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Examining the Effects of Approaches on Reducing Hospital Utilization: The Patient-Centered Medical Home, Continuity of Care, and the Inpatient Palliative Consultation at the End-of-Life

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ABSTRACT

Examining the effects of approaches on reducing hospital utilization: The patient-centered medical home, continuity of care, and the inpatient palliative consultation at the end-of-life

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Background: It has become a national priority to reduce the high health care expenditure in the United States while improving the quality of care. Hospital care is taking up one-third of the healthcare spending, and services offered in hospitals are costly compared to others. Only one-twentieth of the patients with high-needs account for about half of the health care spending. They consuming a high level of hospital services if their conditions are not well-managed in the outpatient settings. Therefore, it is important to examine the effectiveness of the approaches that have the potentials to reduce costly care utilization through improvements in the quality of care. This dissertation thesis focused on examining the effects of three approaches to reduce hospital utilization. The three approaches include the patient-centered medical homes (PCMH), better continuity of care (COC), and the early use of inpatient palliative consultation (IPC) at the end of life.

Methods: Andersen's Behavioral model of health care utilization was used to guide the modeling process of the three individual studies. The first study used data from the Medical Expenditure Panel Survey Household Component (MEPS-HC). Respondents who reported having a usual source of care other than the emergency department (ED) were included, and they were classified into three levels of PCMH groups by their baseline-year care features from 11 selected items. The outcomes were the second-year hospital admissions and ED visits due to the ambulatory care sensitive conditions (ACSCs). Logistic regressions that accounted for survey weights were used. The second study was conducted among a nationally representative Taiwan Population who were admitted for the first time for the five conditions. The outcomes are the numbers of all-cause and condition-specific hospitalizations during the follow-up year after discharge, and the primary explanatory variable was the outpatient COC. Multivariable generalized estimation equation models with a negative binomial distribution and log link were used. The third study used Nebraska Hospital Discharge Data linked with death certificates to identify the inpatient services received by the Nebraska Decedents due to the top six causes of death. The use of IPC was classified by the time receiving it as early use and late use, and the comparison group was the decedents who never encountered IPC. The outcomes were end-of-life events including hospice discharge, place of death, intensive care utilization, life-sustaining treatment, length of stay and total inpatient charges. Mixed-effect logistic regressions, logistic regression, negative binomial regression, and generalized linear model with log link and gamma distribution were used for those outcomes respectively.

Results: The highest level of PCMH primary care was associated with lower risks of having admissions and ED visits due to ACSCs. However, individual attributes of PCMH did not have the same effects. The patients with better COC have significantly fewer all-cause hospitalizations for all the conditions. The COC only worked in patients with ACSC conditions in reducing the condition-specific hospitalizations. The early use of IPC was associated with lower likelihoods of dying in the hospitals, receiving intensive care and the life-sustaining treatment. The use of IPC at either the early or late time was associated with higher odds of being discharged to hospice care, and less length of stay in the inpatient settings and less total inpatient charges.

Conclusion: Approaches such as PCMH, improving continuity of care and the early use of palliative care are promising in reducing the costly hospital services and improving the quality of care. These approaches are replicable to any value-based programs for cost-reduction, quality improvement, and improving population health outcomes.

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LIST OF ABBREVIATIONS

AAFP	American Academy Of Family Physicians
ACME	Automated Classification Of Medical Entities
ACSC	Ambulatory Care Sensitive Condition
AD	Alzheimer's Disease
AECOPD	Acute Exacerbation Chronic Obstructive Pulmonary Disease
AHA	American Hospital Association
AHRF	Area Health Resource File
AHRQ	Agency For Health Care Research And Quality
AMI	Acute Myocardial Infarction
AOR	Adjusted Odds Ratio
APCP	Advanced Primary Care Practice
BMI	Body Mass Index
CCI	Charlson Comorbidity Index
CDC	Centers For Disease Control And Prevention
CHF	Congestive Heart Failure
CI	Confidence Interval
CLD	Chronic Lung Disease
CMS	Centers For Medicare & Medicaid Services
COC	Continuity Of Care
COCI	Continuity Of Care Index
COPD	Chronic Obstructive Pulmonary Disease
CPR	Cardiopulmonary Resuscitation
CVD	Cerebrovascular Disease
DHHS	Department Of Health And Human Services
DM	Diabetes Mellitus
ED	Emergency Department
EN/PN	Enteral Or Parenteral Infusion Of Concentrated Nutritional Substances
EOL	End-Of-Life
ESKD	End Stage Kidney Disease
FQHC	Federally Qualified Health Center
GED	General Equivalency Diploma
GEE	Generalized Estimation Equation
GLM	Generalize Linear Model
GTI	Gastrostomy Tube Insertion
HCCI	Health Care Cost Institute
HD	Heart Disease
HDD	Hospital Discharge Data
HPPR	Hospital Readmissions Reduction Program
ICD	International Classification Of Diseases

ICU	Intensive Care Unit
IMV	Invasive Mechanical Ventilation
IPC	Inpatient Palliative Consultation
IRB	Institutional Review Board??
LHID	Longitudinal Health Insurance Database
LOS	Length Of Stay
LTC	Long Term Care
MEPS	Medical Expenditure Panel Survey
NCHS	National Center For Health Statistics
NHI	National Health Insurance
NH	Non-Hispanic
NIMV	Non-Invasive Mechanical Ventilation
NIS	National Inpatient Sample
NTD	New Taiwan Dollar
OECD	Organization For Economic Co-Operation And Development
OR	Odds Ratio
PC	Palliative Care
PCMH	Patient-Centered Medical Home
POD	Place Of Death
PPACA	Patient Protection And Affordable Care Act
PQI	Prevention Quality Indicators
RUCA	Rural-Urban Commuting Area
SD	Standard Deviation
SE	Standard Errors
SECON	Sequential Continuity
U.S.	United States
USC	Usual Source Of Care
UPC	Usual Provider of Care
VHA	Veterans Health Administration

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CHAPTER 1. INTRODUCTIONS

1.1 Background and problem statement

1.1.1 High expenditure and low quality dilemma of the U.S. health care

High health care spending in the United States (U.S.) is a big concern for policy makers, employers, and patients regardless of whether they are insured or uninsured. In 2017, U.S. health care spending increased 3.9 percent, and reached $3.5 trillion in total, or $10,739 per person (Centers for Medicare & Medicaid Services). According to the 2017 Commonwealth Fund report, the U.S. health care spending ranked the highest among the 11 developed countries examined (E. C. Schneider, Sarnak, Squires, Shah, & Doty, 2017). Moreover, the health spending share of the economy increased from 17.2% in 2013 to 17.6% in 2015 and reached 17.9% in 2017. The highest rates of growth in the recent decade were during 2014 and 2015, which were affected by both the insurance coverage expansion and increased retail prescription drug prices (Martin, Hartman, Washington, Catlin, & Team, 2019). Increases in high health care spending raise the federal deficit which poses a huge financial burden to the government. It has also affected the American family by the way of reducing their available and disposable income as well as the buying power (Auerbach & Kellermann, 2011).

Despite this huge amount of money being spent on healthcare, the U.S. ranked last on the overall performance in the comparison of the Organization for Economic Co-operation and Development (OECD) countries (E. C. Schneider et al., 2017). The care process ranked fifth, with above-average performance on prevention, safety and engagement, while performance was below average in care coordination (E. C. Schneider et al., 2017). Therefore, it is crucial to explore solutions to bend the cost curve while improving the quality of care and health outcomes.

1.1.2 Costly hospital services in the U.S.

There are many reasons for the high health care expenditure in the U.S. The most commonly mentioned reasons include the extraordinary high administrative costs and drug costs, the practice of defensive medicine, the over-utilization of costly care, and the waste caused by unnecessary and redundant services, etc. (Emanuel, 2012; Ginsburg, 2008; Smith, Newhouse, & Freeland, 2009).

The key to controlling the high costs is to first know where the high costs have occurred and what services can be avoided or reduced. In comparison with the services provided by an individual physician, hospital services cost much more, because more human and facility resources are required to providing them. In fact, hospital care accounts for the highest percentage of health care expenditure. Recent data shows that $1.1 trillion, or 33% of the total health care spending was spent on hospital care in 2017 (Martin et al., 2019). The spending is predicted to increase with the development of new technologies and the aging population. Though hospital care might be beneficial to individual health, spending more on hospital care does not necessarily lead to better health outcomes at the population level. On the contrary, it indicates that the money is not being spent efficiently to provide better care.

