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A Quality Initiative to Reduce Pneumonia Readmissions and Mortality in Older Adults

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Abstract

The United States (U.S.) healthcare system journey for making improvements in the quality and value of healthcare continues. Hospital organizations are required to compose and make publically available their health quality outcome data. The publication transparency and increased availability of local, regional and national health quality metrics, including readmission and mortality rates, to governmental agencies, health plans, investors, other hospitals, providers and potential patient and families' knowledge, creates a competitive pressure for a hospital to assure their quality outcomes data are the best. Despite breakthrough improvements using innovative care models that target vulnerable and potentially high cost of care areas such as individuals with chronic illnesses, complex health and social needs, children, and frail elders, have been seen, there remains a need for quality improvement (QI) initiatives to reduce particularly avoidable hospital readmissions and mortality.

A Midwest hospital system identified that their 30-day pneumonia (PNA) readmission rate for FY2017 was higher than the national median and the peer hospitals Centers for Medicare and Medicaid Services (CMS) benchmark percentage. The assumption was if there are more programs and resources available to the PNA patient then there should be better health outcomes. This project evaluated the differences in the PNA patient outcomes, mortality and readmission rates based on the number of hospital readmission reduction strategies (RRS) identified and available for the PNA Medicare patients among three of the Midwest hospital system acute care facilities.

The results of the Chi-square test of independence performed to examine differences between the total number of RRS in FY 2018 and FY 2019 and readmission

and mortality rates was significant for readmissions, $\chi 2$ (3, N= 107) = 25.15, $p < .001$, and mortality $\chi 2$ (3, N= 58) = 34.93, p= <0.001. This project outlined future opportunities for the bundle of RRS that can contribute significantly to reducing mortality and avoidable readmissions in the PNA population.

Introduction

Description of the Problem

The skyrocketing medical costs, poorly controlled chronic diseases, worsening health and contributing factors of social determinants of health in the U.S. are major concerns of insurance plans, employers, consumers, and government agencies (Bradley & Taylor, 2013). The type of care provided in the inpatient hospital setting is a main driver for the healthcare concerns. Hospital admissions with subsequent readmissions are disturbing especially if caused by an unhealthy situation that is exacerbated by increasing age, poorly controlled comorbidities, and Medicare status (Boccuti & Cassillas, 2017).

There are multiple definitions and associated metrics for readmissions however readmission is typically defined as a hospitalization that is measured as occurring within 30 days after hospital discharge. The Centers for Medicare and Medicaid Services (CMS) defines readmission as a hospitalization to an acute care facility within 30 days after hospital discharge for any cause, which includes an unrelated condition from the initial hospital admission (Medicare, n.d.). An example of readmission for any cause or per CMS nomenclature "all cause" is a patient hospitalized for congestive heart failure (CHF), who was readmitted 22 days after discharge following a fall and subsequent hip fracture. This second admission although unrelated to the seminal admission will count as a readmission. The prevalence and consequences of "all cause" readmissions has hospitals and providers needing to explore further why patients are readmitted, and search for strategies aimed at readmission prevention.

Studies have categorized readmissions as being avoidable or unavoidable. Because some hospital readmissions are avoidable, readmission rates are used for

benchmarking purposes (Donze´, Aujesky, Williams, & Schnipper, 2013). The readmission data shows a wide variation in hospital readmission rates, which can assist with predicting why patients admitted to certain hospitals could experience a higher readmission rate compared to being admitted to other hospitals (Boccuti & Cassillas, 2017). Hospital-specific readmission rates are available on the CMS website for transparent comparison of hospital readmission rates for conditions such as acute myocardial infarction (AMI), heart failure (HF), and PNA (PNA) (Silow-Carrol, Edwards, & Lashbrook, 2011)

Hospital readmissions can be related to an inadequately managed or unresolved problem during the prior hospitalization, deterioration in the health of a patient after a hospitalization secondary to a misunderstanding of post-discharge instructions, issues with medication reconciliation, or lack of access to appropriate post-acute services or treatments (Silow-Carrol, et al., 2011). There are CMS incentive programs to reduce hospital readmissions such as the Hospital Readmission Reduction Program (HRRP), which penalizes hospitals monetarily for comparatively high rates of Medicare readmissions (Boccuti & Cassillas, 2017). The conditions currently included in the HRRP are AMI, HF, PNA, chronic obstructive pulmonary disease (COPD), coronary heart bypass graft (CABG), elective total hip arthroplasty (THA), and total knee arthroplasty (TKA). The HRRP is a complicated and poorly understood program, which uses performance periods, weights based on geography, and severity of illness where hospital payments could be significantly reduced in the millions of dollars. Therefore, hospitals are interested in understanding which interventions improve the quality and safety of care

delivered during the inpatient hospital stay and yield appropriate transition of care post-discharge and can reduce hospital readmissions (Silow-Carrol et al., 2011).

Significance of the Problem

Pneumonia is considered a public health issue. Pneumonia and influenza are the eighth leading cause of death in the U.S. (CDC, 2017). The uppermost U.S. reason for mortality from disease-related infections is community acquired pneumonia (CAP) particularly for patients requiring a hospital admission (Ramirez et al., 2017). The estimated U.S. burden of CAP is substantial, with annually more than 1.5 million adults hospitalized, 100,000 deaths occurring during hospitalization, and approximately one of three patients hospitalized with CAP die within one year after being hospitalization (Ramirez et al., 2017). Although CAP can occur at any age; with increasing age there is an increased incidence and risk (Cillóniz, Rodríguez-Hurtado, & Torres, 2018). In the U.S., the incidence of CAP in adults between 65 and 79 years old is 63 cases per 10,000 and rises to 164.3 cases per 10,000 with adults 80 age and older (Cillóniz et al., 2018). The increased risk of CAP with advancing age can be contributed to decreased physical and protective body processes against infectious pathogen, declines in the immune system known as immunosenescence; and a diminished sensitivity of an airway protective cough and reduced swallowing reflexes (Cillóniz et al., 2018).

Purpose of the Project

The study hospitals are part of a large Catholic health care system in the Midwest. The hospital system includes more than 40 hospitals and 2500 employed providers that include acute care facilities, specialty hospitals, critical access hospitals (CAH), physician practices and outpatient facilities. The organizational structure for this hospital system includes system-wide support for three regional areas. Several of the

organization's facilities are located in the state of Missouri. According to the 2016 National Center for Health Statistics (NCHS), the state of Missouri ranked 13th for CAP deaths, with 1,150 total mortalities at 15.1% compared to 13.5% nationally (CDC, 2016). For this hospital system, the 30-day PNA readmission rate for fiscal year (FY) 2017 (July 1, 2016 through June 30, 2017) was 17.8% for older adults. This is higher than their peer group and a CMS benchmark by 0.8% and 1.2% respectively. A QI initiative is needed to assess current strategies aimed to reduce 30-day unplanned readmissions for PNA within the regional operational communities and to identify best practices and opportunities for improvement within the hospital system.

The purpose of this project is to identify and describe the specific hospital readmission reduction initiatives among the included hospital system's acute care facilities to analyze their efficacy on the patient outcomes of mortality and readmission rates. The goal of the project is to summarize findings, best practices, and lessons learned, and subsequently to inform future practices in this healthcare system. The process to understand the CAP burden is through clinical studies or data sets, because CAP is not an U.S. reportable condition (Ramirez et al., 2017). For this project, the CAP data is aggregate data obtained from the hospital electronic health records (EHR) to analysis of 30-day CAP readmission and mortality rates. The significance of influenza season and PNA will be considered. The population, intervention, comparison, and outcome with time (PICOT) question for this project is: For Medicare patients aged 65 and over admitted with a primary diagnosis of PNA to one of the acute care facilities, did the number of evidence-based practice (EBP) RRS utilized during the months of October 1, 2017 – February 28, 2018 compared to the number of EBP RRS utilized during the

months of October 1, 2018 – February 28, 2019 result in lower 30-day all cause readmission and mortality rates for patients with an index admission for PNA?

