

## Assessment of Readmission in a Rural Medical Center

Jennifer A. Mallow, PhD, FNP-BC<sup>1</sup>

Andrea Bailey, MSN, FNP-BC<sup>2</sup>

Karen E. Clark, MD, FACP<sup>3</sup>

Laurie Theeke, PhD, FNP-BC, GCNS-BC, FAAN<sup>4</sup>

<sup>1</sup>Associate Professor, School of Nursing, West Virginia University, [jamallow@hsc.wvu.edu](mailto:jamallow@hsc.wvu.edu)

<sup>2</sup>Clinical Instructor, School of Nursing and Transitional Care Coordination Team Program  
Consultant, School of Medicine, West Virginia University, [anbailey@hsc.wvu.edu](mailto:anbailey@hsc.wvu.edu)

<sup>3</sup>Professor, Chief, and Medical Director of Care Management, School of Medicine, West  
Virginia University, [kclark@hsc.wvu.edu](mailto:kclark@hsc.wvu.edu)

<sup>4</sup>Professor and PhD Program Director, School of Nursing, West Virginia University,  
[ltheeke@hsc.wvu.edu](mailto:ltheeke@hsc.wvu.edu)

### Abstract

Understanding and predicting hospital readmission has been of interest for more than three decades. To strategically place readmission reduction resources where most beneficial, organizations use readmission risk-stratification tools. However, common tools used to assess 30-day risk do not incorporate health disparity and it is unknown how modifying currently validated tools affects their predictive value. The aims of this retrospective study were to describe the population of people who are admitted and re-admitted for hospital care in a rural population and examine the effectiveness of a common risk stratification tool to predict 30-day readmission in a rural population experiencing health disparities. This retrospective cohort study examined data

from de-identified Electronic Health Record and included adult patients admitted to one general medicine service. The factors identified in this study that influence readmission are also identified in the literature and include number of co-morbid conditions and insurance status.

*Keywords:* hospital readmission, care transitions, health disparities, social determinants of health, risk stratification

### **Assessment of Readmission in a Rural Medical Center**

Understanding and predicting hospital readmission has been of interest for large hospital systems for more than three decades (Smith, Norton, & McDonald, 1985; Smith, Weinberger, Katz, & Moore, 1988). More recently, in 2012, the Centers for Medicare & Medicaid (CMS), as required by the Affordable Care Act (ACA), began to penalize hospitals for readmissions considered to be in excess of national averages. Thus, hospital systems have begun to refocus on what can be done to identify patients who are at risk of readmission, improve care delivery, and decrease the likelihood of patients returning to an acute care hospital care within 30 days.

### **Background**

To strategically place readmission reduction resources where most beneficial, organizations use readmission risk-stratification tools. One such tool, the LACE index, is widely used and predicts death or readmission for patients within 30 days after discharge from an acute-care hospital (van Walraven, Wong, & Forster, 2012). The LACE index scoring tool uses the following measures: Length of stay of the index hospitalization, Acuity of the index admission in terms of emergent versus non-emergent admission, Comorbidity of the patient using the Charlson comorbidity index, and the number of Emergency department visits in 6 months (Gruneir et al., 2011; van Walraven et al., 2012). The tool was originally developed and validated in Canada in a population that is different from many American populations, thus leading to the LACE + index

introduced by van Walraven et al. in 2012. Modifications to the original LACE index in the form of the LACE + captured additional variables such as acute diagnoses and procedures during index admission, academic medical center status, and patient age and gender (van Walraven et al., 2012). The LACE index may not be the best tool to predict readmission in populations experiencing significant health disparities.

Health disparities are preventable differences in the burden of disease or opportunities to achieve optimal health that are experienced by socially disadvantaged populations (National Cancer Institute). Rural populations are often at risk for these health disparities. Socioeconomic and behavioral health factors may exacerbate readmission vulnerability in rural populations experiencing health disparities. As hospital systems begin to examine readmission data and look for interventions that will be beneficial, it is clear the cause of readmissions is likely multifactorial. Considering these important patient characteristics is necessary when trying to predict which patients are most likely to experience poor outcomes and readmission. However, common tools used to assess 30-day risk do not incorporate these factors and it is unknown how modifying currently validated tools affects their predictive value.

Assuming the risk of excess readmissions stems from multiple factors, one rural hospital system further modified the LACE tool to include additional parameters to capture socioeconomic and behavioral health factors. Based on qualitative nursing assessment and patient reports, the following pieces of functional assessment data were added to the LACE index within the Electronic Health Record: lack of permanent address, place of residence is a hotel/motel, living alone, history of substance abuse, self-reported financial concerns, and poor health literacy. The aims of this retrospective study were three-fold: 1) to describe the population of people who are admitted and re-admitted for hospital care in a rural population, 2) to examine the effectiveness of

the LACE index to predict 30-day readmission in a rural population experiencing health disparities, and 3) to begin to examine the impact of adding functional status variables to the readmission index for the purposes of correctly identifying patients at risk for readmission.