Many experts have pointed out that some hospital services can be avoided because their occurrences are due to the failures of primary and secondary prevention. For instance, potentially preventable hospitalizations, also known as hospitalizations due to ambulatory care sensitive conditions (ACSCs), are a series of hospital admissions that are likely to be avoided if patients had adequate, timely, and high-quality primary care (Agency for Healthcare Research and Quality, n.d.). They are defined by the Agency for Health Care Research and Quality (AHRQ), and have been used as a quality indicator to access primary care or outpatient services in a community and population (Aldo Rosano et al., 2013).

Another indicator of avoidable hospital services is unplanned hospital readmission, which is considered as a marker of poor health system performance. Though there have been debates on the preventability of the readmissions, since many results are based on subjective judgment, not objective standards, there is evidence to show that some admissions occurred due to the factors that can be manually improved. A recent study examined a national cohort of patients from 12 academic centers and reported that 27% of 30-day hospital readmissions were preventable. The major contributing factors to those readmissions were poor communication, inadequate coordination of care, and insufficient post-discharge resources (Boscardin et al., 2016).

Another large share of hospital care spending occurred in the emergency department (ED). Though the utilization of emergency care remained flat over the past several years, the spending has nearly doubled. In 2009, the average cost of an ED visit was $600 as compared to $1,332 in 2016, according to the recent data from Health Care Cost Institute (HCCI) (Health Care Cost Institute, n.d.). The Centers for Disease Control (CDC) also found that ED visits rates reached the highest point for all age groups in 2015, and one in five Americans made at least one trip per year to the hospital for urgent care, with most being adults and most not admitted for care (The Centers for Disease Control and Prevention, 2017). A large healthcare improvement company with a network of 4000 hospitals and health systems analyzed their data of 24 million ED visits among patients with at least one of the six prevalent chronic conditions, and found that ED visits contributed to approximately 50 percent of all annual visits at nearly 750 hospitals in 2017. The six conditions include asthma, chronic obstructive pulmonary disease (COPD), diabetes, congestive heart failure, hypertension, and behavioral health problems. Additionally, these visits were potentially preventable and equated to approximately $8.3 billion in emergency department (ED) costs (Premier Inc., 2019). Another reason that ED visits can be costly is that they may lead to hospitalization and other high-cost services. One study also found that 31% of the readmissions could have been avoided if those patients who did not necessarily need hospital care had not been admitted (Boscardin et al., 2016).

1.1.3 High-cost population in the U.S. health care system

When designing the interventions to reduce these costly hospital services, it is also important to look at the populations that are most likely to utilize these health services. Data has shown that 5% patients accounted for half of the health care spending in the U.S (Cohen, 2014). These population are often regarded as high-need, high-cost patients. They often have multiple chronic conditions or a severe illness, complex psycho-social needs, and limited ability to perform daily activities (Hayes et al., 2016; E. Schneider, Abrams, Shah, Lewis, & Shah, 2018). Therefore, they are more likely to consume these costly hospital services if their health care needs are not met and the chronic conditions are not well managed (Bodenheimer & Berry-Millett, 2009; Cohen, 2014). For high-need adults, average annual per-person spending on health care services and prescription medicines topped $21,000, which is more than four times the average for all US adults (Hayes et al., 2016; E. Schneider et al., 2018).

Patients at their end of life also tend to consume more intensive health services because they often have more complex health needs. The costs of medical care have been found to be the highest in the last year of one’s life, especially in the last 6 months of life. According to Medicare’s expenditure analysis, 80% of the Medicare decedents used up 30% of the Medicare expenditure each year (Cubanski, Neuman, Griffin, & Damico, 2014). Many life-sustaining treatments are not only costly, but also cause pain and sufferings to patients at their EOL (Prigerson et al., 2009). More importantly, the use of life-sustaining treatments or intensive hospital care does not necessarily lead to better quality of life for patients at EOL (Barnato et al., 2013; Curtis, Engelberg, Bensink, & Ramsey, 2012).

1.1.4 Problem statement

Though there are many other factors leading to the high expenditure in the U.S. healthcare system, costly hospital services that can be reduced through effective interventions become the priorities for many cost-reduction programs. Hence, research studies that examine the effectiveness of the interventions and approaches to reduce costly and unnecessary care are needed to provide empirical evidences to support the system transformation towards a more value-based system. High cost and preventable hospitalizations, ED visits and readmissions, as well as the intense EOL hospital services are examined in this thesis. Populations, especially those with high-risk of consuming these services, are appropriate for examining the effectiveness of various approaches for reducing the costly hospital services.

1.2 Approaches to reduce hospital utilization

Lack of adequate and high-quality primary care is well known as the major healthcare-related determinant for preventable hospitalizations and ED visits at both individual and population level. Hence, any factor that can affect the quality of primary care received by patients can influence the outcomes of hospital and ED utilization. There have been several research studies, including a systematic review that have analyzed the relationship between various aspects of primary health care and the ACSC admissions (Gibson, 2013; Leung, Parks, & Topolski, 2015; A Rosano et al., 2011; Tian, Dixon, & Gao, 2012). These aspects were quantified into numbers that reflected the primary care workforce, primary care episodes, service availability and accessibility, practice size, and financial incentives. However, the collective evidence was inconclusive, due to the varied measures of hospitalization, primary care, and health status of the population examined.

With the passage of the Patient Protection and Affordable Care Act (PPACA) in 2010, the patient-centered medical home (PCMH) was identified as a promising model to provide high-quality primary care without requiring more primary care physicians. But it requires a certain amount of investment to build the infrastructure that would allow the PCMH to function effectively and contribute to a better quality of primary care (Stange et al., 2010). With many practices transforming to the PCMH, evaluations are needed to demonstrate the effectiveness of the model for various outcomes. However, past studies that have examined the effectiveness of PCMH on reducing the ACSC admissions and ED visits in the U.S. have been limited to regional practices and populations, and the results were mixed (Fishman et al., 2012; Hasselt, Mccall, Keyes, Wensky, & Smith, 2010; Kahn et al., 2015; Rosenthal et al., 2013; Yoon et al., 2013). Hence, further investigations are needed to determine the effectiveness of reducing the preventable hospital services.

There have been debates on the preventability of the readmissions, and determinants of the preventable readmissions reported were mostly focused on patient-level factors such as poor care coordination and adherences to medication (Vest, Gamm, Oxford, Gonzalez, & Slawson, 2010). Many interventions to reduce hospital readmissions have also been initiated by the U.S. hospitals under the Hospital Readmission Reduction Programs (HRRP). Those initiatives were often targeted toward certain high-risk populations, and were hospital-oriented, such as discharge planning and transition of care (Benbassat & Taragin, 2013a, 2013b; Boscardin et al., 2016; Kripalani, Theobald, Anctil, & Vasilevskis, 2014). On the other hand, the care received outside the hospitals after patients have been discharged is also an important determinant for patients' needs for intensive care in the future. The continuity of care (COC) is an aspect that reflects patient and provider coordination across time and settings. The care with better continuity ensures the better information exchange and communication, the better coherence with treatment, hence, better management of health needs. However, it is sometimes hard to achieve the continuity if patients have multiple needs and tend to bounce between different settings and providers. Previous studies on examining the continuity of care and readmissions also produced mixed results among different populations (Burns & Puntis, 2016; Nyweide et al., 2013; Nyweide & Bynum, 2017; Santomassino, 2012; Termorshuizena et al., 2012; Van Walraven, Mamdani, Fang, & Austin, 2004; Yang et al., 2017). As many hospitals are working on developing strategies to reduce readmissions for the high-risk patients after discharge, more evidence is needed to demonstrate the effects of COC on readmissions among populations with a different disease burden, in order to guide the development of interventions that promote the COC outside the hospitals.

Palliative care has been proposed as the alternative for patients at the EOL to improve the quality of care for many patients that suffer from worsening symptoms and psychological stresses (Grunfeld et al., 2008). However, the utilization of palliative care has generally not been as prevalent as it should be. Many patients aren't familiar with the concept of palliative care, therefore rely more on curative care that is more costly but might add little value at the EOL. Previous research has also tried to demonstrate the benefits of palliative care on multiple outcomes, such as reducing inpatient admission and costs, decreasing the needs for intensive treatments, etc. (Bajwah et al., 2017; Dunning & Martin, 2017; Greer et al., 2012; Kim et al., 2018; Lilley et al., 2018; May et al., 2015; Temel et al., 2010). They are mostly focused on population with severe or chronic diseases, such as cancer (Salemi, Chima, Spooner, & Zoorob, 2017), diabetes (Dunning & Martin, 2017), and heart disease (Fitzpatrick, Mavissakalian, Luciani, Xu, & Mazurek, 2018). There has been reports from other states such as California (California Healthcare Foundation, 2007), but no up-to-date investigation on the palliative care utilization and its effects was found in Nebraska population.