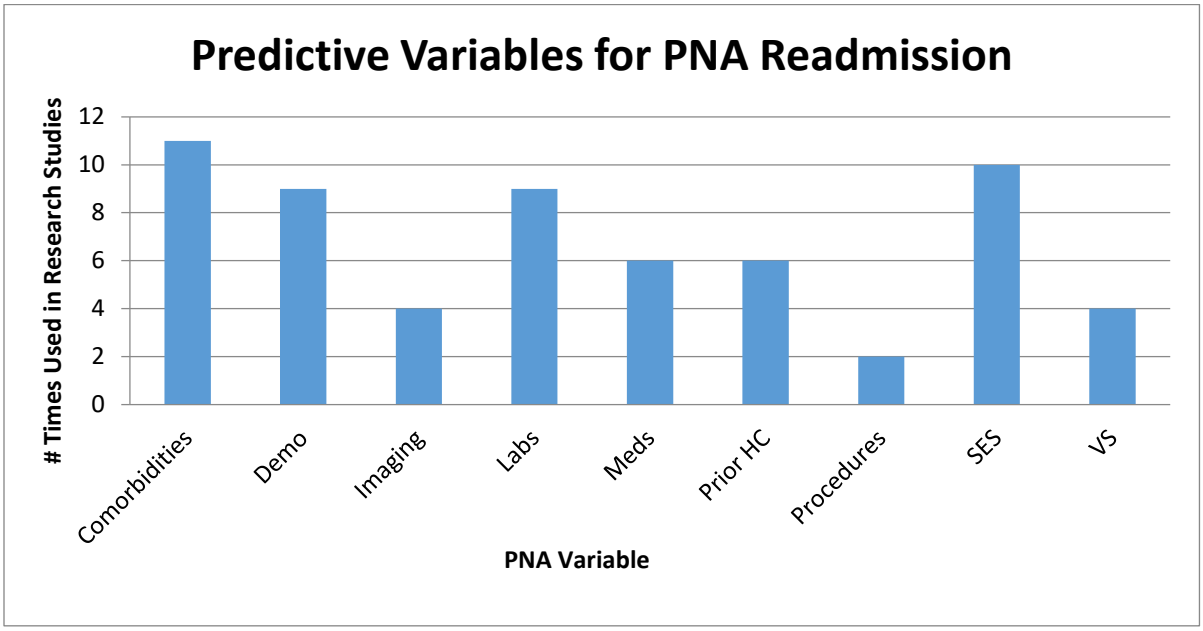
Review of Literature

A total of 22 articles were utilized for the review of literature. The literature review was conducted using Ovid and PubMed. The key search term words were readmission, PNA, unplanned, Medicare, quality improvement, reduction, interventions, and older adults. The literature review included research studies and articles from 2009 through 2018 and was limited to the adult population, a diagnosis of CAP or PNA, and Medicare and Medicaid insurance. Articles were excluded if related to hospital acquired pneumonia (HAP), commercial payers or the pediatric population. There were three main themes that emerged from the literature reviewed. The intervention approaches identified in the literature to lower hospital readmission rates are patient, provider, or system related (Appendix A).

The predictive model approach is a strategy that uses analytics to identify PNA patients at risk for hospital readmission. A predictive strategy enables hospitals and providers to proactively arrange appropriate care coordination and transition of care interventions to reduce 30-day readmissions (Weinreich et al., 2016). A systematic review of patient related factors included 91 abstracts and 12 full-text articles which outlined 11 unique risk-prediction models (Weinreich et al., 2016). Ten of the 11 models studied were based in the U.S. with one being researched in an academic medical center in Spain. All 11 of the studies defined PNA as the primary discharge diagnosis using International Classification of Diseases, Ninth Revision (ICD 9 CM) diagnoses codes, with one prospective study defined CAP using a clinical presentation of signs, symptoms and imaging (Weinreich et al., 2016). The study populations were patients aged 18 years

of age and older who had care delivered in single academic medical centers with information abstracted from Medicare and the Veterans Affairs (VA) data. The outcomes of the 11 studies had some variation where five studies used "all cause" 30-day readmissions, and two studies developed separate models to predict 30-day PNA-related and PNA-unrelated readmissions (Weinreich et al., 2016). The number of variables included per model ranged from 2 to 45 predictors with all of the models including the use of health related comorbidities. The strength of this systematic review is the documentation of the predictive module variables utilized in the 11 studies to assess the reduction of 30-day PNA readmissions. Table I summarizes the number of each of these variables found in this systematic review.

Table I: PNA readmission predictors included in risk prediction models



Source: Weinreich et al., 2016, *Annals ATS*, 13(9), 1-8.

Across all 11 studies in the systematic review, the "all cause" 30-day readmission rates ranged from 11.8 to 20.8% (median, 17.3%). Two of the 11 studies reported PNA-related readmissions rates lower at 2.6 and 7.2% respectively. A weakness in this review

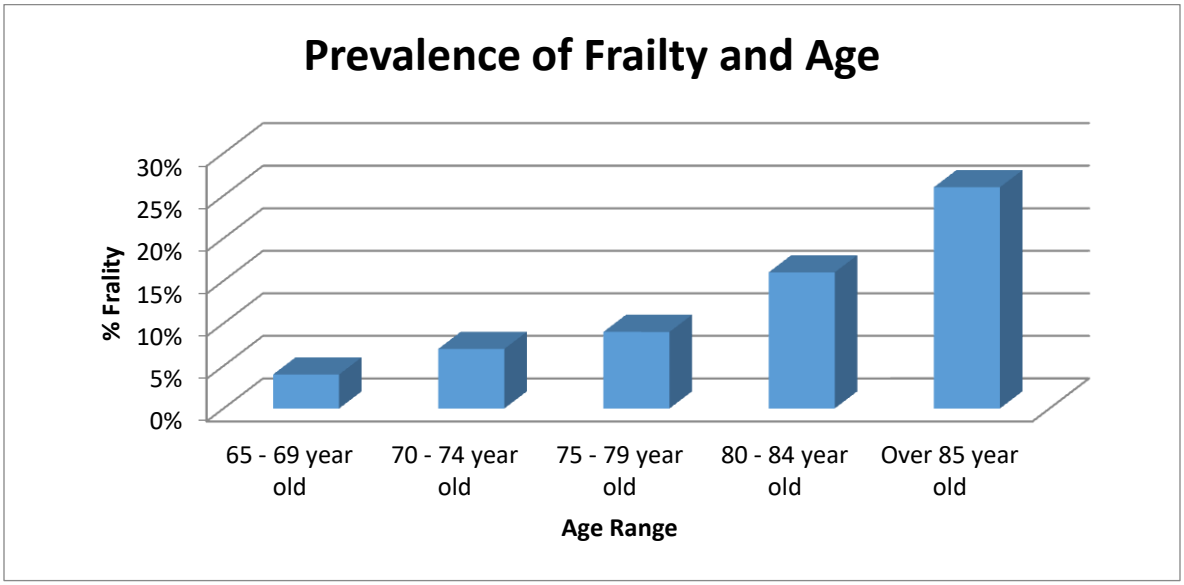
is that none of the 11 studies included strong predictors of death and associated hospital readmission rates such as PNA severity-of-illness score like the Pneumonia Severity Index (PSI) or CURB-65 (confusion of new onset, blood urea nitrogen, respiratory rate, blood pressure, age 65 years and older) (Ravindranath & Raju, 2016). It could be time intensive and expensive for a hospital to implement a readmission risk prediction models for every medical condition. Therefore, another strategy to identify high risk for readmission PNA patients is to use a validated risk prediction assessment such as the LACE index or HOSPITAL score. The LACE assessment tool identifies readmission utilizes risk through the measurement of the length of stay (LOS), acuity of admission, comorbidities, and emergency department (ED) visits, while the HOSPITAL score evaluates the hemoglobin level at discharge, determination of discharge from an oncology service, sodium level at discharge, procedure during hospital stay, index admission type as via the ED, number of hospital admissions in previous year, and index admission LOS (Weinreich et al., 2016). These validated assessment tools can be integrated in the electronic health record for completion and visible for implementation by the interprofessional team.

Mather, Fortunato, Ash, Davis, & Kumar (2014) revealed that the performance of one predictive model was increased when socioeconomic status and prior hospitalizations were variable also considered in risk stratification. This study cohort consisted of 956 index PNA admissions and included identification of vital signs, comorbidities, laboratory values, demographics, socioeconomic, and hospital resource utilization (Mather, et al., 2014). The multi-variate predictive model associated with 30- day readmission included male sex, three or more previous hospital admissions, history of

chronic lung disease, cancer, renal disease, anxiety or depression, median income less than $43,000, discharge to a skilled nursing facility (SNF), and a hematocrit (HCT) value less than 30%. The results of this study found that 148 (15.5%) subjects were readmitted within 30 days (Mather et al., 2014). A weakness of this study is that it was done in an inner-city tertiary care hospital therefore the study validity may be limited to the geographic area and practice type (Mather et al., 2014). Also, no specific interventions for the variables were identified as being significant.

The summary of the review of literature for patient-related factors identified issues that contribute to the risk of PNA readmissions in the Medicare population are not only related to medical management but also involves functional, social, economic, and environmental aspects that influence health. The clinical presentation of a PNA patient with advancing age could be atypical with symptoms that could be indicators of other conditions and disease processes such as falls, anorexia, altered mental status, fatigue, lethargy, or delirium (Cillóniz et al., 2018). The term frailty has been used with elders with physical weakness due to increasing age associated with a number of chronic health conditions. Table 2 illustrates the increasing prevalence of frailty and age.

Table 2: Frailty in Relationship to Age



Source: Cillóniz et al., 2018, *Med Sci (Basel)*, 6(2): 35.