## **Methods**

### **Design**

Using a retrospective cohort sample of electronic records to complete the analysis, the sample was obtained from de-identified Electronic Health Record (EHR), obtained from the Integrated Data Repository (IDR) (Denney, Long, Armistead, Anderson, & Conway, 2016). The IDR is a validated clinical data warehouse that is maintained by the West Virginia Clinical and Translational Science Institute. The study included all adult patients that were admitted to a general medicine service at Ruby Memorial Hospital in Morgantown, West Virginia (WV) between January 1, 2014 and December 31, 2015. The time frame was chosen to obtain baseline data prior to extensive modification of readmission prevention interventions within the institution. Exclusion criteria were data from any patients under 18 years old at the time of admission. This study was granted exempt status by the West Virginia University (WVU) Institutional Review Board (45 CFR 46.101).

### **Setting**

Rural is defined in this study using the Census Bureau's urban-rural classification (Ratcliffe, Burd, Holder, & Fields, 2016). Appalachia is a 13-state region of the Eastern United States (U.S.) in which 42% of the region's population is rural compared with 20 percent of the national population. WV is in the only state that is entirely within Appalachia. The rugged terrain and poor condition of roads hinder access to care and are associated with longer times to reach needed medical care (Wilson, Kratzke, & Hoxmeier, 2012). WV is one of the few U.S. states not

to have a city with more than 100,000 residents and the largest city in the state has less than 50,000 people. Hence, even those who are living in areas classified as “urban” experience health disparity such as geographic isolation, lower socioeconomic status, higher rates of health risk behaviors, limited access to healthcare specialists and subspecialists, and limited job opportunities. The majority (42 of 55) of West Virginia's counties are designated as rural, with most of the state's population living in a rural area. WVU Health System is the only academic medical center in the state and over 85% of the counties in West Virginia are considered health professional shortage areas (U.S. Health Resources & Services Administration, 2019). WVU Medicine includes the physicians, specialists, and sub-specialists of the WVU School of Medicine; the affiliated schools of the WVU Health Sciences Center (Nursing, Pharmacy, Dentistry, and Public Health). The West Virginia University Health System is the largest health system in the state comprised of 14 hospitals and five institutes. All of these are anchored by a 690-bed academic medical center, Ruby Memorial Hospital (RMH), that offers tertiary and quaternary care. The general medicine service at Ruby Memorial Hospital accepts patients from across the entire state. Thus, the data obtained for this study is from individuals living across a rural state. Adult patients with a typical range of acute and chronic medical illness are cared for on general medicine floors or stepdown units. Intensive care is provided in a closed system with coverage by intensivists.

## **Measures**

**Thirty-day readmission.** All patients in the IDR database that had been admitted into the hospital during the timeframe of the study were identified. The first admission within the study timeframe was considered the indexing admission. The 30-day readmission variable was a dichotomous variable, using the indexing admission as baseline. Any patient that was readmitted

within 30 days of the indexing admission was coded as a 1 and those who were not readmitted within 30 days of an indexing admission were coded as a 0.

**LACE+ index.** The LACE+ index scoring tool is an algorithm that quantifies the risk of a patient's hospital readmission within 30 days of discharge. It is comprised of five different variables: length of stay (L), acuity of admission (A), comorbid conditions (C), emergency department utilization (E), and a summed score. Each of those variables are calculated independently. Length of stay is recorded in days, which includes the day of admission and discharge. Therefore, a patient who is admitted in the evening and discharged the next morning would have a length of stay equal to two days. The acuity of admission is determined by the patient class. Patients who were admitted as an inpatient score three for the “A” variable while patients classed as observation score a zero. The comorbid conditions of patient as per the Charlson comorbidity index (Charlson, Szatrowski, Peterson, & Gold, 1994) were collected during the admission. Each comorbidity was assigned a weight that factors into a maximum score of six. Emergency department (ED) utilization in the six months preceding the index hospitalization adds one point to the “E” variable, up to a maximum of four points. If the patient was admitted via the emergency department for the index admission, this emergency department utilization was included in the score. In addition, the fifth variable was a summed score, obtained from the first four variables, ranging from 0-19 where a score of 10 or greater signifies a high risk of readmission within 30 days.

**Patient characteristics.** In addition to the LACE+, this health system further modified the LACE+ tool to include additional parameters to capture socioeconomic patient characteristics. Gender was recorded as a dichotomous variable, male or female. Race was available in the IDR in the following categories: White, black/African American, Hispanic/Latino, Other, or Unknown.

