Title of Project: **Care Interventions and Quality of Care in Rural and Urban Nursing Units**

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Inclusive Dates of Project: 9/30/2014 to 9/29/2018, with a no-cost extension to 9/29/2019.

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1. STRUCTURED ABSTRACT

Purpose: The purpose of the proposed study is to understand the relationships between contextual factors, care interventions, and pressure ulcer rates (PUR) and fall rates (FR) in rural and urban nursing units.

Scope: PUR and FR remain high despite an abundance of studies and evidence-based interventions. Results for rural-urban distinction are inconclusive. Additionally, context (community, hospital, and nursing unit characteristics), nurse work environment (staffing and the practice environment), nurse outcomes (job satisfaction and intent to leave), and preventive care interventions association with PUR and FR have not been studies simultaneously. Finally, longitudinal studies are rare.

Methods: A nonexperimental longitudinal design comparing rural and urban nursing-unit-level data from the National Database of Nursing Quality Indicators® (NDNQI®) augmented with Rural-Urban Commuting Area Codes (RUCAs) and case mix index.

Results: Similar previous studies cross-sectional results (2009) found no differences between PUR and FR in rural and urban nursing units and an association with RN skill-mix, education and experience. In the longitudinal results (2010-2013, 16 quarters), rural nursing units do as well or better than urban units regarding pressure ulcer prevention. Furthermore, care interventions, RN skill mix, and nurse job satisfaction and turnover intentions are associated with the more succinct *unit-acquired* pressure ulcer rate. Results differ when using cross-sectional and longitudinal approaches. Future studies need to include contextual factors, patient characteristics, and preventive care interventions. Policies that affect healthcare payment/penalties should include contextual factors and should be evaluated continuously for unintended consequences resulting from rural/urban and regional location.

Key Words: Pressure ulcers, falls, National Database of Nursing Quality Indicators, nurse outcomes, nurse staffing, rural, urban, longitudinal

2. PURPOSE

Despite well-established evidence and widespread implementation of preventive care interventions, national pressure ulcer rates (PUR) and fall rates (FR) remain high. Numerous studies, mostly cross-sectional, have examined factors that improve or hinder quality of care (QOC), including the QOC indicators PUR and FR. By and large, it is understood that contextual factors are important to consider when examining PUR and FR, but there is little evidence on the longitudinal influence of contextual factors on PUR and FR. Using a nonexperimental longitudinal design, comparing rural and urban nursing units, using unit-level data from the National Database of Nursing Quality Indicators® (NDNQI®) augmented with data on community and hospital characteristics from other databases, our study had the following three aims:

Specific Aim 1: To determine effects of care interventions for pressure ulcer and fall prevention on PUR and FR over 5 years, controlling for community, hospital, and nursing unit characteristics. We hypothesize that increased rates of care interventions are associated with decreased PUR and FR over time.

Specific Aim 2: To examine the effect nurse work environment (NWE) factors and nurse outcomes have on the relationships of care interventions and PUR and FR while controlling for community, hospital, and nursing unit characteristics. We hypothesize that the effects of care interventions on PUR and FR differ according to nursing units' NWE factors and nurse outcomes.

Specific Aim 3: To determine rural and urban differences in the effects of care interventions on PUR and FR and assess the extent to which the potential differences are attributed to NWE factors and nurse outcomes, while controlling for community, hospital, and nursing unit characteristics. We hypothesize that there are differences in rural and urban nursing units in the care intervention effects on PUR and FR and that these differences are only partially attributed to NWE factors and nurse outcomes.

3. SCOPE

Pressure ulcers and falls are among the most common, preventable, and costly patient safety events in US hospitals. In general, hospital-acquired conditions (HACs) have decreased, but PUR and FR remain high. Studies have examined factors that improve or hinder HACs, including PUR and FR. Contextual factors are important to consider when examining PUR and FR, but there is little evidence on the longitudinal influence of contextual factors on PUR and FR. This study includes contextual factors conceptualized as the nurse work environment (NWE) factors (staffing and practice environment) and the environment within which the NWE resides conceptualized as the three levels of the healthcare system (community, hospital, and nursing unit). An especially important community-level contextual factor is geographic location.