For elderly adults requiring hospitalization to the intensive care units (ICU), the use of the Clinical Frailty Scale has provided clinicians with enough data to support that addition of the frailty assessment can assist with realistic quality of life and mortality discussions (Flaatten et al., 2017). The Frailty Index (FI) has been used to classify frailty and includes variables of physical states, chronic health conditions and functional systems such as mobility, debility, patient self-rated general health, hearing, and eyesight screening tools (Blodgett, Howlett, & Rockwood, 2017). The FI tool could be performed in the ambulatory setting such as the primary care provider's offices to proactively document health deficits. A way to operationalize the FI tool is to utilize the FI score with interpretation as scores increase to consider higher risk of negative health outcomes including death (Blodgett et al., 2017).

Although multiple causative agents can lead to CAP, the most common and frequently reported PNA pathogen that leads to hospitalization is Streptococcus

pneumoniae infection in the older adult population (Li, Gubbins, P. & Chen, 2015). Pneumococcal vaccination is considered an important CAP public health intervention that can reduce the burden of vaccine-preventable diseases (Miller, et al., 2015). A retrospective cohort study evaluated the significance of prior pneumococcal vaccination on health outcomes in elderly veterans hospitalized for CAP. This study reviewed 6,723 elderly veterans who were admitted to Veteran Administration (VA) hospitals for CAP and found that prior flu vaccination within one year and pneumococcal vaccine within five years before CAP admission was associated with a 10% reduction in LOS compared to having either vaccination (Li et al., 2015). Outpatient and inpatient providers need to have a robust vaccination surveillance process for the pneumococcal polysaccharide vaccine (PPSV23 or Pneumovax) or the pneumococcal conjugate vaccine (PCV13 or Prevnar 13) for elderly patients at an increased risk for CAP (CDC, 2017).

Silow-Carrol et al. (2011) describe a system related approach which includes transition of care processes such as post-acute period care coordination assistance and post-discharge follow-up care as these interventions have shown to reduce readmissions. An example of a successful hospital system approach is the Mount Sinai Medical Center (MSMC) EHR process where patients at risk of readmission being readmitted into the hospital were proactively and accurately identified for interventions and management (Shameer et al., 2017). The patients enrolled into MSMC's Preventable Admissions Care Team (PACT) program received social work-led interventions that began upon discharge. The patients were identified through psychosocial indicator designs that were documented in the Epic EHR (Shameer et al., 2017). MSMC implemented workflow processes which resulted in a 56% reduction in 30-day readmission rates and were

sustained at 60 and 90 days of discharge (Shameer et al., 2017). Ninety-one percent of patients enrolled in MSMC PACT (n= 615) made follow up appointment within seven to 10 days, with 84% of patients keeping their follow up outpatient appointments (Shameer et al., 2017).

Another example of a hospital system approach to reduce readmissions is to have a dedicated hospital-based readmission reduction (HBRR) team to design and implement transitional care to address behavioral, clinical, social, and other holistic needs (Agency for Healthcare Research and Quality, 2016). The Agency for Healthcare Research and Quality (AHRQ) provides tools and design methods for a HBRR team to establish cross-setting collaborations with services that supports high readmission risk patients in the post-acute and community settings (AHRQ, 2016).

There is variation in readmission rates nationally across states, ranging from 13.3% in Idaho to Washington D.C. being highest at 23% (Jencks, Williams, & Coleman, 2009). There are studies that discuss an association of higher rates of hospital readmission where there are high numbers of available hospital beds, and lower hospital readmission rates in areas where there is an increased access to primary care and continuity of care (Jencks et al., 2009). Hospital systems are investing in teams and partnerships with un-traditional community agencies and resources to manage patients at risk for readmission. As described in the literature, utilization of a multi-disciplinary, systematic approach that includes enhanced patient education with self-management training, telemonitoring programs that extend resources and clinical expertise, and proactive end of life counseling has shown to reduce PNA readmissions (Silow-Carrol et al., 2011).

Methods

This project is a QI initiative for acute care facilities located within a large Midwest hospital system and focuses on the PNA readmission and mortality rates of patients who receive Medicare. The theoretical framework that best fits the purpose, methods, and outcomes is Plan-Do-Study-Act (PDSA). For this project, only the completed the PDS part with consideration to act on implementing the best solutions identified.

Design

The study design is an observational cohort comparison that utilized a mixed method design to broaden the range and depth of understanding on the association of hospital RRS on PNA readmission and mortality rates. A mixed methods approach uses data collection, analysis, and inference methods that combine elements of qualitative and quantitative research (Schoonenboom & Johnson, 2017). The mixed method approach consisted of the use of interviews, aggregate data analysis, and statistical inference to identify relationships of strategies used in the acute care facilities that have implemented PNA RRS and analyze any differences during the influenza season (October through February) when there is an expected higher incidence of PNA admissions and readmissions.

The project coordinator is employed by the healthcare system-wide Quality and Safety (Q & S) department and has access to the health system acute care facilities' CMS readmission and mortality dashboards. The clinical dashboard aggregate data files and definitions are maintained by the Q & S Data Analytics Team. All aggregate data files were downloaded into excel spreadsheets for project analysis using SPSS.

The initial project design had been to include all acute care facilities in the hospital health system. However, after further investigation it was found that complete data for the hospital RRS or a regional operational leader knowledgeable of all strategies in place for that region, were not available for all the acute care facilities in the entire system. Further, complete data for the two comparison years was not available for all hospitals. The decision was made to reduce participation to the three acute care facilities that had complete data and access to the regional operational leader to participate in a readmission reduction strategy interview.

Setting

The descriptions of the three acute care facilities are provided in (Table 3). These hospital were selected for data collection and analysis due to the location of facilities for direct observation opportunities, access to the regional operations leadership for interview, bed size variation, the variation in the hospital system's FY2018 mortality rate being higher than the CMS Mortality Rate for the 2018 Top Quartile Benchmark of 15.4% (IBM Watson Health, 2018), and complete data for both years to allow comparisons.

Table 3: Hospital Characteristics

Hospital	Geography	Bed Size	Teaching Status	Ownership
A	Rural	50	Non-teaching	Private-Not-For Profit
B	Urban	703	Teaching	Private-Not-For Profit
C	Rural	251	Non-teaching	Private-Not-For Profit

**Teaching: Small residency program not affiliated with a Medical University

Sample

The inclusion criteria are male and females that are aged 65 years and older. The denominator is all Medicare patients admitted to one of the three acute care facilities with

a primary admission diagnosis of PNA. The numerator was any cause, unplanned Medicare 30-day PNA readmission and mortality at an acute care hospital. The CSP utilized only aggregate data for analysis, and did not include any protected health information (PHI).

Approval Process

The project was reviewed and approved by both the hospital system and University of Missouri - St. Louis (UMSL) Institutional Review Boards (IRB). This project is a QI initiative with potential benefits to the acute care facilities hospital facilities system-wide on its ability to correlate PNA reduction intervention efforts and identify and communicate best practices and opportunities for improvement for the entire health system.

Procedures

The PNA RRS currently utilized in the participating acute care facilities were obtained from the regional operations leader during a planned face-to-face interview using a tool created from the literature review of EBP RRS (Appendix B). The PNA readmission reduction strategy intervention data collected included inpatient and outpatient interventions such as influenza and pneumococcal vaccinations and telemonitoring. The approximate initial date of implementation for each strategy and knowledge if the strategy was present in both FY time periods were obtained.

The CMS PNA readmission and mortality clinical dashboard data was retrieved for the designated time periods of October through February for FY 2018 and FY 2019. The PNA mortality variables included are the hospital index admission source, index hospital LOS, index hospital principal diagnosis, patient age, gender and home zip code.

The PNA readmission variables included are the index hospital discharge disposition, readmission source, number of days to the readmission, readmission LOS, readmission principal diagnosis, readmission discharge disposition, patient age, gender and home zip code. The variables were analyzed for the PNA population for both of the study time periods. The descriptive analysis for frequency and percentages was initially performed on the data. The nonparametric statistical test of Chi-square Test of Independence (Chi-square) was used to identify if there was a difference in the observed and expected results when comparing the 30-day "all cause" readmission PNA rates of the facilities with the number and type of interventions for statistical significance during the two time periods.

The variable definitions and the plan for requesting the needed data reports were completed in February 2019. After the project was approved through both the hospital and UMSL IRBs in March 2019, the initial meeting was scheduled with the operational leader (Vice President of Case Management) in April 2019. During the interview meeting the approved project's interview tool was utilized to obtain answer questions on RRS including which strategies were present in FY 18 and FY 19.