1.3 Purpose, aims, and hypotheses of the dissertation thesis

The primary purpose of this dissertation is to examine the effects of three approaches that have been proposed to reduce the utilization of costly hospital services among various population. These approaches include the employment of patient-centered medical home model, improvement on continuity of care, and the early use of palliative care at the end-of-life. Specifically, there are three major aims followed by more detailed aims in each area.

Aim 1: Examine the effects of patient-centered medical home and its individual attributes on preventable hospitalizations and ED visits among the U.S. non-institutionalized adults.

> **Aim 1.1:** Model the effect of Patient-centered Medical home on preventable hospitalizations and ED visits.
>
> **Aim 1.2:** Model the individual effect of comprehensiveness, enhanced access, shared decision making, and patient-centered communication on preventable hospitalizations and ED visits.

Hypothesis 1: Patient-centered medical home and its individual attributes are associated with lower risk of having preventable hospitalizations and ED visits among the U.S. non-institutionalized adults.

Aim 2: Examine the effects of post-discharge continuity of care on hospital utilization among Taiwan adult patients hospitalized for five conditions, including acute myocardial infarction (AMI), congestive heart failure (CHF), asthma, chronic obstructive pulmonary disease (COPD), and diabetes mellitus (DM).

> **Aim 2.1:** Model the effect of post-discharge continuity of care on all-cause admissions for patients hospitalized for each of the five conditions separately.
>
> **Aim 2.2:** Model the effect of post-discharge continuity of care on disease-specific admissions for patients hospitalized for each of the five conditions separately.

Hypothesis 2: Higher post-discharge continuity of care is associated with lower hospital utilization among Taiwan adult patients hospitalized for the five conditions.

Aim 3: Examine the effects of inpatient palliative consultation (IPC) on various end-of-life (EOL) outcomes among Nebraska decedents of the top six leading causes of death, including cancer, heart disease (HD), chronic lung disease (CLD), cerebrovascular (CVD) disease, Alzheimer's disease (AD), and DM.

> **Aim 3.1:** Model the effect of early and late IPC on hospice discharge at the EOL.
>
> **Aim 3.2:** Model the effect of early and late IPC on place of death.
>
> **Aim 3.3:** Model the effect of early and late IPC on receiving life-sustaining treatments at the EOL.
>
> **Aim 3.4:** Model the effect of early and late IPC on receiving intense-care at the EOL.

Aim 3.5: Model the effect of early and late IPC on inpatient length-of-stay (LOS) at the EOL.

Aim 3.6: Model the effect of early and late IPC on total inpatient charges at the EOL.

Hypothesis 3: The early use of IPC is associated with higher likelihood of being discharged to hospice care, lower risk of death in hospital, lower risk of receiving life-sustaining treatments and intense-care, shorter LOS, and less inpatient charges among Nebraska decedents for the top six leading causes of death.

CHAPTER 2. CONCEPTUAL FRAMEWORK

In order to correctly model the effects of the three approaches on the utilization of the costly hospital services, factors that impact individual's health care utilization should be considered thoroughly and taken into the adjustment if possible. Andersen's behavioral model of health services utilization was used to conceptualize the mechanism behind the changes or differences of the health services consumption, and to guide the selection of covariates throughout the modeling process of the three individual studies.

Developed in the 1960's by Andersen, this behavioral model of health services utilization has been expanded through many iterations to fit the complex situations in the current health care system. Originally, Andersen's model suggests that people's use of health services is a function of their predisposition to use services, factors that enable or impede use, and need for care (Andersen, 1995) (Equation 2.1). Predisposing characteristics capture the inclination of individuals to use health services, include demographic, social structure, and health beliefs. Enabling resources describe the ability of individuals to obtain health services, include the personal, family and community resources. Need factors include the individual's perceived health statuses, health risks, as well as the health status indicated by one's comorbidity (Figure 2.1). Those are the cofounders that need to be controlled when examining the health care utilization.

Equation 2.1

Health service utilization = f(Predisposing characteristics) + f(Enabling Resources) + f(Need Factors)

The newest iteration of Andersen's model still focuses on the individual as the unit of analysis. The predisposing characters, enabling resources, need factors are classified under the population characteristics, and genetic susceptibility was added as a predisposing determinant. Instead of using health care utilization as the endpoint of interest, it added the effects of the health care system to acknowledge the impacts from the external environment. It also recognized the personal health practices (e.g. diet, exercises, and self-care, etc.) and the health services utilization as the aspects of health behavior. Health behavior can be affected by the changes in the health care system and population characteristics, and also impact the health outcomes and population characteristics interactively. It also includes feedback loops showing that outcomes, in turn, can affect subsequent predisposing factors and perceived need for services as well as health behaviors. The evolved model (Figure 2.2) reflects the dynamic and recursive nature of the health services utilization model under the complex health care system environment.

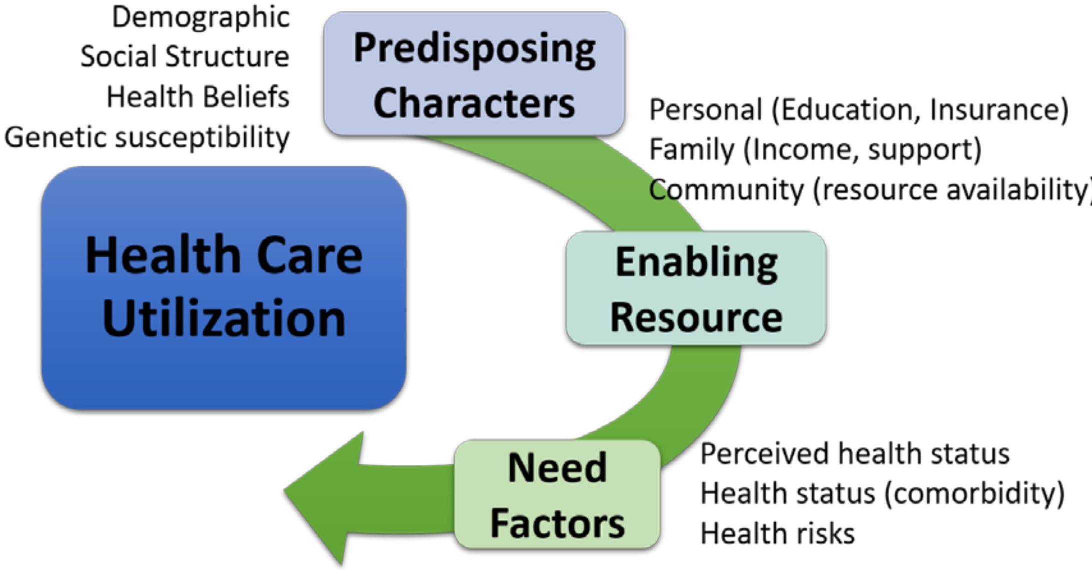


Figure 2.1 Andersen's behavioral model of health services utilization

Based on the interactive relationships of this dynamic framework, I made the hypotheses regarding the effects of the three approaches on the services utilization outcomes through the directionality of the impact following a change in an individual's characteristics or environment. The outcomes for all three studies were the utilization of certain health services. Firstly, the PCMH approach can be viewed as an intervention from the health care system level (Figure 2.3). Strengthening primary care through the adoption of PCMH would realize a more accessible, continuous, comprehensive and well-coordinated system, hence will bear the potentials to improve quality of care, patients health status, and bend the cost curve by reducing hospital expenditures (van Loenen, van den Berg, Westert, & Faber, 2014). And the four attributes of PCMH are actually impacting on different aspects of the dynamic system, and ultimately change the utilization of hospital services that we are looking at (Figure 2.4).

