiken et al., 2011; McHugh et al., 2016). In this study we examine the relationship between stroke patient outcomes and the nurse work environment.

The nurse work environment represents an organizational property of hospitals that signifies the degree to which health systems constrain or enhance the professional practice of nursing (Lake, 2002). For example, in hospitals with better work environments for nurses, administrators support nurses' decision making, prioritize nurses' autonomy over their practice, and facilitate collegial relationships among nurses, physicians and administrators. In many studies and a recent meta-analysis, the results have indicated a relationship between better work environments and several patient outcomes, such as failure to rescue, mortality and readmissions (Brooks Carthon et al., 2015; Lake et al., 2019; Lasater & McHugh, 2016; Ma et al., 2015; McHugh & Ma, 2013; McHugh et al., 2016; Sloane et al., 2018). In a study of 495 hospitals, Lasater and McHugh (2016) found that hospitals where there are better nurse work environments, knee and hip replacement patients experienced 12% lower odds of 30-day readmission versus those cared for in hospitals with poor work environments. Similarly, McHugh & Ma demonstrated 7%–10% lower odds of readmissions for pneumonia, heart failure and myocardial infraction patients when they were cared for in better hospitals (McHugh & Ma, 2013).

1.1 | The nurse work environment and ischemic stroke patients

Ischemic stroke patients face a variety of challenges including new medication regimens and temporary or permanent deficits in their activities of daily living. Bedside nurses are on the frontline of helping patients and families learn and adapt to their new circumstances. As they interact with patients and families at this critical time, they are key informants to the healthcare team, advocating for and communicating the care needs of ischemic stroke patients (Camicia & Lutz, 2016). Creating good work environments for nurses is especially important so that they have adequate time to spend with stroke patients, are able to communicate effectively with all team members and feel supported by managers to make decisions about nursing care. All of these aspects of the nurse work environment facilitate an effective and efficient discharge planning process, which has the potential to decrease delays in discharge and avoidable readmissions (Gonçalves-Bradley et al., 2016). Conversely, nurses working in poor work environments, may lack the time or organizational support to devote to patient education and discharge planning as they instead prioritize other acute medical needs (Brooks Carthon et al., 2019).

We build on prior research through an examination of the relationship between readmission and length of stay for ischemic stroke patients and the nurse work environment, using data from 543 hospitals. The results of this study provide new scientific knowledge based on an examination of the nurse work environment, which may be regarded as a modifiable aspect of health care systems that can be optimized to improve outcomes for ischemic stroke patients. Though nursing care is recognized as an important component of optimal stroke management, most studies entailed a focus on the delivery of specific aspects of stroke care, rather than examining nursing as a systemwide intervention to improve stroke outcomes. Accordingly, the aim of our study was to examine whether hospitals with better nurse work environments were associated with lower 7- and 30-day readmission and shorter length of stay among ischemic stroke patients.

2 | METHODS

2.1 | Design

We conducted a cross-sectional study of data on 543 hospitals located in four states (California, Florida, New Jersey and Pennsylvania) and 175,467 ischemic stroke patients cared for in these hospitals. Data were linked together from four sources from 2015 to 2016 using a common hospital identifier including data from patient's hospitalization records from state offices, the American Hospital Association's Annual Survey of hospitals, survey data of nurses working in hospitals and the American Heart Association's listing of Primary and Comprehensive Stroke Centers.

2.2 | Setting and sample

2.2.1 | Hospitals

The sample included hospitals located in the four states that responded to the 2015 American Hospital Association Annual Survey, had 10 or more nurses respond to the nurse survey and were categorized as adult nonfederal acute care hospitals. Data from

registered nurses (n = 20,913) were collected through the RN4CAST-US, conducted by the University of Pennsylvania. A modified Dillman sampling approach was employed and surveys were sent directly to homes of a random sample of 231,000 nurses in the four states holding active registered nurse licenses (Dillman et al., 2014). The response rate was 26% (n = 52,510) and additional details regarding survey methodology were published elsewhere (Lasater et al., 2019; Sloane et al., 2018). The nurse survey asked questions related to demographics, workload and the work environment. Additionally, nurses were asked to provide detailed information about their site of employment, allowing responses across nurses to be combined at the hospital level. On average there were 38.5 nurse respondents (range: 10–204) per study hospital.