Data Analysis

The initial data analysis consisted of descriptive statistics to describe the PNA readmission and mortality population and the hospital readmission strategies present from FY 2018 (October 2017 through February 2018) and FY 2019 (October 2018 through February 2019). Frequencies and percentages were calculated for each nominal variable (Appendices C and D). The Chi-square Test of Independence (Chi^2) and Fisher's Exact Test (Fisher's) were used to evaluate differences in the number of RRS on readmission and mortality rates and sample demographic variables in FY 2018 and FY 2019.

Results

The Chi^2 and Fisher's statistical test was performed to examine the difference between the total number of RRS and the readmission rates and mortality rates between FY 2018 and 2019 (Tables 4 and 5). The numbers of RRS were aggregated into the total strategies present per acute care facility in FY 2018 and FY 2019. The analysis included identification of RRS per hospital present in FY 2018 and FY 2019 (Appendix E). The difference was significant for readmissions, χ^2 (3, N= 107) = 25.15, p < .001, and Fisher's Exact test ($\alpha = 0.05$, $p < .001$) and mortality χ^2 (3, N= 58) = 34.93, p= <0.001 and Fisher's Exact test ($\alpha = 0.05$, $p < .001$).

Table 4: Statistical Tests for Readmission Reduction Variables- Readmit

Variable	Year 1 –FY 18 (N= 59)	Year 2 – FY 19 (N=48)	Statistic	p
# Readmission Strategies 7 8 10 13	 N= 19 N= 8 N= 0 N-32	 N= 0 N= 8 N= 7 N= 33	Test- Chi-square χ^2 = 25.150 df = 3	p= <0.001
# Readmission Strategies 7 8 10 13	 N= 19 N= 8 N= 0 N-32	 N= 0 N= 8 N= 7 N= 33	Test- Fisher's Exact Test	p= <0.001

Source: Intellectus Statistics [Online computer software]. (2019).

Table 5: Statistical Test for Readmission Reduction Variables- Mortality

Variable	Year 1 –FY 18 (N= 27)	Year 2 – FY 19 (N=31)	Statistic	p
# Readmission Strategies 7 8 10 13	 N= 7 N= 9 N= 0 N-11	 N= 0 N= 0 N=19 N= 12	Test- Chi-square $\chi^2 = 34.93$ df = 3	p= <0.001
# Readmission Strategies 7 8 10 13	 N= 7 N= 9 N= 0 N-11	 N= 0 N= 0 N=19 N= 12	Test- Fisher's Exact Test	p=<0.001

Source: Intellectus Statistics [Online computer software]. (2019).

The number of readmission and mortality rates was higher during influenza season (October – February) than non-influenza season (June – September) for FY 2018 and FY 2019 sample (Table 6).

Table 6: Readmission and Mortality Rates for Influenza versus Non-Influenza Season

Variable	Influenza Season Year 1 –FY 18	Non Influenza Season Year 1 – FY 18	Influenza Season Year 2 –FY 19	Non Influenza Season Year 2 – FY 19
Mortality	N= 27	N= 17	N= 31	N= 19
Variable	Influenza Season Year 1 –FY 18	Non Influenza Season Year 1 – FY 18	Influenza Season Year 2 –FY 19	Non Influenza Season Year 2 – FY 19
Readmission	N= 59	N= 27	N= 48	N=35

The Chi^2 and Fischer' statistical tests were performed to evaluate whether there were differences seen in the demographic variable between FY 2018 and FY 2019 sample (Tables 7 and 8). There were no significance seen in the readmission variables for readmission patient age, readmit patient gender, the index hospital discharge, readmit admission source, readmit source, readmit LOS, days to readmit, readmit discharge disposition, principal diagnosis description, patient expiring age, and gender, index

admission source for mortality cases, mortality index admission LOS, mortality index and principal diagnosis description between FY 2018 and FY 2019.

Table 7: Statistical Tests for Readmission Variables

Variable	Year 1 –FY 18 (N= 59)	Year 2 – FY 19 (N=48)	Statistic	p
Age 66-75 76-85 86 and older	 N=19 N=23 N=16	 N=23 N=15 N= 9	Test- Chi-square $\chi^2 = 2.905$ df = 2	p=0.23
Gender Male Female	 N=30 N=29	 N=16 N= 32	Test- Chi-square $\chi^2 = 3.313$ df = 1	p=0.069
Index Disch Disposition Home HC Facility	 N= 33 N=26	 N= 32 N=16	Test- Chi-square $\chi^2 = 1.279$ df = 1	p= 0.26
Readmit Source From Home From HC Facility	 N= 52 N= 7	 N=44 N= 4	Test- Chi-square $\chi^2 = 0.358$ df = 1	p=0.55
Readmit Source From Home From HC Facility	 N=52 N= 7	 N=44 N= 4	Test- Fisher's Exact Test OR= 0.678	P=0.75
Readmit LOS 0 – 4 5 – 10 11 and more	 N=35 N=19 N= 6	 N=27 N=15 N= 6	Test- Chi-square $\chi^2 = 0.468$ df = 2	p=0.79
Days to Readmit 0 – 15 16 – 30	 N=35 N=22	 N=26 N=22	Test- Chi-square $\chi^2 = 0.561$ df = 1	p=0.45
Readmit Disch Disp Home HC Facility Expired	 N=26 N=25 N= 8	 N=23 N=22 N= 3	Test- Chi-square $\chi^2 = 1.533$ df = 2	p=0.46
Readmit Prin Dx PNA/Influ/Resp Related Non Resp Related	 N=11 N= 48	 N= 15 N=33	Test- Chi-square $\chi^2 = 2.286$ df = 2	p=0.13

Source: Intellectus Statistics [Online computer software]. (2019).

Table 8: Statistical Tests for Mortality Variables

Variable	Year 1 –FY 18 (N= 27)	Year 2 – FY 19 (N=31)	Statistic	p
Age 66-75 76-85 86 and older	 N= 8 N= 9 N=10	 N= 9 N=11 N=10	Test- Chi-square $\chi^2 = 0.101$ df = 2	p=0.95
Gender Male Female	 N=11 N=16	 N=15 N= 16	Test- Chi-square $\chi^2 = 0.341$ df = 1	p=0.56
Index Admission Source From Home From HC Facility	 N=26 N= 1	 N=27 N= 4	Test- Chi-square $\chi^2 = 1.550$ df = 1	p=0.21
Index Admission Source From Home From HC Facility	 N=26 N= 1	 N=27 N= 4	Test- Fisher's Exact Test OR= 3.774	P=0.36
Index Admission LOS 0 – 4 5 – 10 11 and more	 N=11 N= 14 N= 2	 N= 8 N=16 N= 7	Test- Chi-square $\chi^2 = 3.124$ df = 2	p=0.21
Index Admission LOS 0 – 4 5 – 10 11 and more	 N=11 N=14 N= 2	 N= 8 N=16 N= 7	Test- Fisher's Exact Test	p=0.22
Index Adm Prin Dx PNA or Flu Non Resp Related	 N=20 N= 7	 N= 17 N=14	Test- Chi-square $\chi^2 = 2.312$ df = 1	p=0.13

Source: Intellectus Statistics [Online computer software]. (2019).

The PNA admissions denominator for FY 2018 was 337 and for FY 2019 the total hospital admissions were 292. The overall FY 2018 readmission rate for the three acute care hospitals was 17.5% and mortality rate 8%; the overall FY 2019 readmission rate was 16.4% and mortality rate 10.6%. The comparison between FY 2018 to FY 2019 shows a reduction in the readmission rate but an increase in the mortality rate.

Noteworthy observations were more females were admitted, readmitted and expiring during or after a PNA index admission. There had been no patients observed to have been readmitted more than once during a 35 day post discharge period. There were more patients being discharged to a home setting versus to a healthcare facility after the PNA index admission and after an all cause 30-day readmission. Further analysis found the most frequent patient zip codes for PNA readmissions were 63028; Jefferson County (n – 8), 63084; Franklin County (n – 6), and 63017; West St. Louis County (n – 5), and the top 3 patient zip codes for PNA mortality was 63090; Franklin County (n – 6), 63028; Jefferson County (n – 5), and 63020; Jefferson County (n – 4). Of the six patient zip code areas identified for PNA readmissions and mortality, five of the zip codes represented counties that are considered slightly less than average population density for the Midwest area.

Discussion

This project identified that there is a significant difference in the total numbers of hospital readmission strategies in place and the PNA readmission and mortality rates. With the insurance plans, employers, citizens, consumers, and government agencies all concerned about the current upward projector of the increased cost of care cannot be sustained. The work to improve the quality and safety in healthcare particularly to reduce cost due to avoidable readmissions is becoming increasingly important.

The EHR provides valuable patient related health data to not only the treating provider but also to professionals working on QI initiatives to yield better results for individuals and populations to move to toward desired health outcomes with reduced costs. A strength identified in this study is the ability to obtain the metrics from discrete

fields in the EHR for statistical analyzes on the CMS PNA population that are close to real-time. When CMS claims data are used there can be more comprehensive set of variables collected, however the drawback is the delay in obtaining data could be months in the past. The ability to have data available for analysis in close proximity to a patient's index admission provides an agile advantage to the interprofessional team to evaluate QI initiative changes and their effectiveness.