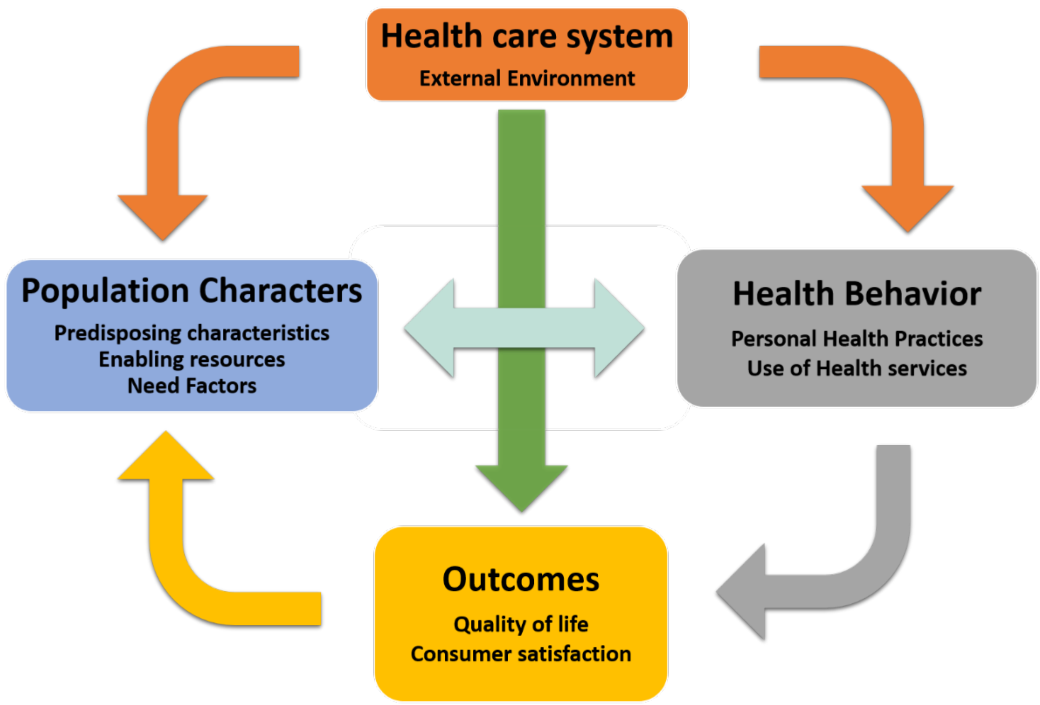


Figure 2.2 Dynamic model of health services utilization

Secondly, as the measure of continuity of care in the second study, a better physician continuity can promote better personal health practices through a longitudinal patient-physician relationship that ensures the consistency and adherence of treatment. The timely disease management under the care with better COC can improve the health status and quality of life, hence reduce the needs for intense hospital care. Therefore, the improvement in other aspects in the dynamic model can all contribute to a reduction of costly service utilization (Figure 2.3).

Lastly, the use of inpatient palliative consultation is aimed at providing EOL care that more oriented to address patient and family needs in improving the quality of life, instead of pursuing curative care. Hence, with the quality of care being enhanced and patients' needs being addressed through the palliative care and hospice care, the needs for high-intensity and curative care, and life-sustaining treatment would be reduced (Figure 2.3).

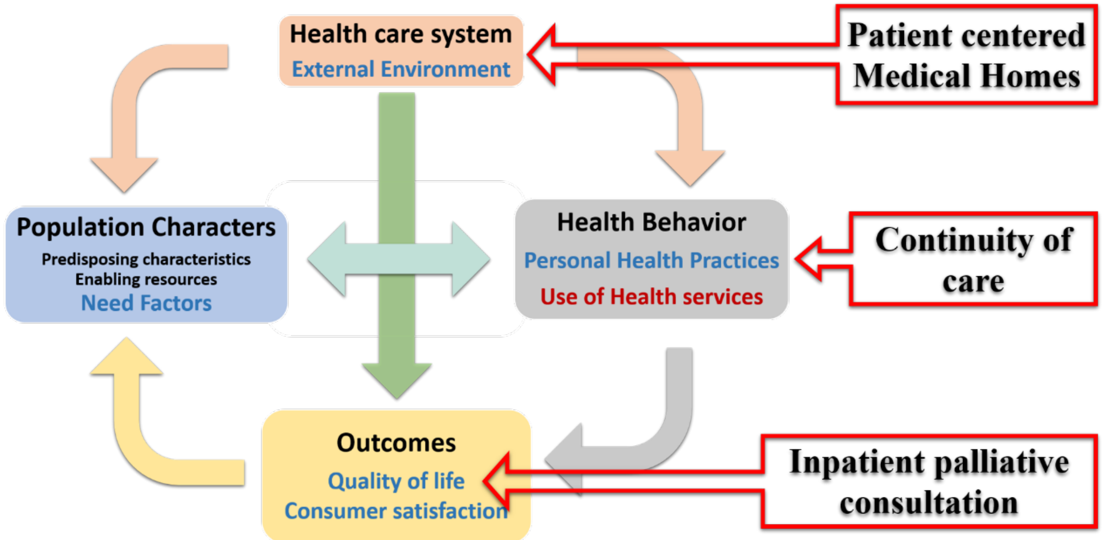


Figure 2.3 Mechanisms of the examined approaches on impacting the health services utilization using the dynamic model

Notes: *Term in red color is the outcome examined in all three studies, factors in blue color are the ones affected by the three approaches conceptually.*

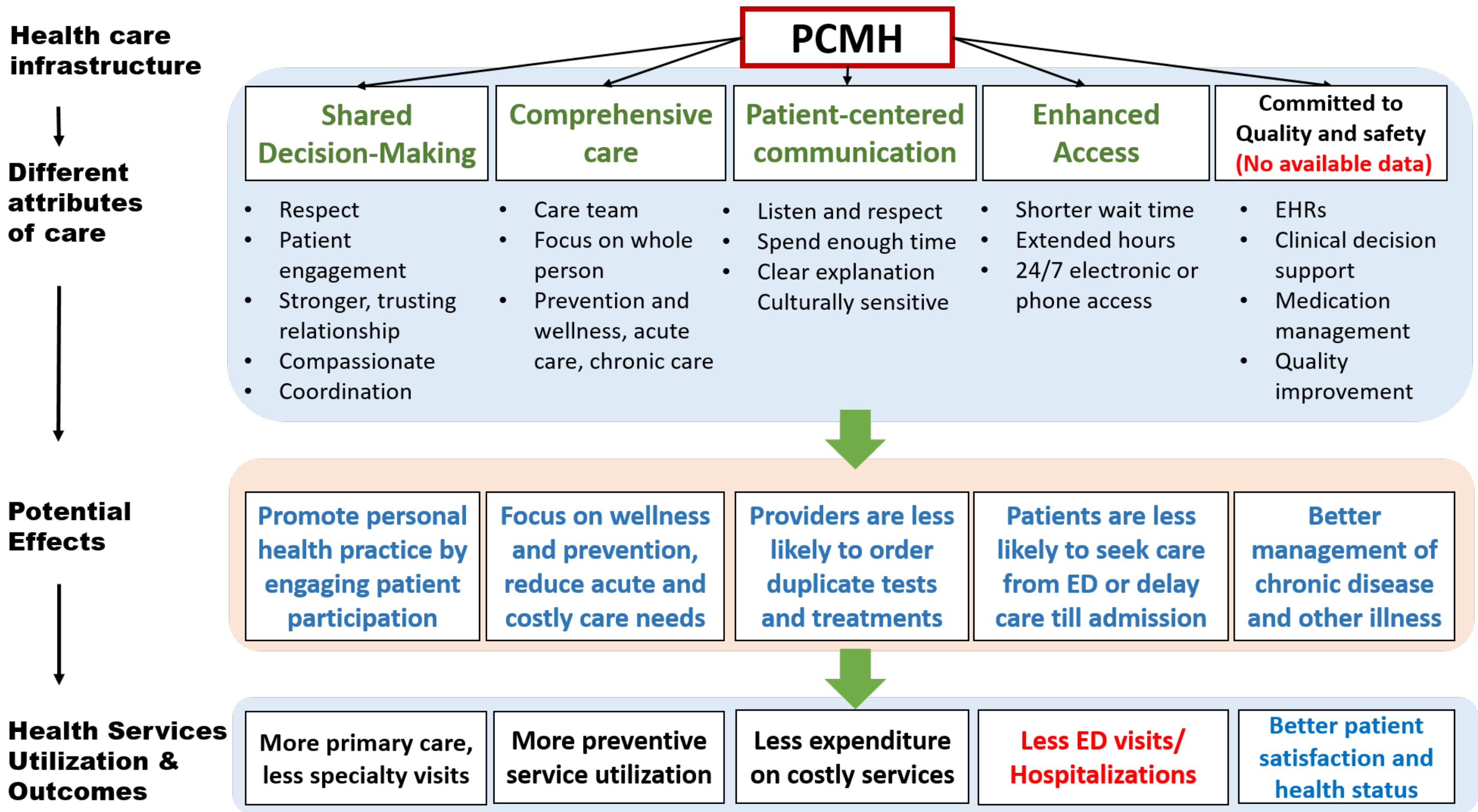


Figure 2.4 Mechanisms of Patient-Centered Medical Home and its attributes impacting the health services utilization

Notes: *Outcomes in red colors are the ones examined in the first study, factors in blue color are the ones affected by PCMH attributes conceptually.*

CHAPTER 3. THE EFFECTS OF PATIENT-CENTERED MEDICAL HOME AND ITS INDIVIDUAL ATTRIBUTES ON REDUCING THE RISK OF PREVENTABLE HOSPITALIZATIONS AND ED VISITS

3.1 Introduction

The patient-centered medical home (PCMH) is an innovative care delivery model designed to achieve improved quality, patient experience, and population health while reducing the cost of care. It was first introduced in pediatrics in 1967 (Sia, Tonniges, Osterhus, & Taba, 2004), and the concept was expanded the concept spread to the all-age population in 2007 through the joint endorsement of 7 principles by several primary care professional societies (American Academy of Family Physicians, 2008). The 7 principles include a personal physician, physician-directed practice team, whole person orientation of care, care coordination, quality and safety, enhanced access to care, and payment that recognizes the value of a PCMH. Lead by the pilot PCMH programs showing significant improvements in many aspects, there have been rapid adoptions of the PCMH model nationally (Nutting et al., 2011). Given that the adoption of the PCMH requires great financial and labor-wide investments and efforts, payers and policymakers are interested in empirical evidence that can demonstrate the effectiveness of PCMH in achieving cost-saving while improving quality of care.