The American Hospital Association Annual Survey was used to account for additional hospital characteristics, including organizational, structural, and financial measures that may be associated with nursing measures and patient outcomes. The American Heart Association's website was utilized to identify hospitals that are designated as Primary or Comprehensive Stroke Center Certified (American Heart Association, 2019).

2.3 | Patients

State agencies provided patient discharge data including the Pennsylvania Health Care Cost Containment office, Florida's the Agency for Health Care Administration, the Office of Statewide Health Planning and Development in California and the New Jersey Department of Health and Senior Services. The patient discharge data included demographics, length of stay, discharge disposition and primary and secondary diagnosis and procedure codes based on the *International Classification of Diseases (ICD) 9th Revision Clinical Medication* for admissions before October 1, 2015 and ICD-10 codes for admissions on and after October 1, 2015. See Table S1 for a list of included ICD-9 and ICD-10 diagnosis codes. The sample included patients who were hospitalized and had a primary diagnosis of ischemic stroke from January 2015 to December 2016. Patients were excluded if they were (1) under the age of 18; (2) experienced a hemorrhagic stroke; (3) left against medical advice, transferred to another hospital or died while in the hospital (study sample n = 175,467; Yale New Haven Health Services Corporation–Center for Outcomes Research and Evaluation, 2017).

2.4 | Variables and measures

2.4.1 | Outcome variables

The primary outcome variables were all-cause 7- and 30-day readmission from an index admission for ischemic stroke and length of stay for the index admission measured at the patient-level. The index admission was defined as the patient's first admission during the study period and based on the Centers for Medicare and Medicaid Services Risk-Standardization Readmission Measures (Yale New Haven Health Services Corporation–Center for Outcomes Research and Evaluation, 2017). Each patient is assigned their own pseudo-identifier. Therefore, readmissions were identified irrespective of the hospitals they were readmitted to. To be consistent with the Centers for Medicare and Medicaid Services readmission measurement, we excluded patients who left against medical advice, were transferred to another hospital or who died during the hospitalization (Yale New Haven Health Services Corporation–Center for Outcomes Research and Evaluation, 2017). Length of stay was measured in days from date of admission to date of discharge.

2.4.2 | Explanatory variable

The nurse work environment was the primary explanatory variable of interest and was measured at the hospital-level. It was derived from the RN4CAST-US using the validated and reliable practice environment scale of the nursing work index (PES-NWI; Lake & Friese, 2006; Lake, 2002; Lake, 2007). The PES-NWI includes 31 items, which ask nurses the extent they agree whether certain organizational features existed in their work environments. There are five subscales that represent the domains of foundations for quality of care, nurse manager leadership, participation in hospital affairs, relations between nurses and physicians, and staffing and resource adequacy. Nurse responses to individual items were averaged to create the subscales. Next, nurses' scores of the subscales were averaged to the hospital-level. A continuous measure of the work environment was a hospital-level average of all five subscales. Finally, for descriptive purposes, hospitals were categorized based on how many subscales were above the median. In “poor” hospitals zero or one subscales were higher than the median, in “mixed” hospitals two or three were higher than the median and in “best” hospitals four or five were higher than the median (Aiken et al., 2008; McHugh et al., 2011).

2.4.3 | Potentially confounding variables (measured at the hospital-level)

We included control variables that have been shown to be associated with patient outcomes in prior work and to account for other potentially confounding structural hospital factors (e.g., teaching status, size, technology status, stroke center status) as well as nurse staffing (Aiken et al., 2002; Bambhroliya et al., 2018; Lasater & McHugh, 2016). The number of beds determined hospital size (<250, 251–500, and >500 beds). The ratio of residents or fellows to beds was used to define teaching status, which was categorized as major (>1:4 resident/fellow-to-bed ratio), minor (≤1:4 resident/fellow-to-bed ratio) and nonteaching (no postgraduate trainees). Hospitals that offer open-heart surgery, major organ transplant, or both are categorized as high technology. An indicator variable was included for hospitals that were designated as Comprehensive Stroke Center or Primary Stroke

Center Certified by the American Heart Association/American Stroke Association and The Joint Commission accrediting organizations (American Heart Association, 2019). Hospitals with these designations have met several standards, such as establishing acute stroke teams, diagnostic testing capabilities and continuing education requirements. We additionally accounted for geographic location by account for the state in which the hospital was located and whether it was located in an urban area.