For the purposes of the analysis, the unknown responses were combined with the other category. Marital status was available in the IDR in the following categories: divorced, separated, married, other, significant other, single, unknown, and widowed. For the purposes of the analysis, separated and divorced were combined, and unknown was combined with the other category. Age was calculated from date of birth at the indexing admission and recorded as a continuous variable. Insurance status was available in the IDR in the following categories: Medicaid, Medicare, private, self-pay, and other. Having a primary care provider was obtained and recorded as a categorical variable: yes, no, and unknown. For the purposes of analysis unknown was combined with no. The LACE + tool specific following chronic conditions were collected and dichotomized as a patient either having the condition or not: myocardial infarction, congestive heart failure, peripheral vascular disease, cardiovascular disease, dementia, chronic obstructive pulmonary disease, rheumatic disease, peptic ulcer, liver disease (mild and severe), diabetes (with and without complications), hemiplegia, renal disease, malignancy, tumor, and acquired immune deficiency syndrome (AIDS). The total number of chronic conditions was calculated by tallying the total of each of the above conditions.

**Functional status.** Information related to socioeconomic status and functional health included literacy, history and/or treatment for alcohol, drug or behavioral issues, financial concerns, functional health assessments, and living arrangements. Health literacy was measured by the Brief Health Literacy Screen (BHLS) (Sand-Jecklin & Coyle, 2014). The BHLS is a five-question tool that measures patient's ability to understand and remember written and/or verbal health information. The tool results in a summed score from 0 – 25, with scores less than 19 indicating limited health literacy. The tool is relatively new and was developed and tested in the same population. However, Cronbach's alpha for the BHLS in this study was .79. Inter-item

correlations ranged from .21 to .60 and exploratory factor analysis indicated that the instrument was measuring one factor, with item loadings of .65 to .84 (Sand-Jecklin, Daniels, & Lucke-Wold, 2017).

Living arrangements were available from the data repository in the following categories: apartment, assisted living, condominium, correctional facility, extended care facility, group home, homeless/hotel/motel/shelter/no address, house, independent living facility, mobile home, nursing home, rehab hospital, residential facility, shelter, and skilled nursing unit. The following variables were collected as a dichotomous variable (yes/no) and recorded as past difficulty with one or more of these issues: hearing deficit, visual deficit, ambulation deficit, difficulty performing activities of daily living, difficulty completing errands, memory deficits, financial concerns, and treatment for alcohol, or illicit drugs. Also, having a primary care provider was collected as a dichotomous variable as yes, they have a primary care provider listed, or no, they do not have a primary care provider listed.

### **Data Analysis**

Data were analyzed using Statistical Package for the Social Sciences 24. The first review of the data included a comprehensive descriptive analysis of all study variables for participants who have been admitted within 30 days of an indexing admission. Next, Chi-square test for independence was used to explore the relationships between 30-day readmission status and the following categorical study variables: gender, race, marital status, insurance status, having a primary care provider, each chronic condition, living arrangements, hearing deficit, visual deficit, ambulation deficit, difficulty performing activities of daily living, difficulty completing errands, memory deficits, financial concerns, and treatment for alcohol, or illicit drugs. Mean comparisons were conducted using Independent-samples t-tests for the dichotomous categorical readmission

variable and the following continuous variables: age, number of chronic conditions, health literacy, length of stay, emergency department utilization, and LACE+ score.

## Results

### Sample Descriptors

The sample ( $n = 9,854$ ) included mostly mid-life adults (*mean age = 57.5*, *SD 18.2*), was nearly gender equal, included a majority of White, married, insured by the Centers for Medicaid and Medicare Services, and chronically ill. The readmission rate within 30 days for the population was 22.3% and the majority of the patients were re-admitted as inpatients (74%) verses those who were in-house and classified as observation patients (26%). The remainder of the demographic information of the sample can be seen in Table 1.

**Table 1**

*Demographics for total population*

Demographic		<i>n</i> Total (9854)	%
<b>Gender</b>	Female	5018	50.9
	Male	4835	49.1
<b>Race</b>	Black/African American	304	3.1
	Hispanic/Latino	44	0.4
	White	9317	94.6
	Other	189	1.9
<b>Marital Status</b>	Divorced	1392	14.1
	Married	4109	41.7
	Significant Other	32	0.3
	Single	2566	26.0
	Widowed	1370	13.9
	Other	204	2.1
<b>Financial Class</b>	Medicaid	2543	25.8
	Medicare	4950	50.2
	Private	1934	19.6

	Self-Pay	197	2.0
	Other	230	2.3
<b>Has Primary Care Provider</b>			
	Yes	7534	76.5
	No	2320	23.5
<b>Functional Status Variable</b>			
	Hearing Impairment	899	9.1
	Visual Impairment	746	7.6
	Ambulation Difficulty	3527	35.8
	ADL Deficit	2128	21.6
	Difficulty completing Errands	2836	28.8
	Memory Impairment	1919	19.5
	History of Treatment for Substance Disorder	1088	11.0
	Financial Concerns	403	4.1
<b>Living Arrangements</b>			
	Independent Community Dwelling	8417	85.4
	Assisted Community Dwelling	295	3.0
	Unstable or Homeless	119	1.2
	Missing Data	1023	10.4
<b>Continuous Demographic</b>			
	Age	57.53	18.25
	# Admissions in 1 Year	2.19	5.89
	# Chronic Conditions	1.48	2.15
	LACE+ Score	8.42	4.38
	Health Literacy Score	17.99	8.20

When exploring demographic characteristics in this sample, chi-square tests for independence indicated significant associations between being admitted within 30 days and gender, race, marital status, financial class and having a primary care provider. As seen in Table 2.