Evaluation of the impact of the PCMH model on healthcare utilization, cost and quality varies in methods, measures and populations, and have yielded mixed results. Some found significantly reduced ED visits after implementing PCMH (Flottemesch et al., 2012; Hoff, Weller, & DePuccio, 2012), or fewer ED visits when compared to control groups (Hasselt et al., 2010). Many studies observed significantly reduced per member per month costs (Christensen et al., 2013; Rosenthal et al., 2016), while some reported that the association of PCMH with reduced costs only limited to the most medically complex patients (Flottemesch et al., 2012). Reviews also found that many PCMH programs achieved success in decreasing utilization of resource-intensive services like ED, specialty and inpatient care (Nielson, Olayiwola, Grundy, & Grumbach, 2014), and increased improvement of quality of care measures (Hoff et al., 2012). A systematic review of PCMH interventions has found a small to positive effect on patient experiences and the delivery of preventive care services (Jackson et al., 2013). PCMH interventions reported favorable results were often limited to the high-risk population such as Medicare beneficiaries or patients with chronic or mental illness (Peikes, Zutshi, Genevro, Parchman, & Meyers, 2012). Hence, more timely and rigorous research on evaluating PCMH's economic effects in a general population is needed for adding more evidence.

In previous research, there are three approaches to define the concept of PCMH: (1) an exposure to an intervention (pilot project or practice) (Friedberg, Rosenthal, Werner, Volpp, & Schneider, 2015); (2) an operational definition of PCMH, meaning a primary care practice that have been recognized by a third party (Hasselt et al., 2010); and (3) patients' experiences of care (Romaire, Bell, & Grossman, 2012b). Patient experiences with care have been found to be associated with many health outcomes as they were conceived to interfere with patients' health behaviors as well as health care seeking behaviors. For example, a systematic review showed positive associations between patient experience, patient safety and clinical effectiveness, including adherence to medication and health-promoting behaviors, such as the use of screening services and immunizations (Doyle, Lennox, & Bell, 2013). A study using a national sample shows that respondents who rated their provider's communication higher reported greater utilization of preventive services (Villani & Mortensen, 2013). However, another study found out that practices' use of PCMH processes was not associated with patient experience (interpersonal exchange, treatment goal setting, and out-of-office contact) (Martsolf et al., 2012). Therefore, it is worth investigating from the patients' perspective to see if their experience of PCMH would have impacts on their health utilization, associated cost, and quality outcomes.

There has been growing literature on using the patient-reported experience of care in survey data to define the PCMH status. Previous studies on the effect of patient-report PCMH status mostly focus on specific population, such as children and youth (Han, Yu, & Friedberg, 2017; Romaire & Bell, 2010; Romaire, Bell, & Grossman, 2012a; Romaire et al., 2012b), Latino population (Beal, Hernandez, & Doty, 2009), Medicare population (Stockbridge & Philpot, 2014), and adults with mental illness (Bowdoin, Rodriguez-Monguio, Puleo, Keller, & Roche, 2016). All of them reported some favorable results of PCMH status associated with lower ED utilization, lower expenditure, and a higher likelihood of receiving preventive services at different extent. Therefore, it is meaningful to investigate whether the patient-report PCMH features would have a similar influence on those outcomes in non-elderly adults in a nationally representative sample.

Empirical studies on the effects of PCMH over avoidable hospitalizations and ED visits were limited and the evidence was mixed. A study on senior population comparing one pilot PCMH clinics with the remaining 19 clinics in one large healthcare system in Seattle demonstrated lower ACSC admissions in 12 months and 21 months (Fishman et al., 2012). A similar comparison study in Rhode Island did not detect any association between PCMH and ACSC admissions when comparing the pilot PCMH practices with the controls (Rosenthal et al., 2013). A national Veterans Health Administration (VHA) study found that their patients from VHA primary care clinics with higher overall medical home score had a lower risk of avoidable hospitalizations (Yoon et al., 2013). The evaluation of CMS's Federally Qualified Health Center (FQHC) advanced primary care practice (APCP) demonstration did not show significant reductions on ACSC admission and ACSC ED visits when comparing pre- and post-implementation and comparing practices with NCQA level-3 PCMH recognition versus those without (Kahn et al., 2015). A study on Medicare population demonstrated a significant reduction on the rate of ED visit for ACSCs comparing the pre- and post-adoption of PCMH, but no effects were found for other utilization of care including ACSC admissions (Hasselt et al., 2010). The examination of individual PCMH attribute also showed some positive effects. For example, shared decision-making contributes to a better quality of care in terms of empowering patients in actively participating in managing their own care and health. Studies have also demonstrated the effects of shared decision-making on cost reduction and quality improvement. The Lewin Group report found that routine use of patient decision aids and shared decision making in connection with 11 procedures could save Medicare $3.8 billion over 5 years and $9.2 billion over 10 years (The Lewin Group, 2008).

Due to the inconclusiveness of the evidence, our study aims to use the nationally representative U.S. population survey to examine the effects of PCMH on preventable hospitalizations and ED visits. The major hypothesis is that receiving a higher level of PCMH in the first year is associated with less likelihood of having ACSC admission and ED visit in the second year. There might be some attributes individually affecting the likelihood of having these costly care outcomes.

3.2 Methods

3.2.1 Data source and sample population

Data for this study were from the Medical Expenditure Panel Survey Household Component (MEPS-HC). Administrated by the Agency for Healthcare Research and Quality (AHRQ), MEPS is a two-year panel survey of the nationally representative noninstitutionalized U.S. civilian families and individuals. A new panel of sample households is selected each year and will be interviewed for five rounds during the two full calendar years. The study population was derived from the longitudinal data files, which only include respondents who participated in all five rounds and had two years of data on health status, utilization, and medical expenditure, etc. This panel design provides an opportunity of examining person level changes in these aspects while the longitudinal weights have been adjusted to produce national estimates. Starting from 2013, MEPS omitted ICD-9-CM condition and procedure codes in the hospital inpatient stay files and emergency room visits files. Since the computation of the outcome variables would use ICD-9-CM codes, only the recent data before 2013 were used in this study.

The study population contains adult respondents (≥18y) pooled from Panel 12-16 longitudinal data files. Respondents aged 18 and older, having a usual source of care (USC) other than ED, and no missing data on all the variables used in the regression models were included. Data on hospitalizations and ED visits were drawn from hospital inpatient stay files 2008-2012, and emergency room visits files 2008-2012. Data from medical condition files 2008-2012 were used to compute respondents' Charlson Comorbidity Index (CCI).

3.2.2 Measures

3.2.2.1 Primary independent variable

The primary independent variable in this study was respondent's first-year PCMH status. A total of 11 items describing respondents' USC were pre-selected based on previous literature. The factor analysis was conducted and the result (Appendix 3.1) was used to group these items into four major attributes of PCMH: comprehensiveness, enhance access, shared decision making and patient-centered communication. Each answer to the question will be given a score of 0, 1 or 2, and the total score of the items under each attribute will be the level of that attribute and re-classified (and re-score) into low (0), medium (1) and high (2) level. Finally, based on the total score of the four attributes (range 0-8), respondents will be classified into three groups: non-PCMH group, partial-PCMH group, and full-PCMH group. The detailed scoring system was shown in Table 3.1.