The nurse survey provided information on nurse staffing. Each nurse surveyed reported the numbers of patients and nurses on the unit the last shift the nurse worked. We created the staffing measure by dividing the average number of patients reported by nurses by the average number of nurses on the unit for that same shift. We then aggregated these reports across staff nurses in a given hospital to estimate average hospital nurse staffing. We also adjusted for the number of nurses in the hospital from the nurse survey who worked in medical–surgical units and the number of nurses who worked in intensive care units.

2.5 | Risk adjustment

We also accounted for 34 patient characteristics including gender, age, race, whether they transferred into the hospital, discharge disposition and 29 Elixhauser comorbidities based on prior work and Centers for Medicare and Medicaid Services Risk-Standardization Readmission Measures (Barnett et al., 2015: Elixhauser et al., 1998: Lichtman et al., 2013: Yale New Haven Health Services Corporation – Center for Outcomes Research and Evaluation, 2017).

2.6 | Analysis

First, summary statistics were computed for patient characteristics. Next, hospital characteristics were described by level of nurse work environment using χ^2 tests for categorical variables and analysis of variance for continuous variables. To determine the association between patient outcomes (7- and 30-day readmissions and length of stay) and the nurse work environment several regression models were fit. To determine the odds on 7- and 30-day readmissions logistic regression was used. Due to the absence of zero values and overdispersion in hospital length of stay, zero-truncated negative binomial regression models were used for this outcome (Cameron, 1998). In these models, relative length of stay was expressed as incidence-rate ratios. The work environment was treated as a continuous variable and in standard deviation units to ease the interpretation of the effects of the work environment on the patient outcomes. The first series of models examined the association between work environment and each outcome (individually). Additional models accounted for patient characteristics, and finally adjusted for hospital characteristics. All models accounted for clustering of patients within hospitals using the Huber-White sandwich estimator (Rogers, 1994). STATA 15 was used for all analyses.

TABLE 1 Ischemic stroke patient characteristics (N = 175,467)

Sample characteristics	*n* or mean	Percent or *SD*
Readmission within 7 days	6,865	3.9%
Readmission within 30 days	17,720	10.1%
Length of stay	4.9	8.1
Age (in years)	71.8	14.1
Total comorbidities	3.0	1.7
Race and ethnicity		
White	113,679	64.8%
Black	23,959	13.6%
Hispanic	22,830	13.0%
Other	12,928	7.4%
Male	87,017	49.6%
Transfer	7,357	4.2%
Top five comorbidities		
Hypertension	150,340	85.7%
Diabetes, uncomplicated	42,669	24.3%
Renal failure	28,081	16.0%
Fluid and electrolyte disorders	36,391	20.7%
Chronic pulmonary disease	25,693	14.6%
Discharge disposition		
Home	64,213	36.6%
Skilled nursing facility	39,553	22.5%
Home with homecare	27,507	15.7%
Another type of facility	43,312	24.7%
Intermediate care	750	0.4%

Note: Percentages may not equal 100% due to missing. Comorbidities based on Elixhauser. N = count.

2.7 | Informed consent and ethical approval

Consent was obtained from nurses participating in the RN4CAST-US. Informed consent of patients was waived due to deidentification of their data in the state discharge files. Our Institutional Review Board approved this study.