It was noted that there had not been a reduction in the total number of readmission strategies in any of the acute care facilities from FY 2018 and FY 2019, but rather additional strategies implemented in FY 2019. One acute care facility had the same number of RRS (n=13) in both study periods. One readmission strategy that was noted to be present in only one acute care facility. That strategy was having a hospital employed provider and advanced practice registered nurse (APRN) designated to manage the PNA patients admitted in the covering skilled nursing facility (SNF). This strategy provided the SNF patients with the individualized medical care and additional clinicians pre and post index admissions.

Although the highest number of RRS were present in FY 2019 including proactive end-of-life counseling and advanced directive, it was also observed that this year had more patients dying (n=31) compared to FY 2018 (n=27).

The use of this data for predictive modeling or artificial intelligence (AI) had been identified in the literature as an effective approach to proactively identify patients at a higher risk of readmission and mortality where appropriate resources can be mobilized for the patient. This project identified that the hospital system was not utilizing AI which

could proactively provide providers, case management, and other supportive services information to better assist patients at risk for readmission.

The data collected also allowed for an analysis of patients metrics while inpatient and outpatient. The term episode of care has been defined as upon an index hospital admission through 90 days post discharge. There are CMS Demonstration projects and value-based payment methodologies that incentivize hospitals and providers for identified improvements in quality and costs for an episode of care. This project can be leveraged for a PNA episode of care to reduce avoidable hospital readmission to reduce medical costs.

Limitations of this study include the inability to identify the specific impact of each RRS or combination of strategies. This is an important question as hospital system budgets for non-direct patient care staff are critically evaluated on the need for specific Q & S resources, programs and services. The QI initiative such as this project can show cost versus benefit comparisons that assist in budgetary discussions and decisions.

Conclusion

The hospital organizations that have innovative supportive departments that assist in the creation, implementation and monitoring of high reliable, safe, and cost effective healthcare programs can identify best practices to reduce avoidable medical costs of care. This project identified that for Medicare patients aged 65 and over admitted with a primary diagnosis of PNA that the number of EBP RRS utilized can result in lower 30-day all cause readmissions as seen by a drop for the three acute care hospitals FY 2018 readmission rate of 17.5 to 16.4% for FY 2019. Although this project design did not include all the acute care facilities within the Midwest hospital system due to incomplete

FY 2018 and FY 2019 EHR and RRS data or include which RRS could have contributed significantly to the reduction in FY 2019 readmission rates; the three hospitals studied appeared to have a PDSA cycles that tended to implement additional RRS each year. A recommendation for the hospital system is to create standardized RRS bundles based on a patient's risk stratification for readmission, discharge disposition of home, home with home health services, or SNF or other post-acute facility and determined social determinants of health. There needs to be a clear method of evaluating the bundle RRS relationship on did the patient receive the RRS and then an established monitoring of readmission and mortality rates for this population.

This project evaluated RRS that were implemented within the three acute care facilities; however there are a vast number of other community resources outside of the hospital system that assist with programs, services, and resources to augment the RRS for the PNA patient. A best practice recommendation for the hospital system is to include identified preferred community agencies in their bundle RRS. The care and services provided by these community agencies also need to be included in the identification of patient receiving the service and the established monitoring of readmission and mortality rates for the PNA patients. The findings from the best targeted PNA RRS bundles that produce improved health outcomes can be utilized for other populations and payor sources. The doctoral prepared nurses are well positioned to contribute and to lead transformational healthcare programs like the QI project to reduce readmission and mortality in the elderly population.

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Appendix A: PNA Evidence Table

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
Author(s), Date, Title, Journal Information, doi	Purpose & Outcome Measures or Goals (Aims)	Sample & Setting	Study Design & Interventions	Results, Strengths/Weaknesses, Limitations, & Recommendations
Agency for Healthcare Research and Quality. (2016). Designing and delivering whole-person transitional care: the hospital guide to reducing medicaid readmissions. *Collaborative Healthcare Strategies, Inc., and John Snow, Inc.*, under Contract No. HSA290201000034I). Rockville, MD: Publication No. 16-0047-EF	The intent of this publication is to help hospital-based readmission reduction teams design and deliver transitional care to address "whole-person needs" (clinical, behavioral, and social).	The strategies are for hospitalized patients to support upon discharge to avoid readmission.	This article provided tools and design methods for a hospital-based reduction team that provides cross-setting collaborations with services that supports patients in the post-acute and community settings. Outlined enhanced services for the high-risk patients.	This article provided toolkits for transitional care, however there are no statistics to determine effectiveness of tools provided.
Amarasingham R., Patel P.C., Toto K, Nelson L.L., Swanson T.S., Moore B.J., Xie, B, Zhang, S., Alvarez, K.S., and Ma, Y. (2013). Allocating scarce resources in real-time to reduce heart failure readmissions: A prospective, controlled study. *BMJ Qual Saf*; 22:998–1005.	The purpose of this article is to test a multidisciplinary approach to reduce heart failure (HF) readmissions that tailors the intensity of care transition intervention to the risk of the patient using a suite of electronic medical record (EMR)-enabled programs. To readmissions it may be more effective if resources are applied	The sample was 834 adult inpatient HF admissions in the pre-intervention period and 913 in the post intervention Period evaluated; two periods of equal length: the pre-intervention period (1 December 2008 to 30 November 2009) and the post-intervention period (1 December 2009 to 30 November 2010). at Parkland Health and Hospital System, a 780-bed tertiary care	A quasi-experimental approach using a prospective controlled study that evaluated 29 clinical, social, behavioral and utilization factors *(These variables included, among others, Brain Natriuretic Peptide (BNP), troponin, creatinine kinase, blood urea nitrogen, albumin, gender, marital status, payor status, number of documented home address changes within the past 12 months, history of positive urine cocaine within*	The HF nurse practitioner reviewed the EMR of high-risk patients electronically flagged by the software program to confirm the presence of HF using echocardiographic data. Up to 3 patients per day with the highest ranked risk scores were enrolled daily. The unadjusted readmission rate declined from 26.2% in the pre-intervention period to 21.2% in the post-intervention period (p=0.01). In contrast, there was no significant change in the unadjusted and adjusted readmission rates for PNA and AMI over the same period. There were 45

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
	differentially according to a patient's relative risk of readmission.	teaching hospital located in Dallas, Texas.	*the past 12 months, history of missed clinic visits within the past 6 months and number of hospital admissions prior to index admission)* extracted in real time from the EMR within 24 h of admission for HF. The Tabak score stratifies the HF patients daily by their 30-day readmission risk using a published electronic predictive model. Patients at highest risk received an intensive set of evidence-based interventions designed to reduce readmission using existing resources. To control for secular trends, the researchers compared concurrent rates of 30-day readmission for patients with acute myocardial infarction (AMI) and pneumonia (PNA)	fewer readmissions with 913 patients enrolled and 228 patients receiving intervention.
Assaad, U., El-Masri, I., Porhomayon, J., and El-Solh, A. (2012). Pneumonia immunization in older adults: review of vaccine effectiveness and strategies. *Clin Interv Aging*; 7: 453–461. doi: 10.2147/CIA.S29675.	The focus of this article is on an analysis of the effectiveness of pneumococcal vaccination as the primary preventive strategy in the elderly against Streptococcus pneumoniae and influenza infections.	The participants in this article are adults, with specific information based on race, education and insurance coverage.	This article design is a systematic review of randomized controlled trials (RCTs) and observational studies aimed at determining clinical outcomes and immune response following pneumococcal vaccination.	Could be some bias as article disclosed that AES has served as a consultant for Pfizer. the Advisory Committee on Immunization Practices (ACIP) advocates a single dose of 23-valent pneumococcal capsular polysaccharide vaccine (PPSV23) for all persons aged 65 years and older. In addition, for adults aged 19–64 years, PPSV23 should be administered to those who

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
				are immunocompromised (including chronic renal failure or nephrotic syndrome); those with functional or anatomic asplenia; those who are immunocompetent and have chronic conditions such as alcoholism, diabetes mellitus, or chronic lung disease; those who are smokers; and those with cochlear implants or cerebrospinal fluid leaks. A repeat vaccination is recommended for persons ≥ 65 years of age who received their first vaccine at <65 years of age, but revaccination is not recommended for persons who received their first vaccination at ≥65 years of age unless the patient is immunocompromised or asplenic. One-time revaccination after 5 years is recommended for older adults with chronic renal failure, nephritic syndrome, or immunosuppressive conditions.
Boccuti, C., and Casillas, G. (2017). Aiming for fewer hospital u-turns: the medicare hospital reduction program. *The Henry J. Kaiser Family Foundation*. Retrieved from https://www.kff.org/medicare/issue-brief/aiming-for-fewer-hospital-u-turns-the-medicare-	The purpose of this article is to analyze the first five years of the Hospital Readmission Reduction Program (HRRP).	The participants in this article are Medicare patients readmitted for either heart attack, heart failure, pneumonia, chronic obstructive pulmonary disease (COPD), elective hip or knee replacement, and coronary artery bypass graft	This study design is background information and expert opinion.	The analysis of the HRRP is that there have been reductions in hospital readmission. A continuing decline in preventable readmission rates would help slow the growth in Medicare spending and may also signal improved care for patients during and after their hospitalizations.