**Table 2***Chi-square Analysis of Demographics and 30-Day Readmission*

Demographic	Readmitted , N, (%)	Not Readmitted N, (%)	$X^2$ , <i>P</i> Value	Effect size Statistic
<b>Gender</b>			10.01, 0.007*	<i>phi</i> = 0.03
Female	1053 (48.0)	3965 (51.8)		
Male	1141 (52.0)	3694 (48.2)		
<b>Race</b>			20.48, 0.000*	<i>Cramer's V</i> = 0.05
Black/African American	70 (3.2)	234 (3.1)		
Hispanic/Latino	15 (0.7)	29 (0.4)		
White	2088 (95.2)	7229 (94.4)		
Other	21 (0.9)	168 (2.2)		
<b>Marital Status</b>			41.22, 0.000*	<i>Cramer's V</i> = 0.07
Divorced	417 (19.0)	1156 (15.1)		
Married	853 (39.9)	3256 (42.5)		
Significant Other	9 (0.4)	23 (0.3)		
Single	603 (27.5)	1963 (25.6)		
Widowed	281 (12.8)	1089 (14.2)		
Other	31 (1.4)	2 (0.0)		
<b>Financial Class</b>			43.01, 0.000*	<i>Cramer's V</i> = 0.07
Medicaid	654 (29.8)	1889 (24.7)		
Medicare	1112 (50.7)	3838 (50.1)		
Private	352 (16.0)	1582 (20.7)		
Self-Pay	29 (1.3)	168 (2.2)		
Other	47 (2.1)	183 (2.4)		
<b>Has Primary Care Provider</b>			13.33, 0.001*	<i>phi</i> = 0.04
Yes	1734 (79.0)	5800 (75.7)		
No	460 (20.9)	1297 (16.9)		

\*Denotes Significant results  
the effect sizes of all the associations are very small.

Regardless of the admission diagnosis, there was an association between all chronic illness except dementia and AIDS. See Table 3 for detailed chi-square results related to 30-day readmission and each chronic illness.

**Table 3**

*Chi-square Analysis of Chronic Illness Type and 30-Day Readmission. (n= 9854)*

Demographic		Readmitted, n, (%)	Not Readmitted n, (%)	$\chi^2$ , P Value	Phi coefficient
<b>Myocardial Infarction</b>	Yes	353 (16.1)	847 (11.1)	40.4, 0.000*	<i>phi</i> = 0.06
	No	1841 (83.9)	6813 (88.9)		
<b>CHF</b>	Yes	490(22.3)	1135(14.8)	69.9, 0.000*	<i>phi</i> = 0.08
	No	1704(8.4)	6525 (85.2)		
<b>PVD</b>	Yes	337(17.2)	811(10.6)	69.9, 0.000*	<i>phi</i> = 0.08
	No	1817(82.8)	6848(89.4)		
<b>CVD</b>	Yes	350(16.0)	996(13.0)	12.6, 0.000*	<i>phi</i> = 0.04
	No	1844(84.0)	6664(87.0)		
<b>Dementia</b>	Yes	89 (4.1)	312 (4.1)	0.001, 0.97	<i>phi</i> = 0.00
	No	2105 (95.9)	7348 (95.9)		
<b>COPD</b>	Yes	292 (13.3)	589 (7.7)	66.2, 0.000*	<i>phi</i> = 0.08
	No	1902 (86.7)	7071 (92.3)		
<b>RA</b>	Yes	93 (4.2)	230 (3.0)	8.22, 0.005*	<i>phi</i> = 0.03
	No	2101(95.8)	7430 (97.0)		
<b>Peptic Ulcer</b>	Yes	113 (5.2)	257 (3.4)	15.2, 0.000*	<i>phi</i> = 0.04
	No	2081(94.8)	7403 (96.6)		
<b>Liver Disease, Mild</b>	Yes	363 (16.5)	719 (9.4)	89.4, 0.000*	<i>phi</i> = 0.09
	No	1831 (83.5)	6941 (90.6)		
<b>Diabetes, without Complications</b>	Yes	618 (28.2)	1593 (20.8)	53.3, 0.000*	<i>phi</i> = 0.07
	No	1576 (71.8)	6067 (79.2)		
<b>Diabetes, with Complications</b>	Yes	284 (12.9)	631 (8.2)	44.9, 0.000*	<i>phi</i> = 0.07
	No	1910 (87.1)	7029 (91.8)		
<b>Hemiplegia</b>	Yes	85 (3.9)	221 (2.8)	7.1, 0.008*	<i>phi</i> = 0.03
	No	2109 (96.1)	7448 (97.2)		
<b>Renal Disease</b>	Yes	326 (14.9)	856 (11.2)	21.9, 0.000*	<i>phi</i> = 0.05
	No	1868 (85.1)	6804 (88.8)		
<b>Malignancy</b>	Yes	243 (11.1)	638(8.3)	15.8, 0.000*	<i>phi</i> = 0.04
	No	1951 (88.9)	7022 (91.7)		
<b>Liver Disease, Severe</b>	Yes	91 (4.1)	215 (2.8)	10.2, 0.001*	<i>phi</i> = 0.03
	No	2103 (95.9)	7445 (97.2)		
<b>Aids</b>	Yes	5 (0.2)	25 (0.3)	0.54, 0.46	<i>phi</i> = -0.07
	No	99.8 (0.7)	7635 (99.7)		