3.2.2.2 Outcome variables

The study outcomes were six dichotomous variables indicating whether the respondents had at least one ACSC outcome at their second year of survey, respectively. The six outcomes include having overall, acute and chronic ACSC admissions, and overall, acute and chronic ACSC ED visits. The acute and chronic ACSC were conditions that are potentially preventable given appropriate primary and preventive care, established from the area-level Prevention Quality Indicators (PQIs) developed by the AHRQ (Appendix 3.2). The ACSC admissions were identified by the hospital inpatient stay diagnostic codes provided in 2008-2012 hospital inpatient stay files. The ACSC ED visits were identified by the emergency room visits diagnostic codes provided in 2008-2012 emergency room visits files. The information was linked back to each respondent through the individual sample person identifier (DUPERSID). Therefore, respondent was considered having no ACSC admission and ED visit and coded “0” if there is no record linked back. The second year’s data were used to avoid the reversible effects between the outcome and explanatory variables computed from same year data.

3.2.2.3 Covariates

Based on Andersen’s model, covariates adjusted in all models include predisposing factors, enabling resources, and need factors. The predisposing factors included respondents’ demographic characteristics (age, gender, race, marital status, region, rurality), and health beliefs (risk-taking, overcoming disease without medical help). Enabling resources included socioeconomic status (employment, education, family poverty level, insurance), health behaviors (smoking, BMI), health status (perceived general & mental health, functional limitation, CCI), and panel. Most of the variables were computed from their first-year responses to the specific survey items (Round 1, 2, or 3), and the second-year data (Round 3, 4, 5) were only used to substitute when first-year data were missing. Specifically, CCI was computed using medical conditions reported by respondents in their second year.

3.2.3 Statistical analysis

Respondents’ characteristics were proportionally calculated and summarized for the total population and for the three PCMH groups, accounting for survey weights. The differences of the proportional distribution of each characteristic among three PCMH groups were examined using Chi-square tests incorporating survey weights. The effects of PCMH on overall, acute and chronic ACSC admission/ED visit were separately modeled using multivariable logistic regression adjusting for multiple covariates and accounting for survey weights (Equation 3.1). Sensitivity Analyses were also conducted to testify if the effects would change if the primary explanatory variable was re-categorized and if the effects were due to the different characteristics among the PCMH groups. Hence, respondents were re-grouped into two PCMH group and propensity score matching technique were used to balance the differences in characteristics in two groups and multivariable logistic regressions were fitted again over the balanced groups.

Additionally, in order to examine the effect of the individual attribute, a similar multivariable logistic regression model was fitted for each outcome, with all four PCMH attributes incorporating in the model (Equation 3.2). All analyses were completed using Stata 14.2 (StataCorp LLC., College Station, TX, USA). The adjusted Odds Ratios were reported. The study was exempt from Institutional Review Board examination.

Model Equation 3.1:

Logit (Outcome) = $\beta_0 + \beta_1 Demographics + \beta_2 Socioeconomics + \beta_3\ Health\ Beliefs + \beta_4 Health\ Behaviors + \beta_5 Health\ Status + \beta_6 Panel + \boldsymbol{\beta_7 PCC}$

Model Equation 3.2:

Logit (Outcome) = $\gamma_0 + \gamma_1 Demographics + \gamma_2 Socioeconomics + \gamma_3 Health\ Beliefs + \gamma_4 Health\ Behaviors + \gamma_5 Health\ Status + \gamma_6 Panel + \boldsymbol{\gamma_7 Comoprehensiveness} + \boldsymbol{\gamma_8 Access} + \boldsymbol{\gamma_9 Decision\ Making} + \boldsymbol{\gamma_{10} Communication}$

3.3 Results

3.3.1 Characteristics of the respondents in three PCMH groups

A total of 13,863 eligible respondents representing 301,259k U.S. noninstitutionalized civilians were analyzed. A weighted 48.30% of respondents were classified as having partial-PCMH at their first year, 21.53% reported full PCMH characteristics, and the rest of the population classified as non-PCMH group. Among the three groups, significant differences were detected on the distributions of many characteristics. Respondents who rated their USC as full PCMH were more likely to be non-Hispanic White, married, underemployment, having a higher level of education, coming from a wealthier family, with private insurance, with non-smoking status, with better perceived general and mental health, having no functional limitation (Table 3.2).

3.3.2 The effects of PCMH on the odds of having ACSC admissions and ED visits

The weighted percentage of the respondents that reported having at least one ACSC admission and ED visit at the second year of the survey were summarized by PCMH groups and by the level of individual PCMH attribute (Table 3.3). The regression results (Table 3.4) showed that the odds of having an overall ACSC admission in the second year for respondents in full PCMH group were 0.67 times (AOR 0.67, $p = 0.03$) of the odds for respondents in the non-PCMH group. Similarly, the odds of having any overall ACSC ED visit in the second year for respondents in full PCMH group were 0.65 times (AOR 0.65, $p = 0.015$) of the odds for respondents in non-PCMH group. The odds were not significantly different when comparing respondents from the partial-PCMH group with the reference group for the overall ACSC admission and ED visit. No significant effects of PCMH were detected separately for acute and chronic ACSC admissions and ED visits. The sensitivity analyses results showed similar results with original analyses, which implied that better PCMH was associated with less odds of having any overall ACSC admission and overall ACSC ED visit in the second year.

3.3.3 The effects of individual PCMH attributes on the odds of having ACSC admissions and ED visits

The analyses on the effects of the individual PCMH attributes on the six outcomes did not reveal many significant results (Table 3.4). There was only one significant AOR showing that high comprehensiveness of UCS could reduce the odds of having chronic ACSC admission in the second year (AOR 0.27, $p = 0.045$). No other significant effects of individual PCMH attributes were detected for the six outcomes.

3.4 Discussions

This study examined the effects of PCMH on preventable hospitalizations and ED visits among a representative U.S. adult population who reported having USC other than ED. The results found that receiving the highest level of PCMH in the first year is associated with less likelihood of having the overall preventable admission and ED visit in the second year. However, the respondents who reported partial PCMH features for their USC do not differ from those who reported non-PCMH in the likelihood of being admitted or visiting ED due to ACSC. It supported our major hypothesis and confirmed that the primary care possessing all four attributes of PCMH is of better quality, hence can affect a person's likelihood of encountering preventable hospitalization and ED visit. These main results were inconsistent with a national study of patients from 814 VHA primary care clinics, which also demonstrated that greater adoption of medical home features was significantly associated with a lower risk of encountering avoidable hospitalizations (Yoon et al., 2013). Differently, their medical home features were obtained from the American College of Physicians Medical Home Builder scoring system which covers seven medical home components to describe the clinic practice biopsy.

The current study also attempted to look further into the effect of each PCMH attribute on the six outcomes. Not many significant individual effects were found in the analyses, which meant that improvement on any one of these aspects alone does not reduce the likelihood of encountering preventable hospitalization and ED visits. This was not surprising due to the fact that PCMH is a comprehensive model of care incorporating different contributing aspects, and every aspect is essential in contributing to the quality of primary care. This is probably the reason that many practices did not observe an immediate positive effect on patient outcomes at the beginning stage of the PCMH transformation (Rosenthal et al., 2013). Either they have only adopted some PCMH attributes due to limited resource, or the effects on patient outcomes need longer time to show up. Our results on the individual effects were different from the VHA study, in which researchers found two components, access and scheduling, and care coordination, independently associated with a lower risk of having avoidable hospitalization. Oddly, higher population management was related to a higher risk of avoidable hospitalization from their analysis. They explained that this could be due to the reasons that either clinic with greater population management had a more severe population, or they enabled the identification of higher-risk patients so they got hospitalized (Yoon et al., 2013).

This study contributes to the current literature in adding evidence on the mixed results over the effect of PCMH on preventable hospitalization and ED visit by embedding several strengths in design. Firstly, this is the first study utilizing the national survey data on the general U.S. adult population, which enabled us to generate weighted estimates to represent the national population. Many previous studies examined populations of children (Han et al., 2017) and seniors (Fishman et al., 2012), population with chronic diseases (An, 2016), or patients from regional practices (Rosenthal et al., 2013), which limited the applicability of interpreting their study results to a broader population. Secondly, the PCMH features were derived and computed from 11 patient-report characteristics of their USC, which was a detailed reflection of the care they actually received, rather than the yes-or-no PCMH recognition on their USC sites. Thirdly, the study took the advantage of the 2-year survey design and utilized a similar approach from some previous studies (Stockbridge & Philpot, 2014; Yoon et al., 2013), which the baseline medical home features and patient outcomes in the follow-up year were used, in order to avoid the reversible effect between the same-year PCMH and outcomes. Last but not least, the exclusion of respondents who do not have USC or using ED as their USC enabled us to examine the pure effect of PCMH features. Since the comparison group no longer contained those lack of access to health care, we could say that the effects detected were due to the difference in the quality of care, not because of the differences in access of care.