3 | RESULTS

There were 175,467 patients who experienced an admission for ischemic stroke in our data. Table 1 contains the demographic characteristics of the sample. On average patients were 71.8 years old (standard deviation [SD] = 14.1), 49.6% were male and 64.8% were white. Patients on average had 3.0 comorbidities (SD = 1.7) with the top comorbidity being hypertension (85.7%). The 7- and 30-day readmission rates were 3.9% and 10.1%, respectively, and length of stay was on average 4.9 days (SD = 8.1).

Characteristics of 543 study hospitals overall and by level of nurse work environment are included in Table 2. Nurses had fewer patients

TABLE 2 Hospital characteristics where ischemic stroke patients receive care

Characteristic	Hospitals (n = 543)		Nurse work environment: Poor (n = 213, 39.2%)		Mixed (n = 126, 23.2%)		Best (n = 204, 37.6%)		p
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	
Nurse staffing (patients/nurse)	4.4	1.0	4.6	1.1	4.5	1.2	4.2	0.9	<0.001
Work environment	2.7	0.2	2.5	0.1	2.7	0.1	3.0	0.1	<0.001
	n	%	*n*	%	*n*	%	*n*	%	
Bed size									<0.001
Small	45	8.3	15	33.3	11	24.4	19	42.2	
Medium	227	41.8	97	42.7	70	30.8	60	26.4	
Large	271	49.9	101	37.3	45	16.6	125	46.1	
Teaching status									<0.001
None	222	40.9	71	32.0	56	25.2	95	42.8	
Minor	255	47.0	125	49.0	57	22.3	73	28.6	
Major	49	9.0	13	26.5	8	16.3	28	57.1	
Technology status									0.112
High	280	51.6	115	41.1	55	19.6	110	39.3	
Low	253	46.6	96	37.9	69	27.3	88	34.8	
Stroke center									0.115
Yes	31	5.6	8	25.8	6	19.4	17	54.8	
No	512	94.3	205	40.0	120	23.4	187	36.5	
Location									0.093
Urban	536	98.7	211	39.4	122	22.8	203	37.6	
Nonurban	7	1.3	2	28.6	4	57.1	1	14.3	

Note: Percentages may not equal 100% due to missing. Work environment created from the 5 subscales of the Practice Environment Scale of the Nursing Work Index where 0–1 subscales above the median were categorized as poor, 2–3 subscales above the median as mixed and 4–5 subscales above the median as best. Row percentages displayed for categorical variables. Stroke Center includes Comprehensive and Primary Stroke Center designation recognized by The Joint Commission, American Heart Association and American Stroke Association.

(4.2 patients per nurse, $SD = 0.9$) in hospitals with the best work environments compared to hospitals with poor work environments (4.6 patients per nurse, $SD = 1.1$; $p < 0.001$) and hospitals with the best environments had higher average work environment scores. Hospitals with more beds and that were major teaching hospitals were more frequently in the best work environment hospitals. Work environments were not significantly different in high technology hospitals and other hospitals. Thirty-one (5.6%) of the study hospitals were Comprehensive or Primary Stroke Centers and seven were Nonurban hospitals. No statistically significant difference was found with regard to the nurse work environment between hospitals that were stroke centers compared to those that were not, nor between urban and nonurban hospitals.

3.1 | Association of the nurse work environment and post-stroke patient outcomes

Table 3 shows the odds ratios (OR) and incidence rate ratios indicating the association of the work environment with the odds of 7- and 30-day readmissions and the likelihood of longer stays, from models which are unadjusted (Model 1) and models that are adjusted for patient characteristics (Model 2) and additionally for hospital characteristics, including staffing (Model 3). In unadjusted regression models there was no statistically significant association between the nurse work environment and any of the three patient outcomes. In the fully adjusted models the work environment was significantly associated with all three outcomes. Each standard deviation increase in the nurse work environment was associated with a 4% decrease in the odds of 7-day readmission (OR, 0.96; 95% confidence interval [CI], [0.93–0.99]) and a 3% decrease in the odds of 30-day readmissions (OR, 0.97; 95% CI, [0.94–0.99]). Additionally, when accounting for hospital and patient characteristics, a standard deviation increase in the work environment resulted in 3% lower likelihood of a longer hospital stay (incident-rate ratio, 0.97; 95% CI, [0.95–0.99]). Nurse staffing appeared to have no significant association with the outcomes for stroke patients.