\* Denotes significant results

Significant associations were also found between functional status variables and 30-day readmission status. However, there were missing data for each of the functional status variables and cases with missing data were excluded from the analysis. The associations between 30-day readmission showed that the percentage of readmissions was lower for those with hearing, visual and memory deficits. Conversely, those with ambulation difficulty, ADL deficits, difficulty completing errands and a history of substance abuse treatment had higher 30-day readmission rates than patients without one or more of these characteristics. See Table 4 for detailed chi-square results and missing data related to 30-day readmission and functional status variables.

**Table 4**

*Chi-square Analysis of Functional Status and 30-Day Readmission. (n = 9854)*

Demographic (N = Missing Data)		Readmitted, n, (%)	Not Readmitted n, (%)	$\chi^2$ , P Value	Phi coefficient
<b>Hearing Deficit</b> (N = 716)	Yes	173 (7.9)	726 (9.5)	15.1, 0.001*	<i>phi</i> = 0.04
	No	1893 (86.3)	6346 (82.8)		
<b>Visual Deficit</b> (N = 721)	Yes	157 (7.2)	589 (7.7)	9.2, 0.01*	<i>phi</i> = 0.03
	No	1907(86.9)	6480 (84.6)		
<b>Ambulation Difficulty</b> (N = 725)	Yes	868 (39.6)	2659 (34.7)	22.2, 0.000*	<i>phi</i> = 0.05
	No	1197 (54.6)	4405 (57.5)		
<b>ADL Deficit</b> (N = 721)	Yes	515 (23.5)	1613 (21.1)	12.6, 0.002*	<i>phi</i> = 0.04
	No	1550 (70.6)	5455 (71.2)		
<b>Difficulty Completing Errands</b> (N = 725)	Yes	668 (30.4)	2168 (28.3)	10.6, 0.005*	<i>phi</i> = 0.03
	No	1396 (63.6)	4897 (63.9)		
<b>Memory Deficit</b> (N = 729)	Yes	409 (18.6)	1510 (19.7)	9.6, 0.008*	<i>phi</i> = 0.03
	No	1652 (75.3)	5554 (72.5)		
<b>History of Substance Abuse Treatment</b> (N = 8766)	Yes	288 (13.1)	800 (10.4)	12.49, 0.000*	<i>phi</i> = 0.04
	No	<i>missing</i>	<i>missing</i>		
<b>Financial Concerns</b> (N = 2766)	Yes	99 (4.5)	304 (4.0)	4.47, 0.107	<i>phi</i> = 0.02
	No	1449 (66.0)	5236 (68.4)		

\*Denotes significant results

Statistically significant differences were found related to age, number of chronic conditions, number of ED visits, and LACE+ scores between those who were readmitted within 30 days and those who were not readmitted. There was no significant difference in scores for health literacy scores or length of stay. See Table 5 for detailed results of independent samples t-tests.

**Table 5**

*Comparisons of Continuous Variables and 30-Day Readmission*

<b>Variable</b>	<b>Mean</b>	<b>n</b>	<b>SD</b>	<b>Std. Error Mean</b>	<b>t</b>	<b>df</b>	<b>Cohen's d</b>	<b>p</b>
<b>Age</b>								
Not Re-admitted	57.89	7660	18.6	0.21	3.87	3820.41	0.04	0.000*
Re-admitted	56.27	2194	17.0	0.36				
<b># of Chronic Conditions</b>								
Not Re-admitted	1.3	7660	2.0	0.02	-10.37	3119.44	0.10	0.000*
Re-admitted	1.9	2194	2.4	0.05				
<b>Health Literacy</b>								
Not Re-admitted	18.0	4464	8.2	0.12	0.49	5277.00	0.00	0.62
Re-admitted	17.86	815	8.1	0.28				
<b>Length of Stay</b>								
Not Re-admitted	5.0	7660	6.4	0.07	-0.92	9852.00	0.00	0.36
Re-admitted	5.1	2194	6.5	0.14				
<b>ED Visits last 6 Months</b>								
Not Re-admitted	0.2	7660	0.8	0.01	-14.12	2276.41	0.14	0.000*
Re-admitted	1.1	2194	3.0	0.06				
<b>LACE+</b>								
Not Re-admitted	8.1	7528	4.3	0.05	-12.33	3291.91	0.12	0.000*
Re-admitted	9.5	2143	4.6	0.10				