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
hospital-readmission-reduction-program/.		(CABG). There was also an analysis of readmissions by hospital characteristic (teaching urban vs. rural)		
Calvillo-King L, Arnold, D., Eubank, K.J., Lo M, Yunyongying P., Stieglitz, H., Halm, E.A. (2013). Impact of social factors on risk of readmission or mortality in pneumonia and heart failure: systematic review. *J Gen Intern Med*; 28:269–282.	The purpose of this study is to assess the impact of social factors on risk of readmission or mortality after hospitalization for CAP and HF that are variables outside a hospital's control.	Seventy-two articles met inclusion criteria (20 CAP, 52 HF) from 1980 to 2012	Systematic review searched OVID, PubMed and PSYCHINFO for studies were characteristics extracted, domains of social factors examined, and presence and magnitude of associations	Findings of disparities by race/ethnicity or gender were very mixed. Measures of low socioeconomic status (low income, education, Medicaid insurance) clearly increased risk. There was proof of concept evidence that social environment (housing stability, social support), behavioral (adherence, smoking, substance abuse), socio-cognitive (language proficiency), and neighborhood (rurality, distance to hospital) factors were independent predictors of poor post hospital outcomes.
Cillóniz, C., Rodríguez-Hurtado, D., Torres, A. (2018). Characteristics and management of community-acquired pneumonia in the era of global aging. *Med Sci (Basel)* 6(2): 35.	The aim of this study is to identify how the clinical presentation of community-acquired pneumonia (CAP) in may be atypical, and describes pneumonia in older patients could present with presenting symptoms such as falls and altered mental status, fatigue, lethargy, delirium, or	The participants in this article are elderly adults with diagnosis of CAP.	The study design of this article is critically-appraised individual articles across the globe.	The authors analyzed CAP studies from other countries and compared to the United States. The summary outlined how clinical teams combining pulmonary specialists, infectious diseases and geriatric specialists are needed for its management. Establishing functional status in elderly patients with CAP is also essential since it is related to clinical outcomes and treatment response.

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
	anorexia. This article outlines approaches to avoid delayed diagnosis and therapy.			
De Alba, I., and Amin, A. (2014). Pneumonia readmissions: risk factors and implications. *Ochsner J.* 14(4): 649–654.	The primary focus of this article is to discuss how most 30-day readmissions are not because of pneumonia-related causes. The outcome stated is there was a reduction in readmission rates when interventions targeted transitional care, care coordination, and post-discharge care.	The age of the study participants is assumed to be adults with Medicare or Medicaid insurance coverage and hospitalized. Of the studies chosen in this article the method of selecting the samples were not clearly described.	The design of this article is a summary of case-controlled studies using Centers for Medicare and Medicaid Services (CMS) readmission data.	The researchers quoted results from several studies that analyzed CMS readmission data. In the methods section, the authors did not clearly define the exact number of studies used for their article. The authors gave brief summaries of the studies chosen and provided some implications of the research. It would have been helpful if more information on the cited studies and data gathered.
Hatipoğlu, U., Wells, B., Chagin, K., Dhruv Joshi, D., Milinovich, A and Rothberg, M. (2018). Predicting 30-day all-cause readmission risk for subjects admitted with pneumonia at the point of care. *Respiratory Care*, 63 (1) 43-49; doi: https://doi.org/10.4187/respcare.05719.	The purpose of this study is to create an accurate prediction model, improving in-hospital care, transitions of care and post-discharge disease management programs for determining the risk of 30-d readmission at the point of discharge.	The model was created using a data set of 1,295 hospitalizations at the Cleveland Clinic Main Campus with pneumonia over 3 years.		The final model contained 13 variables and had a bias-corrected C statistic of 0.74 (95% CI 0.71–0.77). Number of admissions in the prior 6 months, opioid prescription, serum albumin during the first 24 h, international normalized ratio and blood urea nitrogen during the last 24 h were the predictor variables with the greatest weight in the model. This data can potentially be used to focus post-acute care interventions in a high-risk group of patients
Joynt, K., Figueroa, J., Orav, E., and Jha, A. (2016). Opinions on the	The purpose of this article is to determine the opinions of US hospital	This study surveyed leadership at 1600 US acute care hospitals	This study used a stratified sampling design to oversample hospitals in the	Compared with 36.1% for public reporting of readmission rates and 23.7% for public reporting of discharge

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
hospital readmission reduction program: results of a national survey of hospital leaders. *Am J Manag Care*; 22(8):e287-e294. Retrieved from https://www.ajmc.com/journals/issue/2016/2016-vol22-n8/opinions-on-the-hospital-readmission-reduction-program-results-of-a-national-survey-of-hospital-leaders	leadership on the Hospital Readmissions Reduction Program (HRRP), a national mandatory penalty-for-performance program.	that were subject to the Hospital Readmission Reduction Program (HRRP) and achieved a 62% response rate. Results were stratified by the size of the HRRP penalty that hospitals received in 2013 and adjusted for no response and sampling strategy.	highest and lowest quintile of performance on readmissions, and hospitals serving a high proportion of minority patients.	processes, 65.8% of respondents reported that the HRRP had a "great impact" on efforts to reduce readmissions. The most common critique of the HRRP penalty was that it did not adequately account for differences in socioeconomic status between hospitals (75.8% "agree" or "agree strongly"); other concerns included that the penalties were "much too large" (67.7%), and hospitals' inability to impact patient adherence (64.1%). These sentiments were each more common in leaders of hospitals with higher HRRP penalties.
Kwok CS, Loke YK, Woo K, Myint PK. (2013). Risk prediction models for mortality in community-acquired pneumonia: a systematic review. *Biomed Res Int.*:504136.	This study aims to systematically identify and evaluate the performance of published risk prediction models for CAP.	20 different published risk prediction models in November 2011 for mortality in CAP. Four models relied on clinical variables that could be assessed in community settings.	Systematic review searched MEDLINE, EMBASE, and Cochrane library for initial derivation and validation studies for models which predict pneumonia mortality. We aimed to present the comparative usefulness of their mortality prediction.	Variables were categorized into five groups: patient characteristics (age, gender, immunosuppression, and renal disease), clinical variables (pulse rate, blood pressure, respiratory rate, temperature, presence of shock, and confusion), laboratory measures (urea/blood urea nitrogen (BUN), white cell count, PaO2/SaO2, hematocrit, glucose, sodium, and pH), radiological findings (pleural effusion and multilobar pneumonia on chest X-ray), and physician judgment (need for mechanical ventilation). The four most commonly used variables (found in >10 scores) were confusion or altered mental status, respiratory rate, systolic

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
				blood pressure, and urea. There is no convincing evidence that other risk prediction models improve upon the well-established CURB-65 and PSI models.
Li, C., Gubbins, P., Chen, G. (2015). Prior pneumococcal and influenza vaccinations and in-hospital outcomes for community-acquired pneumonia in elderly veterans. *Society of Hospital Medicine;* 10(5), 287-293. doi 10.1002/jhm.2328.	This article examined the effect of prior pneumonia vaccination (PV) in the 5 years and flu vaccination (FV) in the 1 year before hospitalized elderly veterans for community-acquired pneumonia (CAP) and their health outcomes.	This study participants were a total of 6,723 elderly veterans who were admitted to Veterans Affairs hospitals for CAP between October 1, 2002 and September 30, 2003.	This study design is a retrospective cohort study that evaluated the association of prior PV and/or FV with inpatient mortality and length of stay (LOS) for the primary diagnosis, and risk of any bacteremia and respiratory complications (secondary) using logistic regressions and generalized linear model, controlling for patient demographic and clinical characteristics.	The researchers identified that prior PV alone was not associated with shortened LOS, or reduced risk of inpatient mortality or respiratory complications. Lower risk of bacteremia was associated with prior PV (odds ratio: 0.66; 95% confidence interval [CI]: 0.48-0.90). After adjusting for patients' characteristics, risk of inpatient mortality was not statistically significantly different across the vaccination groups but having had both PV and FV before CAP admission was associated with a 10% reduction in LOS (95% CI: 0.86-0.95) compared to having had neither vaccination. This study showed a benefit for having both PV and FV before CAP admission may reduce LOS and improve CAP outcomes in hospitalized patients.
Mather, J.F., Fortunato, G.J., Ash, J.L., Davis, M.J., and Kumar A. (2014). Prediction of pneumonia 30-day readmissions: a single-center attempt to increase model performance.	The intent is to leverage variables shown to be significant in previously reported predictive models and supplement the CMS medical record model 6 with additional variables in an effort to produce	133,368 admissions to Hartford Hospital, an 800-bed teaching hospital in Hartford, Connecticut from January 2009 to March 2012, the study cohort consisted of 956 index admissions for	Retrospective observational analysis collected variables previously reported to be associated with 30-day all-cause readmission, male sex, 3 or more previous admissions, chronic lung disease, cancer, median income < $43,000, history of	Of 956 pneumonia admissions, 148 were readmitted within 30 days, for an unadjusted readmission rate of 15.5%. Pneumonia-related hospital readmissions accounted for 16.9% of total 30-day readmissions. Five (20%) of the subjects readmitted for