TABLE 3 Effect of a one standard deviation increase in the work environment on odds of 7- and 30-day readmissions and incident rate-ratio of length of stay

	Model (1)	Model (2)	Model (3)
	Unadjusted	Adjusted for patient characteristics	Adjusted for patient and hospital characteristics
	Odds ratios (OR) from models for 7-day readmission		
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Work environment	0.98 (0.94–1.01)	0.96* (10.93–0.99)	0.96* (0.93–0.99)
Staffing			1.03 (0.98–1.08)
	OR from models for 30-day readmission		
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Work environment	1.00 (0.97–1.03)	0.97 (0.95–1.00)	0.97* (0.94–0.99)
Staffing			1.02 (0.99–1.06)
	Incident rate ratio from models for length of stay		
	IRR (95% CI)	**IRR (95% CI)**	**IRR (95% CI)**
Work environment	1.00 (0.98–1.04)	0.98 (0.96–1.00)	0.97** (0.95–0.99)
Staffing			1.00 (0.98–1.03)

Note: 7- and 30-day readmission models utilize logistic regression and length of stay models utilize truncated negative binomial regression and all models account for clustering of patients within hospitals. Patient characteristics include age, sex, race, whether the patient was a transfer from another hospital, 29 comorbid conditions (Elixhauser) and discharge disposition. Hospital characteristics include nurse staffing, bed size, teaching status, high technology, stroke center status, number of medical-surgical nurses, number of intensive care unit nurses, state and urban/rural location.

Abbreviations: CI, confidence interval; IRR, incident-rate ratio.

*$p < .05$.

**$p < .01$.

4 | DISCUSSION

In our study of 543 hospitals we found that ischemic stroke patients cared for in hospitals with better nurse work environments had lower odds of 7- and 30-day readmissions as well as shorter lengths of stay when also accounting for other patient and hospital characteristics. These findings support similar results demonstrating an association between better nurse work environments and lower 30-day readmissions for surgical and general medical patients (Brooks Carthon et al., 2015; Lasater & McHugh, 2016; Ma et al., 2015; McHugh & Ma, 2013). We also offer new evidence demonstrating a relationship between more favorable nurse work environments and 7-day readmissions and lower length of stay.

Our findings have important implications for quality improvement initiatives for stroke care management. The American Heart Association/American Stroke Association and the European Stroke Organization both endorse several measures and processes to standardize stroke care management including rapid use of intravenous and intra-arterial therapies and instituting secondary preventative measures including blood pressure control and anticoagulation beginning during the initial hospitalization (European Stroke Organization, 2020; Powers et al., 2019). Additionally, in the United States hospitals can seek designation as Primary or Comprehensive Stroke Centers, which are markers of consistent stroke care protocol implementation and excellent stroke care outcomes. Primary Stroke Centers are hospitals that implement acute stroke teams, protocolize stroke care, provide coordinated care and have dedicated stroke units (Man et al., 2018). While receiving timely stroke care is important, only half of the United States population lives within 60 min of a Primary Stroke Center (Alberts et al., 2013). This makes our findings of the importance of good work environments all the more relevant given the presence of nurses in all hospitals caring for stroke patients. We had good representation of these hospitals in our study with 31 of the 37-desiganted stroke centers included in our four-state data. However, when including stroke center status as a hospital-level control in our analysis, there was not a significant association between stroke center status and any of the outcomes. Rather, the nurse work environment remained as a significant predictor of lower 7- and 30-day readmissions and lower length of stay. This suggests that although not all hospitals will attain stroke center designation, they all have the ability to improve their nurse work environments, which may serve as one mechanism to improve stroke outcomes.