**Discussion**

While readmission assessment and prediction has been of interest for three decades, this study is the first to begin examining the relationships between sociodemographic, behavioral and functional status variables in relation to readmission rates in a rural population within the context of validated readmission risk tools. The descriptors of this study sample are of the general population of WV. These results are consistent with knowledge related to determinants of health in rural Appalachia (Marshall et al., 2017). The residents of WV experience significant health

disparities including experiencing the highest incidence of uninsured or underinsured status, low high school graduation rates, highest incidence of infectious disease, highest prevalence of low birth-weight infants, and low availability of primary care providers compared to other states. All these factors correspond to the five identified key domains of social determinants of health (Department of Health and Human Services, 2019).

There was a difference between the LACE+ scores of those who were readmitted and those who were not. However, LACE+ scores for those who were readmitted were lower than published thresholds (van Walraven et al., 2012). Hence, the LACE+ scores were not effective in predicting those at risk for readmission in this population. In addition, the population readmission rate exceeded the national averages for those with chronic illnesses (Fingar, Barrett, & Jiang, 2006). Individual components of the LACE+ that were predictive for readmission was co-morbid conditions and ED visits within the last six months. These predictive items probably accounted for the lower threshold for readmission in this rural population.

The functional status findings may not be surprising. Cornell University's 2016 disability status report identifies WV as the state with the highest prevalence of disabilities among non-institutionalized working adults (Ward, Myers, Wong, & Ravesloot, 2017). National rates of identified disabilities are 10.9%, with WV at 18.5% (Erickson, 2018). With the patients in this study, ambulatory disability ranked highest among the six types of disabilities identified by the American Community Survey, at 10.6%, followed by cognitive and independent living (Erickson, Lee, & von Schrader, 2018). As mid-life adults, the population experiences significant ambulation difficulty, ADL deficits, difficulty completing errands and memory impairment. It has long been known that ambulation difficulty in people over the age of 65 has been linked to readmissions (Marcantonio et al., 1999; Navathe et al., 2018). The difficulty with completing ADLs and

completing routine errands is likely linked to ambulation difficulty. In addition, ambulatory disability may be more disruptive to ADLs in rural versus urban areas due to lack of public transportation services and rugged terrain. However, knowing that this rural population may experience ambulation difficulty at a younger age deserves more examination in relation to readmission.

The available data related to substance use was collected as a history of receiving treatment for substance abuse and thus does not measure those who have a history of alcohol or drug abuse that are currently using or have not sought treatment in the past from this facility. Information about substance use and abuse is often under reported. WV has the highest rate of drug overdoses in the nation and comparison data indicates that approximately one in 10 people in WV battle with addiction (Moody, Satterwhite, & Bickel, 2017). Thus, due to the large amount of missing data, it is possible that addiction incidence may be higher than previously believed and certainly would impact readmission rates. Recent studies by Gerke, et al, find positive screening scores for active alcohol consumption, drinking behavior and alcohol related problems as well as drug use or abuse in the previous 12 months are associated with higher risk for 30-day readmission to general medicine wards (Gerke et al., 2018).

Understanding living arrangements in the context of the available data is also difficult. While the vast majority of the population lives in the community independently, the number of people in the home and amount of informal and formal care-giver support is not routinely assessed or collected. Thus, this information is not available in the EHR and not part of this analysis. However, lack of caregiver support for acute illness when discharged and loneliness have been linked to poor physical outcomes for those with chronic illness (Greysen et al., 2016; Petite et al., 2015). In addition, those living in assisted community dwellings may receive services that keep

them in those institutions and out of acute care hospitals. However, understanding people's preference and amount of support needed to remain in their home in relation to readmission has not been routinely measured in relation to readmission assessment.

While there were significant differences in patient characteristics and 30-day readmission rates, effect sizes were very small. Readmission rates were higher in males, Whites, those that were single or divorced, receive Medicaid benefits and have a chronic illness. Those who readmitted were younger than those who did not. While contrary to previously reported findings related to age (Cooksley et al., 2015), this finding is similar to recent findings that indicate higher readmissions for younger adults with mental health disorders and patients of all ages with multiple chronic conditions (Berry et al., 2018). Healthcare Cost and Utilization Project (H-CUP) data findings are similar in that males receiving Medicaid benefits with mental illness admit more frequently (Jiang, Weiss, Barrett, & Sheng, 2015). Mental health diagnosis is not commonly measured in LACE+ assessment and thus, not collected for evaluation in this study. While health literacy was not significant in relation to readmission status in this population, the overall health literacy of all patients was low and there was essentially no variability in the scores between groups. While not significant in relation to readmission, it certainly merits consideration when developing interventions to reduce hospital readmissions in this rural population.