Approximately 19% of the population (59.5 million) resides in 72% of US land area considered rural. Rural populations receive most of their care in their surrounding hospitals, but evidence on QOC and HACs in rural hospitals is inconclusive. The mixed results when comparing QOC indicators in rural and urban hospitals can be explained partlyby the lack of contextual factors in prior studies. The majority of these studies did not include NWE factors and nurse outcomes, and none included care interventions that are all contextual factors included in the current study. Furthermore, most were cross-sectional studies and used hospital-level analyses. Our longitudinal study, which measures context, identifies resources (i.e., staffing), and uses unit-level analyses, can elucidate these complex relationships. Hence, our results can guide federal and state governments' strategies to improve QOC by, for example, requiring measuring and reporting of contextual factors that are relevant for both rural and urban hospitals. Payment policies that optimize these contextual factors would be a logical next step.

4. METHODS

Study Design

Guided by structural contingency theory (SCT), we used a nonexperimental longitudinal design, comparing rural and urban nursing units, using 2009-2013 (20 quarters) unit-level data from the NDNQI® augmented with data on community and hospital characteristics from national data files for Rural-Urban Commuting Area Codes (RUCAs) with zip code approximation and case mix index from the Centers for Medicare and Medicaid Services.

According to SCT, an organization's effectiveness depends upon a match between its context and structure. In order to achieve optimal effectiveness, an organization's structure must consider the environment - or context - in which it operates. In our study, context is conceptualized at three levels: community, hospital, and nursing unit. Structure is allocations of work roles and mechanisms including resources that allow the nursing unit to perform the needed work. In our study, structure is the NWE measured as staffing and the practice environment. Finally, effectiveness is desired results. In this study, effectiveness is conceptualized as care interventions, nurse outcomes, and pressure ulcer rates. All three effectiveness concepts are influenced by a fit between a nursing units' structure and context. Finally, nurse outcomes influence care interventions, which in turn influence fall and pressure ulcer rates. The measures for the study concepts are listed in the table below.

Measures

CONTEXT		
Community Characteristics	Region	Northeast, Midwest, South, West
	Location	Rural (rural, small town, micropolitan) or Urban

Hospital Characteristics	Hospital size	Number of staffed beds
	Case mix index	Average DRG weight
Nursing Unit Characteristics	Type of unit	Medical/surgical, ICU, rehabilitation units
STRUCTURE Nurse work environment		
Staffing	All staff hours/patient day	All staff hours worked in a 24-hour period
	RN hours/patient day	RN hours worked in a 24-hour period
	RN skill mix	Percentage of nursing care hours provided by RNs
	Education	Percentage of RNs who held a Bachelor of Science in nursing or higher degree
	Experience	Percentage of RNs with less than 2 years and percentage of RNs with more than 10 years in practice
Practice environment	The PES-NWI	Average of each of five scales (3-9 items) and a composite score on a four-point Likert scale
EFFECTIVENESS		
Care interventions		
Pressure Ulcer prevention	1. Skin assessment on admission 2. Risk assessment on admission 3. Any risk assessment 4. Patients at risk for pressure ulcer	Percentage of patients with pressure ulcers who received this intervention in a quarter
Fall prevention	1. Prior fall risk assessment. 2. Patient deemed at risk for fall	Percentage of patients with falls who received this intervention in a quarter
Nurse outcomes		
Job satisfaction	Degree to which RNs like their work	7-item 6-point Likert scale in which higher scores represent higher satisfaction
Intent to leave		Percentage of nurses who plan to leave their unit within 1 year
Hospital-acquired conditions		
Fall rate	All falls within a quarter	falls per 1000 patient-days