4.1 | Investing in the nurse work environment to improve post-stroke outcomes

Our results suggest that providing investments to improve nurse work environments should also be considered as a systems-level

intervention to improve stroke outcomes (Brooks Carthon et al., 2015; Kutney-Lee et al., 2013; Lake et al., 2019). An example of investments in nurse work environments may formally be achieved through Magnet© designation. Hospitals that have attained Magnet© designation are known for high quality nurse work environments and have demonstrated improved patient outcomes, such as lower failure to rescue and mortality as well as higher end of life care quality (Kutney-Lee et al., 2015; Lasater & Schlak, 2020; McHugh et al., 2013). Even hospitals without Magnet© designation can improve their work environments through low-cost investments, such as increasing the visibility of nursing leadership among staff, allowing bedside nurses to participate in shared decision making regarding their clinical practice and fostering interdisciplinary teamwork.

Our findings regarding 7-day readmissions are particularly important due to the proximity of readmission to inpatient care. In studies focused on the variation in timing of readmissions, investigators have found that early readmissions are more frequently associated with the index hospitalization and quality of the care received during initial hospitalization (Chin et al., 2016; Graham et al., 2015; Graham et al., 2018; Lichtman et al., 2013). However, they have not considered many factors related to nursing, but rather focused on how patient and physician characteristics contribute to early readmissions (Graham et al., 2015; Pham et al., 2019). Similarly, variations in length of stay have also primarily been attributed to patient characteristics and system-level factors, such as bed availability, efficiency of laboratory and support services and discharge planning (Buttigieg et al., 2018). Although some researchers have demonstrated an association between better nurse staffing and reduced length of stay, this study extends prior research by demonstrating a similar association with the nurse work environment. We hypothesize that both outcomes improve in hospitals with good work environments because nurses are able to practice to their full abilities, they are provided with enough resources and supports for them to deliver optimal care and are supported to form collegial relations among the multidisciplinary team.

There were various limitations to our study. Causal inferences are not fully supported by cross-sectional data. However, similar associations between patient outcomes and the hospital nurse work environment have been demonstrated many times over two decades and in many different countries (Aiken et al., 2008; Aiken et al., 2012; Kutney-Lee et al., 2013; McHugh et al., 2016). Additionally, there is recent evidence that the cross-sectional associations between patient quality and safety and the nurse work environment are similar to the associations that are found when changes over time are examined using longitudinal data (Sloane et al., 2018). Moreover, it is important to note that our data do not enable us to link ischemic stroke patients to the individual nurses on specific nursing units who provide their care. Rather, this is an organizational study that regards work environments and staffing as hospital characteristics and examines whether differences in the patient outcomes result from general differences in nurse work environments and nurse staffing levels across the different hospitals in which they receive their care. Finally, though our analysis accounted for hospital and patient characteristics, there are measures of stroke severity and stroke care we were unable to measure, such as time to anticoagulation. However, our analyses accounted for Primary and Comprehensive Stroke Center status, which is a marker for excellent stroke care. Even when adding this control variable, lower odds of 7- and 30-day readmissions and lower length of stay was associated with the nurse work environment.

5 | CONCLUSION

In this study we found an association between 7- and 30-day readmissions and hospital length of stay and the nurse work environment among ischemic stroke patients. Nurse work environments are a modifiable feature of hospitals that should be considered when providing comprehensive stroke services and attempting to improve post-stroke outcomes.

ACKNOWLEDGMENTS

The National Institute of Minority Health & Health Disparities (Grant No. MD011518, J. Margo Brooks Carthon, PI) and the National Institutes of Nursing Research (Grant No. R01NR016002, Matthew McHugh, PI; Grant No. R01NR014855, Linda Aiken, PI; and Grant No. T32NR007104, Linda Aiken, PI).

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

DATA AVAILABILITY STATEMENT

The data used in this study are subject to a data use agreement with each of the state agencies and thus cannot be shared directly by the authors, but contact information for the agency representatives may be made available upon request.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

How to cite this article: Brom, H., Carthon, J. M. B., Sloane, D., McHugh, M., & Aiken, L. (2021). Better nurse work environments associated with fewer readmissions and shorter length of stay among adults with ischemic stroke: A cross-sectional analysis of United States hospitals. *Res Nurs Health*, 1–9. https://doi.org/10.1002/nur.22121