### **Limitations**

The study population was primarily White which may be different in other rural areas of the country. Missing data was identified for all functional health variables. This study was a retrospective analysis of a specific Appalachian sample located in North Central WV. Thus, the findings cannot be generalized to other rural populations without replication. In addition, no specific rural status data of individual patients was collected. Thus, the findings cannot be

generalized to all rural populations, the rest of the U.S. or even to all of Appalachia. Variables regarding substance abuse history and treatment were missing in the data almost completely. Missing data could not be analyzed because using imputed means or for the purposes of prediction of readmission could skew the results. Further investigation is warranted to related to these patient characteristics in the future.

### **Future Implications**

More research is needed to understand the complex nature of readmissions in rural populations. A larger study to further investigate incorporating the social determinants of health into readmission assessment and to automate some type of readmission risk assessment within the EHR is currently being developed. Future initiatives should focus on common data elements to collect determinants of health, specifically in rural populations. These efforts will assist in developing clinical, social, and behavioral interventions for the most vulnerable populations.

### **Conclusions**

The LACE+ index is not effective in identifying those at risk for readmissions in this rural population. It is likely that functional status and significant health disparities cause of 30-day readmissions in this rural population. However, further research is warranted. The factors identified in this study that influence readmission are also identified in the literature and include number of co-morbid conditions and insurance status. While most individuals had insurance, the majority of those who were readmitted within 30 days had Medicaid as their primary insurance. Since people with Medicaid who live in rural areas face unique needs, future initiatives aimed at assessing and reducing 30-day readmission rates should focus on distinct clinical, social, and behavioral needs for rural populations. Before developing customized care transition plans and

precision healthcare approaches to prevent readmissions, system level changes in collecting health determinant data are needed.

*The Authors declare that there is no conflict of interest.*

## References

- Berry, J. G., Gay, J. C., Maddox, K. J., Coleman, E. A., Bucholz, E. M., O'Neill, M. R., . . . Hall, M. (2018). Age trends in 30 day hospital readmissions: U.S. national retrospective analysis. *BMJ*, *360*, k497. <https://doi.org/10.1136/bmj.k497>
- Charlson, M., Szatrowski, T. P., Peterson, J., & Gold, J. (1994). Validation of a combined comorbidity index. *Journal of Clinical Epidemiology*, *47*(11), 1245-1251. [https://doi.org/10.1016/0895-4356\(94\)90129-5](https://doi.org/10.1016/0895-4356(94)90129-5)
- Cooksley, T., Nanayakkara, P., Nickel, C., Subbe, C., Kellett, J., Kidney, R., . . . Lassen, A. (2015). Readmissions of medical patients: an external validation of two existing prediction scores. *QJM: An International Journal of Medicine*, *109*(4), 245-248. <https://doi.org/10.1093/qjmed/hcv130>
- Denney, M. J., Long, D. M., Armistead, M. G., Anderson, J. L., & Conway, B. N. (2016). Validating the extract, transform, load process used to populate a large clinical research database. *International Journal of Medical Informatics*, *94*, 271-274. <https://doi.org/10.1016/j.ijmedinf.2016.07.009>
- Department of Health and Human Services; Centers for Medicare & Medicaid Services. (2019). Hospital Readmissions Reduction Program (HRRP). Retrieved from <https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html>

- Erickson, W. L., C.; von Schrader, S. (2018). 2016 Disability Status Report: West Virginia. Retrieved from <http://www.nasuad.org/node/70150>
- Fingar, K., Barrett, M., & Jiang, H. (2006). A comparison of all-cause 7-day and 30-day readmissions, 2014: Healthcare Cost and Utilization Project (HCUP). October 2017. Agency for Healthcare Research and Quality, Rockville, MD. Retrieved from [www.hcup-us.ahrq.gov/reports/statbriefs/sb230-7-Day-Versus-30-Day-Readmissions.jsp](http://www.hcup-us.ahrq.gov/reports/statbriefs/sb230-7-Day-Versus-30-Day-Readmissions.jsp).
- Gerke, S. P., Agle, J. D., Wilson, C., Gassman, R. A., Fors, P., & Crabb, D. W. (2018). An initial assessment of the utility of validated alcohol and drug screening tools in predicting 30-day readmission to adult general medicine wards. *American Journal of Medical Quality*. <https://doi.org/10.1177/1062860617750469>
- Greysen, S. R., Harrison, J. D., Kripalani, S., Vasilevskis, E., Robinson, E., Metlay, J., . . . Ruhnke, G. W. (2016). Understanding patient-centred readmission factors: a multi-site, mixed-methods study. *BMJ Quality & Safety*. <https://doi.org/10.1136/bmjqs-2015-004570>
- Gruneir, A., Dhalla, I. A., van Walraven, C., Fischer, H. D., Camacho, X., Rochon, P. A., & Anderson, G. M. (2011). Unplanned readmissions after hospital discharge among patients identified as being at high risk for readmission using a validated predictive algorithm. *Open Medicine*, 5(2), e104-e111.
- National Cancer Institute. Health disparities defined. Retrieved from <http://crchd.cancer.gov/disparities/defined.html>
- Jiang, H. J., Weiss, A. J., Barrett, M. L., & Sheng, M. (2015). STATISTICAL BRIEF# 190. Retrieved from <https://hcup-us.ahrq.gov/reports/statbriefs/sb190-Hospital-Stays-Super-Utilizers-Payer-2012.pdf>