Like many cross-sectional studies using secondary data, the current study also had some limitations. First of all, it is a cross-sectional analysis, therefore no causal relationship can be determined. We have used PCMH measures in baseline year and the outcomes in the second year to avoid the potential reverse effects that may exist between the same-year explanatory and outcome variables. Secondly, both the PCMH measures and the outcomes were reported by survey respondents, which embraced potential response biases. Pointed out by previous research using MEPS data, patients tend to over-rate their care because they might be used to suboptimal care, over-rate their health beliefs, behaviors and status, and under-report the outcomes like hospitalizations and ED visits. Therefore, it is hard to predict how these biases will affect our results. Thirdly, due to the limited variables provided in the survey, we can only compute four attributes of PCMH. Other important attributes of PCMH, such as care coordination, commitment to quality and safety, population health management and health information technology implementation could not be taken into consideration in our study.

As a complex design of primary care, PCMH does have the potential to improve patient outcomes in term of the utilization of costly care such as hospitalization and ED visits. However, the improvement of a single attribute might not lead to the improvement of patient health outcomes. The results on individual attribute analyses also indicated the importance of incorporating every attribute in PCMH transformation for primary care practice to achieve better quality. Further research investigating the effects of other PCMH attributes on patient outcomes were also needed to guide the implementation of PCMH during the system transformation.

3.5 Conclusion

The highest level of patient-reported PCMH was associated with lower risks of having overall ACSC hospitalization and ED visit among the adult U.S. population with USC. The four attributes, comprehensive, enhanced access, patient-centered communication, and shared decision-making, did not work alone in affecting these patient outcomes. In order to achieve significant patient outcomes, all attributes of PCMH should be adopted if possible during the practice transformation towards PCMH.

3.6 Figures and Tables

Table 3.1 Definitions of Patient-centered Medical home and its individual attributes using MEPS survey questions

PCMH Attributes	Items in MEPS	Computed scores Low 0	Medium 1	High 2
Comprehensiveness		0-2	3	4
	USC provided care for new health problems *			
	USC provided preventive healthcare *			
	USC provided care for ongoing health problems *			
	USC provided referrals to other health professionals *			
Enhanced Access		0-2	3-5	6
	Whether USC had office hours at night or on the weekend *			
	Difficulty of accessing USC provider by phone †			
	Difficulty of accessing USC provider after hours†			
Shared Decision Making		0-3	4-7	8
	How often the USC provider showed respect for medical, traditional, and alternative treatments that the person is happy with ‡			
	How often the USC provider asked the person to help make decisions between a choice of treatments ‡			
	Does USC provider presented and explain all options to the person *			
	Does USC provider asked about prescription medications and treatments other doctors may give *			
Patient-centered communication		0-3	4-7	8
	How often USC provider listened carefully to you‡			
	How often USC provider explained things in a way that was easy to understand ‡			
	How often USC provider showed respect for what you had to say ‡			
	How often USC provider spent enough time with you ‡			
Patient-centered Medical home (PCMH)				
Total Score of the four individual PCMH attributes			8	
Three groups of PCMH				
	Non-PCMH		0-4	
	Partial-PCMH		5-6	
	Full-PCMH		7-8	
Two groups of PCMH (Sensitivity Analysis)				
	Non-PCMH		0-5	
	PCMH		6-8	

Notes: *MEPS, Medical Expenditure Panel Survey; USC, Usual Source of Care. *Questions with original binary answers 1=Yes and 0=No, which were recoded as 2=Yes and 0=No in "Shared decision making" and "Enhanced Access" domain to obtain same weight as other questions. †Questions with original 4-level answers rating the difficulty, which were recoded as 2=Not at all difficult, 1=Not too difficult, 0=Somewhat difficult/Very difficult. ‡Questions with original 4-level answers rating frequency, which were recoded as 2=Always, 1=Usually, 0= Sometimes/Never.*

Table 3.2 Demographic, socioeconomic, and health characteristics: 2008-2012 U.S. noninstitutionalized Adults (MEPS panel 12-16)

	Total	Non-PCMH	Partial-PCMH	Full-PCMH	P value
Sample size (unweighted)	13,863	4,452	6,530	2,881	
Weighted population (1,000)	301,259	90,880	145,512	64,867	
Weighted percentage (%)	100	30.17	48.30	21.53	
Demographics, W%					
Gender					0.53
Male	41.74	41.22	42.25	41.31	
Female	58.26	58.78	57.75	58.69	
Age category					0.05
18-44	39.33	40.85	39.41	37.00	
45-64	40.31	39.96	39.53	42.57	
65+	20.36	19.19	21.06	20.43	
Race/Ethnicity					<0.001
Non-Hispanic White	72.88	69.46	74.07	74.99	
Non-Hispanic Black	10.85	10.72	10.61	11.54	
Hispanic	10.54	13.01	10.00	8.27	
Non-Hispanic Asian	3.42	4.24	3.20	2.75	
Non-Hispanic Other	2.32	2.57	2.10	2.44	
Marital Status					<0.001
Not married	35.63	39.28	35.14	31.61	
Married	64.37	60.72	64.86	68.39	
Region					<0.001
Northeast	21.12	17.75	20.95	26.22	
Midwest	21.49	19.39	21.64	24.11	
South	35.99	37.44	36.17	33.58	
West	21.40	25.43	21.25	16.08	
MSA					0.49
No	17.04	17.02	17.59	15.84	
Yes	82.96	82.98	82.41	84.16	
Socioeconomic status, W%					
Employment status					<0.001
Not employed	37.51	40.74	36.79	34.61	
Employed	62.49	59.26	63.21	65.39	
Education level					0.02
No degree	11.36	13.12	11.02	9.65	
High school diploma/GED	45.95	45.60	46.33	45.58	
Bachelor's degree	31.33	30.30	31.71	31.92	
Advanced degree	11.36	10.98	10.94	12.84	
Family poverty level					<0.001
<200% FPL	26.21	31.15	24.96	22.09	
200% - 400% FPL	30.46	30.42	31.02	29.26	
> 400% FPL	43.33	38.43	44.02	48.65	
Insurance coverage					<0.001
Any private insurance	74.34	70.10	74.86	79.09	
Public insurance	19.06	21.88	18.57	16.24	
Uninsured	6.60	8.02	6.58	4.67	
Health behaviors, W%					

Smoking status					<0.001
No	83.88	81.86	84.18	86.03	
Yes	16.12	18.14	15.82	13.97	
BMI					0.84
<18.5	1.35	1.40	1.38	1.22	
18.5-24.9	31.00	30.76	31.07	31.17	
25-29.9	32.96	33.67	33.06	31.73	
>=30	34.70	34.17	34.49	35.88	
Health beliefs, W%					
Risk taking					0.63
No and uncertain	82.12	81.54	82.44	82.21	
Yes, more likely to taking risk	17.88	18.46	17.56	17.79	
Belief to overcome illness without medical help					<0.001
No and uncertain	83.55	81.21	84.55	84.59	
Yes	16.45	18.79	15.45	15.41	
Health status, W%					
Perceived general health					<0.001
Excellent	23.41	17.86	24.02	29.84	
Very Good/Good	57.40	57.44	57.58	56.94	
Fair/Poor	19.18	24.70	18.40	13.22	
Perceived mental health					<0.001
Excellent	41.05	34.02	41.48	49.95	
Very Good/Good	50.42	54.46	50.75	44.01	
Fair/Poor	8.53	11.52	7.77	6.04	
Functional Limitation					<0.001
No	74.37	69.69	75.57	78.24	
Yes	25.63	30.31	24.43	21.76	
Charlson Comorbidity Index					0.13
0	75.71	74.22	75.92	77.35	
1-2	15.77	17.17	15.46	14.49	
>2	8.52	8.61	8.62	8.17	
Panel, W%					0.09
12	18.71	19.09	18.09	19.58	
13	19.84	21.46	19.15	19.14	
14	20.43	20.84	19.75	21.38	
15	19.95	18.39	21.44	18.79	
16	21.06	20.22	21.56	21.12	

Notes: *MEPS, Medical Expenditure Panel Survey; ACSC, Ambulatory Care Sensitive Conditions. PCMH, Patient-Centered Medical Home; MSA, Metropolitan Statistical Area; GED, General Educational Development; FPL, Federal Poverty Line; BMI, body mass index; W%, weighted percentage calculated using survey weights. P value was based on Chi-square tests incorporating survey weights.*