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
Respir Care; 59:199–208.	a model to identify before discharge patients at high risk for readmission.	pneumonia, using CMS definition	anxiety or depression, and hematocrit < 30% and indicators of hospital utilization.	pneumonia-related causes died in the hospital, and 13 (52%) were transferred to a skilled nursing facility. The most frequent diagnosis for pneumonia-unrelated readmissions included aspiration pneumonitis, congestive heart failure, and cardiorespiratory failure and shock.
Mitchell S., Martin J, Holmes S, van Deusen, L., Cancino, R., Paasche-Orlow, M., Brach, C, and Jack, B. (2016). How hospitals reengineer their discharge processes to reduce readmissions. *J Healthc Qual*. 38 (2): 116-26. doi: 10.1097/JHQ.0000000000000005.	The aim of this article is to identify the factors that influenced five California hospitals to implement Project Re-Engineered Discharge (RED) and the subsequent impact on RED program sustainability.	This study involved participant observation, key informant and focus group interviews with 64 individuals at five California hospitals implementing RED in 2012 and 2013.	The study design is case control study where interview transcripts were coded and analyzed using a modified grounded theory approach and constant comparative analysis.	This study showed that the sustainability of RED in participating hospitals was possible when the hospitals approached RED implementation as a transformational process rather than a patient safety project. Leadership, high fidelity to using the 12 steps in the RED toolkit, and an implementation team who embraced change and failure in the pursuit of better patient care and outcomes was key. Hospitals that were unsuccessful in implementing a sustainable RED process lacked all or most of these components in their approach. These findings provided valuable details, however would have been better if there were statistics to show the variances between "successful" vs. "unsuccessful" hospitals.
Nagasako, E.M., Reidhead, M., Waterman, B., and Dunagan, W.C. (2014). Adding socioeconomic data to hospital readmissions		The studied 12,070 hospital readmissions for patients discharged from non-federal Missouri acute care or critical access hospitals		

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
calculations may produce more useful results. *Health Aff (Millwood)*; 33:786–791.		between June 1, 2009 and May 31, 2012, with principal diagnoses of acute myocardial infarction, heart failure, and pneumonia.		
Ramirez, J.A., Wiemken, T.L., Peyrani, P., Arnold, F.W., Kelley, R., Mattingly, W.A., Nakamatsu, R., Pena, S., Guinn, B.E., Furmanek, S.P.,Persaud, A.K., Raghuram, A., Fernandez, F., Beavin, L., Bosson, R., Fernandez-Botran, R., Cavallazzi, R., Bordon, J., Valdivieso, C., Schulte, J., & Carrico, R.M. (2017). Adults hospitalized with Pneumonia in the united states: incidence, epidemiology, and mortality. *Clinical Infectious Diseases*, 65(11), 1806-1812.				
Shameer, K., Johnson K., Yahi, A., Miotto, R., Ricks, D., Li, L., Jebakaran, J. Kovatch, P., Sengupta, P., Gelijns, A., Moskovitz, A., Darrow, B., Reich, D., Kasarskis, A.,	The purpose of this article is to describe Mount Sinai Heart Hospital's attempt to develop a data-driven, electronic-medical record (EMR)-wide feature selection	The study participants were 1,068 individuals admitted to Mount Sinai Heart service during the year 2014.	The study design is a cohort study. A total of 4,205 variables were extracted from EMR including diagnosis codes (n=1,763), medications (n=1,028), laboratory measurements (n=846), surgical	The researchers provided details of their steps, methods, and study limitations. The use of data-driven machine learning can be utilized in other population other than HF.

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
Tatonetti, N., Pinney, S., and Dudley, J. (2017). Predictive modeling of hospital readmission rates using electronic medical record-wide machine learning: a case study using mount sinai heart failure cohort. *Pac Symp Biocomput*; 22:276-287. doi: 10.1142/9789813207813_0027.	approach and subsequent machine learning to predict 30-day heart failure (HF) readmission probabilities.		procedures (n=564) and vital signs (n=4). They used a multistep modeling strategy called the Naïve Bayes algorithm. This algorithm created individual models of cases (readmitted) and controls (non-readmitted). Then features contributing to predictive risk from independent models were combined into a composite model using a correlation-based feature selection (CFS) method. All models were trained and tested using a 5-fold cross-validation method, with 70% of the cohort used for training and the remaining 30% for testing. Compared to existing predictive models for HF readmission rates (AUCs in the range of 0.6–0.7), results from our EMR-wide predictive model (AUC=0.78; Accuracy=83.19%)	
Silow-Carrol, S., Edwards, J., and Lashbrook, A. (2011). Reducing hospital readmissions: lessons from top-performing hospitals. *The Commonwealth Fund*; 1473(5), 1-20.	This report offers a synthesis of findings from four case studies of hospitals with exceptionally low hospital readmission rates	The articles states that the hospitals identified and targeted patients at the highest risk for readmissions, using the diagnoses such as heart failure, myocardial infarction and pneumonia	The design of this article is a summary of four cases series from McKay-Dee Hospital in Ogden, Utah; Memorial Hermann Memorial City Medical Center in Houston, Texas; Mercy Medical Center in Cedar Rapids, Iowa; and St. John's Regional Health Center in	This article did a good job summarizing the similar interventions of the four hospitals analyzed (close care coordination, early post discharge follow up care, enhanced patient education, patient self-management training, end of life counseling, extending the resources and clinical expertise available, improved coordination across the

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		patients that were elderly and had complex medical and social needs, and those without the financial resources to obtain post-hospital care. It would have been better to use specific DRGs to identify the population involved.	Springfield, Missouri.	health care continuum, State Action on Readmissions (STAAR), and employed home health liaisons. Also highlighted daily interdisciplinary care coordination rounds. Although there were a few tables with statistics, most of the information was qualitative.
Tang V.L., Halm E.A., Fine M.J., Johnson C.S., Anzueto A, and Mortensen E.M. (2014). Predictors of rehospitalization after admission for pneumonia in the Veterans Affairs healthcare system. *J Hosp Med*; 9:379–383.	The purpose of this study was to examine predictors of early (≤30 days) readmission in the VA for patients age 65 years and older hospitalized for pneumonia. The priori hypothesis was that comorbid illnesses, such as congestive heart failure and chronic obstructive pulmonary disease, and patients with high medical complexity, such as high number of medications and/or prior hospitalizations and nursing home residence, are the primary factors associated with increased risk of rehospitalization	The sample included a cohort of 45,134 patients 65 years old and older who were hospitalized with pneumonia in 150 VA acute care hospitals and 850 outpatient clinics throughout the U.S from October 2001 to September 2007	Retrospective data analysis. Randomly divided patients from our initial cohort into equal derivation or validation cohorts. We assessed differences between the two groups using Student's t-test for continuous variables and chi-square test for categorical variables	Variables that were significantly associated with rehospitalization in the models included age, marital status, the number of emergency department clinic visits a year prior, prior admission, number of non-pharmacy clinic visits in 1 year prior, and hospital length of stay. The increasing age and number of ER and clinic visits were associated with higher odds of readmission. The longer the length of stay and those patients that were married had a lower odds of subsequent readmission. Other variables included were the presence of chronic renal disease, prior malignancy, nursing home residence, congestive heart failure, and prior use of oral corticosteroids. It remains to be determined if readmissions after pneumonia are truly preventable or mostly attributable to the patient's prior health status.