Hospital-acquired pressure ulcer rate	Prevalence rate collected on a random day in a quarter	Percentage of patients who develop a hospital acquired pressure ulcer
Unit-acquired pressure ulcer rate	Prevalence rate collected on a random day in a quarter	Percentage of patients who developed a unit acquired pressure ulcer rate

Sample

For the cross-sectional analyses, we used 2009 NDNQI® data, as follows: Falls: 4496 units (222 rural and 4274 urban) in 625 hospitals (65 rural and 560 urban); pressure ulcer: 4316 units (205 rural and 4111 urban) in 601 hospitals (60 rural and 541 urban).

For the longitudinal analyses, we included 5761 units (332 rural and 5429 urban) in 772 hospitals (89 rural and 683 urban), with a total of 56,190 quarterly data points from 2010 to 2013 (16 quarters).

Analyses

We did several analyses to address the three aims. First, we did descriptive comparisons according to rural/urban on all variables. Second, we did cross-sectional analyses for the first year. Third, we did longitudinal analyses of PUR for 4 years. Finally, we are in the process of comparing findings and analytic methods according to longitudinal and cross-sectional approaches.

5. RESULTS

Descriptive Results

Before addressing the aims, we did descriptive results for the baseline year (2009). We found no differences in the FR and nursing-unit-acquired PUR, but hospital-acquired PUR was about 30% lower in rural units despite similar percentages of patients deemed at risk for PUR in the two settings. In contrast, though the FR was similar in rural and urban units, for patients who fell, both the percentage of patients assessed for fall risk and patients deemed at risk for falls were higher in rural units. The rural nurses scored their practice environment and job satisfaction lower, but their intent-to-leave scores were also lower than their urban colleagues. Although nursing care hours provided by all staff was higher in rural units, proportion of hours provided by RNs and by RNs with a BS or higher were both lower in rural nursing units (Baernholdt et al, 2017).

Cross-sectional regression results

In subsequent multilevel negative binomial regressions using a two-stage random-intercepts model, we found no differences between rural and urban location, but the Northeast region had a lower FR than other regions. Rehabilitation units had a higher

FR compared with critical care and med/surg units. Increases in all staffing hours, RN hours, RNs with more than 10 years' experience, and job satisfaction and decrease in RNs were associated with a lower FR, whereas increases in RNs with fewer than 2 years' experience and in intent-to-leave ratings were associated with higher FR. The practice environment was not associated with the FR (Baernholdt et al, 2018)

For unit-acquired PUR, the lowest rates were in the West region and in hospitals with fewer than 100 beds. Again, higher rates were found in rehabilitation units. In contrast to FR, higher staffing (both all staff and RN hours) was associated with higher PUR, but higher number of RNs with more than 10 years' experience was associated with lower PUR. Being on a unit with higher proportion of patients deemed at risk for pressure ulcer was also associated with higher PUR. This was the only patient acuity variable we had in the models, which may account for the contradictory finding of higher staffing associated with higher PUR.

Longitudinal results

Because we only had data on patients who fell, rather than on all patients on a unit, we could not do longitudinal analyses for FR. For PUR, the definition changed in 2009, so we only used data from 2010-2013, or 16 quarters. Additionally, the practice environment could not be included, because there were no variations over the 4 years. We examined rural and urban units separately for longitudinal associations between PUR and explanatory variables. We employed multilevel binomial regression, in which within-unit changes in pressure ulcer rates were related to the within-unit changes in the explanatory variables (i.e., nursing unit characteristics, nursing outcomes, and individual care interventions) while controlling for region, hospital size, case mix index, unit type, unit percentage of patients at risk for pressure ulcer, year, and quarter. The models also accounted for unexplained variation across nursing units and hospitals as well as dependence of data (i.e., longitudinal measurements nested within units that were nested within hospitals) by including two random effects corresponding to the hospital and unit levels, respectively. The resulting odds ratio is interpreted as a multiplicative effect on the odds of developing a pressure ulcer for every one point of within-unit increase (or per 10% within-unit increase) in an independent variable adjusted for the other variables included in the model. The three care intervention variables, as well as the two staffing variables and two nurse outcome variables, were included separately in the models to avoid collinearity. If a unit did not have data in a follow-up quarter, this unit was still included in the analyses except for the missing quarter (Baernholdt et al, in press).