- Marshall, J., Thomas, L., Lane, N., Holmes, G., Arcury, T., & Randolph, R. Health Disparities in Appalachia. (2017) *Creating a Culture of Health in Appalachia: Disparities and Bright Spots*. Raleigh, NC: PDA, INC.; Chapel Hill, NC: The Cecil G. Sheps Center for Health Services Research The University of North Carolina at Chapel Hill.
- Marcantonio, E. R., McKean, S., Goldfinger, M., Kleefield, S., Yurkofsky, M., & Brennan, T. A. (1999). Factors associated with unplanned hospital readmission among patients 65 years of age and older in a Medicare managed care plan. *The American Journal of Medicine*, 107(1), 13-17. [https://doi.org/10.1016/S0002-9343\(99\)00159-X](https://doi.org/10.1016/S0002-9343(99)00159-X)
- Moody, L. N., Satterwhite, E., & Bickel, W. K. (2017). Substance use in rural Central Appalachia: Current status and treatment considerations. *Journal of Rural Mental Health*, 41(2), 123. <https://doi.org/10.1037/rmh0000064>
- Navathe, A. S., Zhong, F., Lei, V. J., Chang, F. Y., Sordo, M., Topaz, M., . . . Zhou, L. (2018). Hospital readmission and social risk factors identified from physician notes. *Health Services Research*, 53(2), 1110-1136. <https://doi.org/10.1111/1475-6773.12670>
- Petitte, T., Mallow, J., Barnes, E., Petrone, A., Barr, T., & Theeke, L. (2015). A systematic review of loneliness and common chronic physical conditions in adults. *The Open Psychology Journal*, 8(Suppl 2), 113. <https://doi.org/10.2174/1874350101508010113>
- Ratcliffe, M., Burd, C., Holder, K., & Fields, A. (2016). Defining rural at the U.S. Census Bureau. *American Community Survey and Geography Brief-1*, U.S. Census Bureau, Washington, DC.
- Sand-Jecklin, K., & Coyle, S. (2014). Efficiently assessing patient health literacy: the BHLS instrument. *Clinical Nursing Research*, 23(6), 581-600. <https://doi.org/10.1177/1054773813488417>

- Sand-Jecklin, K., Daniels, C. S., & Lucke-Wold, N. (2017). Incorporating health literacy screening into patients' health assessment. *Clinical Nursing Research*, 26(2), 176-190. <https://doi.org/10.1177/1054773815619592>
- Smith, D. M., Norton, J. A., & McDonald, C. J. (1985). Nonelective readmissions of medical patients. *Journal of Chronic Diseases*, 38(3), 213-224. [https://doi.org/10.1016/0021-9681\(85\)90064-5](https://doi.org/10.1016/0021-9681(85)90064-5)
- Smith, D. M., Weinberger, M., Katz, B. P., & Moore, P. S. (1988). Postdischarge care and readmissions. *Medical Care*, 699-708. <https://doi.org/10.1097/00005650-198807000-00005>
- U.S. Census Bureau. (2019). QuickFacts, West Virginia. Retrieved from <https://www.census.gov/quickfacts/WV>
- U.S. Health Resources & Services Administration. (2019). Shortage areas by state and county Retrieved from <https://data.hrsa.gov/tools/shortage-area/hpsa-find>
- van Walraven, C., Wong, J., & Forster, A. J. (2012). Derivation and validation of a diagnostic score based on case-mix groups to predict 30-day death or urgent readmission. *Open Medicine*, 6(3), e80-e89.
- Ward, B., Myers, A., Wong, J., & Ravesloot, C. (2017). Disability items from the current population survey (2008–2015) and permanent versus temporary disability status. *American Journal of Public Health*, 107(5), 706-708. <https://doi.org/10.2105/AJPH.2017.303666>
- Wilson, S. L., Kratzke, C., & Hoxmeier, J. (2012). Predictors of access to healthcare: What matters to rural Appalachians? *Global journal of health science*, 4(6), 23. <https://doi.org/10.5539/gjhs.v4n6p23>