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Wasfy, J., Zigler, C., Choirat, C., Wang, Y., Dominici, F., and Yeh, R. (2016). Readmission rates after passage of the hospital readmission reduction program. A pre-post analysis. *Ann Intern Med*. 166(5): 324–331.	The primary objective of this article is to evaluate whether passage of the Hospital Readmission Reduction Program (HRRP) was followed by acceleration in improvement in 30-day risk-standardized readmission rates (RSRR) s after hospitalizations for acute myocardial infarction (AMI), congestive heart failure (CHF), or pneumonia and whether the lowest-performing hospitals had faster acceleration in improvement after passage of the law than hospitals that were already performing well.	The sample is 15,170,008 Medicare patients discharged alive from 2000 to 2013. The setting is all U.S. acute care hospitals.	The design of this article is a pre–post analysis stratified by 30-day readmission rates after hospitalization for AMI, CHF, or pneumonia for hospitals in the highest-performance (0% penalty), average-performance (>0% and <0.50% penalty), low-performance (≥0.50% and <0.99% penalty), and lowest-performance (≥0.99% penalty) groups.	Findings suggest that implementation of the HRRP achieved its goal of accelerating reductions in hospital readmissions, particularly for the lowest-performing institutions. findings also show how policies motivate health care providers to improve performance. Findings suggest that coupling performance metrics to financial incentives may have more substantial effects on performance than public reporting alone.
Weinreich, M., Nguyen, O., Wang, D., Mayo, H., Mortensen, E., Halm, E., and Makam, A. (2016). Predicting the risk of readmission in pneumonia. A systematic review of model performance. *Annals ATS*, 13(9), 1-8. https://doi.org/10.1513/AnnalsAT	The purpose of this study is to synthesize the available literature on readmission risk prediction models for adults who are hospitalized with pneumonia and describe their performance.	992 citations reviewed, 7 studies met inclusion criteria, which included 11 unique risk prediction models	The design of this article is a systematic review. The database searched was Ovid MEDLINE, Embase, The Cochrane Library and Cumulative Index to Nursing and Allied Health Literature databases from inception through July 2015.	To improve predictive accuracy, future models should include measures of pneumonia illness severity, hospital complications, and stability on discharge. Most readmissions are not due to a recurrence or inadequate treatment of the pneumonia itself but rather from the impact of the acute illness on their other comorbidities and general health. To identify patients at high

CITATION	PURPOSE / BACKGROUND	PARTICIPANTS / SETTING	METHODS / DESIGN	RESULTS / LIMITATIONS / RECOMMENDATIONS
S.201602-135SR				risk for readmission, it is essential to not only include predictors of pneumonia illness severity and compliance with guideline concordant therapies but also include predictors of frailty and medical complexity that may put patients at greater risk for post hospital syndrome or decompensation of their other chronic conditions.
Zangerle, C., and Kingston, M.B. (2016). Managing care coordination and transitions: the nurse leader's role. *American Organization of Nurse Executives* (AONE). 171-173.	The primary objective of this article is to outline six key strategies on how nurses can lead role to assist with care coordination and transition management roles for patients.	The article is for the hospital setting, however details on the patients were not provided.	The design of this article is background information. No type of research design was utilized.	This article was a report out from a collaborative of nurse leaders from the American Organization of Nurse Executives (AONE) and the American Academy of Ambulatory Care Nursing (AAACN). The output from this meeting was good; however there had not been any information on next steps or implementation plans.

Appendix B

Readmission Reduction Strategy Interview Tool			
Description of Readmission Reduction Strategy	**Midwest Hospital System**		
	Site A	**Site B**	**Site C**
	Instructions: List Y/N if strategy present. If Y enter date implemented		
Pneumococcal vaccinations IP/OP EHR Support			
Influenza vaccinations IP/OP EHR Support			
Hospital-Based Readmission Reduction Team			
Proactive End-of-Life Counseling (Advanced Directive)			
IP Case Management for PNA patient			
OP Case Management for PNA patient			
Transitional Case Management for PNA patient			
Care Coordination with PCP for PNA patient			
Telemonitoring/VCC			
Community Health Worker (CHW) Support			
Use of ASO/Insurance readmission risk reports			
Post Acute Care Team (Provider and NP support)			
Contracted Post-Acute Providers/Support			
Use of a predictive readmission model			
Readmission risk stratification PNA specific			
Incorporates CURB-65 Assessment			
Incorporates LACE Assessment			
Use of Frailty Assessment Inpatient/Outpatient			
Other:			

Appendix C: Summary Table of FY 2018 and FY 2019 Readmission Data

Variable	n	%	Cumulative %
FY			
18	59	55.140	55.140
19	48	44.860	100.000
Missing	0	0.000	100.000
Index_Disch_Disp			
Discharged to home	65	60.748	60.748
Discharged to HC Facility	42	39.252	100.000
Missing	0	0.000	100.000
Pat_Age			
65 years old or younger	2	1.869	1.869
66 – 75 years old	42	39.252	41.121
76 – 85 years old	38	35.514	76.636
86 years or older	25	23.364	100.000
Missing	0	0.000	100.000
Pat_Gender			
Male	46	42.991	42.991
Female	61	57.009	100.000
Missing	0	0.000	100.000
Rdmt_Adm_Source			
Readmitted from a home setting	96	89.720	89.720
Readmitted from a HC facility	11	10.280	100.000
Missing	0	0.000	100.000
Rdmt_Days_to_Rdmt			
Readmission 1 - 15 days post discharge	61	57.009	57.009
Readmission 16 - 30 days post discharge	44	41.121	98.131
Readmission more than 30 days	2	1.869	100.000
Missing	0	0.000	100.000
Rdmt LOS			
1 - 4 days	62	57.944	57.944
5 - 10 days	34	31.776	89.720
greater than 10	11	10.280	100.000
Missing	0	0.000	100.000
Rdmt Disch Disp			
Expired during readmission	30	28.037	28.037
Readmit dischg to Home	57	53.271	81.308
Readmission dischg to HC Facility	20	18.692	100.000
Missing	0	0.000	100.000
Rdmt Prin DX Desc			
Readmission Dx PNA or Influenza related	26	24.299	24.299
Readmission DX not related PNA or Flu	81	75.701	100.000
Missing	0	0.000	100.000

Source: Intellectus Statistics [Online computer software]. (2019).

Appendix D: Summary of FY 2018 and FY 2019 Mortality Data

Variable	n	%	Cumulative %
FY			
18	27	46.552	46.552
19	31	53.448	100.000
Missing	0	0.000	100.000
Index_Adm_Source			
Admit from non-HC facility	53	91.379	91.379
Admit from non-HC facility	5	8.621	100.000
Missing	0	0.000	100.000
Index_Disch_Disp			
Expired during Index admission	28	48.276	48.276
Expired at home	15	25.862	74.138
Expired in a HC facility	15	25.862	100.000
Missing	0	0.000	100.000
Index_LOS			
1 - 4 days	19	32.759	32.759
5 - 10 days	30	51.724	84.483
Greater than 11 days	9	15.517	100.000
Missing	0	0.000	100.000
Index_Prin_DX_Desc			
PNA or Flu	37	63.793	63.793
Not PNA Related or Flu	21	36.207	100.000
Missing	0	0.000	100.000
Pat_Age			
65 years old or younger	1	1.724	1.724
66 – 75 years old	17	29.310	31.034
76 – 85 years old	20	34.483	65.517
86 years or older	20	34.483	100.000
Missing	0	0.000	100.000
Pat_Gender			
Male	26	44.828	44.828
Female	32	55.172	100.000
Missing	0	0.000	100.000

Source: Intellectus Statistics [Online computer software]. (2019).

Appendix E: RRS per Hospital for FY 2018 and FY 2019

Variable	***FY 18***			***FY 19***		
Readmission Reduction Strategies	***Hosp A***	***Hosp B***	***Hosp C***	***Hosp A***	***Hosp B***	***Hosp C***
Pneumococcal vaccinations IP/OP EMR Support	Y	Y	Y	Y	Y	Y
Influenza vaccinations IP/OP EMR Support	Y	Y	Y	Y	Y	Y
Hospital-Based Readmission Reduction Team	N	Y	Y	Y	Y	Y
Proactive End-of-Life Counseling (Advanced Directive)	Y	Y	Y	Y	Y	Y
IP Case Management for PNA patient	Y	Y	Y	Y	Y	Y
OP Case Management for PNA patient	Y	Y	Y	Y	Y	Y
Transitional Case Management for PNA patient	Y	Y	Y	Y	Y	Y
Care Coordination with PCP for PNA patient	Y	Y	Y	Y	Y	Y
Telemonitoring	N	Y	N	Y	Y	Y
Community Health Worker (CHW) Support	N	Y	N	Y	Y	Y
Use of ASO/Insurance readmission risk reports	N	Y	N	N	Y	N
Post Acute Care Team (Provider and NP support)	N	Y	N	N	Y	N
Contracted Post-Acute Providers/Support	N	Y	N	N	Y	N
Use of a predictive readmission model	N	N	N	N	N	N
Readmission risk stratification PNA specific	N	N	N	N	N	N
Incorporates CURB-65 Assessment	N	N	N	N	N	N
Incorporates LACE Assessment	N	N	N	N	N	N
Use of Frailty Assessment Inpatient/Outpatient	N	N	N	N	N	N
Totals	7	13	8	10	13	10