All three aims were supported. We did find that the three care interventions were associated with a decrease in the likelihood of developing a pressure ulcer (Aim 1). Furthermore, we found that increased RN skill mix and job satisfaction were associated with decreased PUR in both rural and urban nursing units, whereas increased intent to leave was associated with increased PUR in urban units only (Aims 2 and 3). Finally, though the three care interventions were associated with a decrease in the likelihood of

developing a pressure ulcer, different effects were noted in rural and urban units (aim 3). In rural units, there was a 21% decrease in the odds of developing a pressure ulcer for every 10% increase in patients who had any risk assessment. In urban units, there was a 5% decrease in the odds of developing a pressure ulcer for every 10% increase in patients who had a skin assessment on admission and a 3% decrease in the odds of developing a pressure ulcer for every 10% increase in patients who had a risk assessment on admission.

Comparison of cross-sectional and longitudinal approaches

Longitudinal analysis allowed us to assess the effect of nurse staffing, nurse outcomes, and care interventions while removing confounding factors (e.g., unit size, geographic location). Previous reports in the literature and our findings using cross-sectional data are mixed, probably due to variations in cross-sectional design and the influence of confounding factors. Our ongoing work is to understand what might have contributed to the differences in cross-sectional and longitudinal associations. NDNQI data with both cross-sectional and longitudinal data available provides us an opportunity to investigate this.

Discussion

Our study findings add to the evidence that preventing falls and pressure ulcers is complex. Our cross-sectional study of FR and PUR found no differences between rural and urban nursing units, similar to previous studies. However, also like previous studies, we did find that RN skill mix, education, and experience were associated with FR and PUR. What is new and our main contribution is the longitudinal part of the study, in which we found that rural nursing units do as well or better than urban units regarding pressure ulcer prevention. Thus, patients in rural hospitals do not receive inferior care compared with their urban counterparts. Furthermore, we found that care interventions, RN skill mix, and nurse job satisfaction and turnover intentions are associated with the more succinct *unit-acquired* pressure ulcer rate. Previous studies have assessed hospital-acquired pressure ulcer rates, which may or may not have happened on a specific nursing unit. We find that unit-level care interventions do make a difference in preventing pressure ulcers. Finally, our results support that pressure ulcer prevention is complex and that, in order to decrease PUR, contextual and patient characteristics along with preventive care interventions must be considered.

Conclusion and implications

Prior research found cross-sectional associations between care interventions, hospital and nursing unit characteristics, and FR and PUR. Whether these associations persist over time was unknown. Additionally, comparisons of quality measures across rural and urban location had mixed findings. Our results suggest that rural nursing units do as well as urban units but that contextual factors must be considered. Furthermore, our findings support the notion that pressure ulcer prevention is complex and requires one to assess the whole system surrounding a pressure ulcer incident, including a nursing

unit's RN skill mix, job satisfaction, and intent to stay together with specific care interventions and/or bundles. Future studies and interventions need to include contextual factors, especially at the unit level, and patient characteristics along with preventive care interventions. Policies that affect healthcare payment and penalties should include contextual factors and continuously be evaluated for unintended consequences resulting from rural/urban and regional location.

6. LIST OF PUBLICATIONS AND PRODUCTS.

Baernholdt M, Yan G, Hinton ID, Cramer E, Dunton N. Effect of preventive care interventions on pressure ulcer rates in a national sample of rural and urban nursing units: Longitudinal associations over 4 years. Int J Nurs Stud (in press) https://doi.org/10.1016/j.ijnurstu.2019.103455

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