Table 3.3 The weighted percentage of the respondents that reported having at least one ACSC outcome at the second year of survey under different level of Patient-centered Medical home and its individual attributes (MEPS Panel 12-16)

	Weighted % ACSC admission			Weighted % ACSC ED visit		
	Overall	**Acute**	**Chronic**	**Overall**	**Acute**	**Chronic**
Patient-Centered Medical Home (PCMH)						
Non PCMH	2.19	1.04	1.31	3.12	1.31	1.86
Partial PCMH	1.55	0.75	0.96	2.33	0.83	1.57
Full PCMH	1.33	0.53	0.89	1.78	0.68	1.13
Comprehensiveness						
Low	3.11	*0 Obs*	0.31	2.38	*0 Obs*	2.38
Medium	1.55	0.33	0.12	3.47	1.79	1.68
High	1.70	0.73	0.10	2.43	0.93	1.55
Enhanced Access						
Low	2.14	0.99	1.22	2.87	1.00	1.92
Medium	1.50	0.58	0.99	2.38	0.98	1.47
High	1.21	0.45	0.78	1.61	0.68	0.93
Shared Decision Making						
Low	1.89	0.77	0.13	3.26	1.34	1.99
Medium	1.72	0.77	0.10	2.47	0.91	1.56
High	1.63	0.65	0.10	2.25	0.88	1.45
Patient-Centered Communication						
Low	2.24	0.88	1.45	2.99	1.07	1.93
Medium	1.33	0.59	0.79	2.26	1.05	1.32
High	1.65	0.72	0.99	2.27	0.77	1.52
Sensitivity Analysis Using Propensity Score Match and Two Groups of PCMH						
Patient-Centered Medical Home (PCMH)						
Non-PCMH	2.23	0.92	0.13	3.07	1.33	1.76
PCMH	1.58	0.56	0.08	1.96	0.65	1.38

Notes: *MEPS, Medical Expenditure Panel Survey; ACSC, Ambulatory Care Sensitive Conditions. PCMH, Patient-Centered Medical Home; Weighted %, the weighted percentage of the respondents that reported having at least one outcome event at the second year. Sensitivity analysis was conducted by re-classifying PCMH score in two groups and using propensity score matching.*

Table 3.4 The effects of Patient-centered Medical home and its individual attributes on ACSC Admission and ED visit (MEPS Panel 12-16)

	OR of ACSC admission			OR of ACSC ED visit		
	Overall	**Acute**	**Chronic**	**Overall**	**Acute**	**Chronic**
Patient-Centered Medical Home (PCMH)						
Non PCMH	Ref	Ref	Ref	Ref	Ref	Ref
Partial PCMH	0.77	0.79	0.71	0.80	0.66	0.97
Full PCMH	0.67*	0.53	0.75	0.65*	0.62	0.73
Comprehensiveness						
Low	Ref	*0 Obs*	Ref	Ref	*0 Obs*	Ref
Medium	0.47	0.47	0.38	0.94	1.88	0.63
High	0.45	Ref	0.27*	0.92	Ref	0.55
Enhanced Access						
Low	Ref	Ref	Ref	Ref	Ref	Ref
Medium	0.84	0.71	1.00	1.04	1.20	0.95
High	0.75	0.67	0.84	0.90	0.93	0.67
Shared Decision Making						
Low	Ref	Ref	Ref	Ref	Ref	Ref
Medium	1.13	1.15	0.91	1.13	1.15	0.91
High	1.05	0.97	0.89	1.05	0.97	0.89
Patient-Centered Communication						
Low	Ref	Ref	Ref	Ref	Ref	Ref
Medium	0.62	0.70	0.60	0.62	0.70	0.60
High	0.84	1.03	0.76	0.84	1.03	0.76
Sensitivity Analysis Using Propensity Score Match and Two Groups of PCMH						
Patient-Centered Medical Home (PCMH)						
Non-PCMH	Ref	Ref	Ref	Ref	Ref	Ref
PCMH	0.65*	0.61	0.67	0.54*	0.72	0.95

Notes: *MEPS, Medical Expenditure Panel Survey; ACSC, Ambulatory Care Sensitive Conditions; ED, emergency department; PCMH, Patient-Centered Medical Home; OR, Odds Ratio. The effects of PCMH on overall, acute and chronic ACSC admission were modeled using survey multivariable logistic regression accounting for survey weights. The individual attributes' effects were modeled by including all four attributes in one model. Covariates adjusted in all models included respondents' demographic characteristics (age; gender; race, marital status, region, rurality), socioeconomic status (employment, education, family poverty level, insurance), health beliefs (risk taking, overcoming disease without medical helps), health behaviors (smoking, BMI), health status (perceived general & mental health, functional limitation, Charlson Comorbidity Index), and panel. *P<0.05*

CHAPTER 4. THE EFFECTS OF POST-DISCHARGE CONTINUITY OF CARE ON HOSPITAL UTILIZATION AMONG TAIWAN PATIENTS

4.1 Introduction

Unplanned hospital readmission has been a common financial burden and quality issue among health care systems around the world. In the United States, nearly 20% of the Medicare fee-for-service patients were re-hospitalized within 30 days of discharge, and the annual Medicare expenditure of unplanned readmissions was estimated around $17 billion, which raised great calls for interventions (Jencks, 2009). Recent statistics also revealed that averagely readmissions costs were more than index admissions, no matter who the payer was (Barrett, Wier, Jiang, & Steiner, 2015). These readmissions are not only costly but also reflect poor quality of previous hospital care or post-discharge care. Some believed that the trends of minimizing the length of stay in acute care sites and earlier discharge have somehow lead to lower quality of inpatient care, and reversely triggered the increase of readmission rates (Carey & Lin, 2014; Kaboli et al., 2013). Therefore, in order to hold hospitals accountable for the quality of care, the U.S. Centers for Medicare & Medicaid Services (CMS) established a Hospital Readmissions Reduction Program (HPPR) starting from October 1, 2012 (Center for Medicare & Medicaid Services, 2017). By linking the payment to the measures of quality of care, hospitals face strong financial incentives to reduce excess readmissions via innovative efforts such as care coordination and discharge planning. However, some believed that hospitals should not take sole responsibility for readmissions, since quality of inpatient care only contributes partially to readmission. Many hospitals were penalized because they didn't have much control for the post-discharge outpatient care and the patients they served (American Hospital Association, 2016). Therefore, various interventions targeting either the care and discharge of index hospitalizations or the post-discharge care coordination have been applied to reduce the readmission among different populations (Hansen, Young, Hinami, Leung, & Williams, 2011).

Most experts agree that to reduce unplanned hospital readmissions requires appropriate patient management in the outpatient settings (Caminal, Starfield, Sánchez, Casanova, & Morales, 2004). Effective and timely outpatient care can prevent the onset of the illness, control the acute condition, and manage the chronic diseases, so that patients do not end up in hospitals (Ansari, Laditka, & Laditka, 2006). For hospitalized patients, the continuous outpatient follow-ups are the keys to ensure long-term recovery and keep patients from returning to the hospitals (Van Walraven et al., 2004). Therefore, the continuity also plays an important role in the quality of care and might reduce the risk of readmission for hospitalized patients.

Continuity of care (COC) stands for the consistency and coherence of the healthcare events experienced by the patients as they navigate the health care system (American Academy of Family Physicians, 2018). COC generally involves 3 different dimensions: relational, informational and management continuity, with the aim of reducing disruptions caused by the involvement of different practitioners and care settings (Haggerty, Roberge, Freeman, & Beaulieu, 2013). Informational continuity focuses on communication between providers over time. The information shared in the communication is more than medical data but important personal knowledge that is necessary to the care. Management continuity emphasizes on the importance of shared management plans for patients with multiple comorbidities who are managed by multiple providers. Relational continuity represents the connection of the care across the past, present, and future, meaning that a long-term relationship is built between the patient and the trusted doctor. Breakdowns in COC often put patients at risk, leading to repetitive tests, inappropriate prescriptions (Chu, Chen, & Cheng, 2012), medical compliance, or premature death (Leleu & Minvielle, 2013; McAlister et al., 2013). Many empirical studies have also demonstrated the effects of better COC on reducing the risk of unnecessary visits such as urgent readmission (Termorshuizena et al., 2012; Yang et al., 2017), emergency department episodes (Cheng, Hou, & Chen, 2011; Nyweide et al., 2013), and hospital admissions (Bayliss, Ellis, Shoup, & Mcquillan, 2015; Cheng, Chen, & Hou, 2010), especially on avoidable hospitalizations due to ambulatory care sensitive conditions (ACSCs) among certain populations (I. Lin, Wu, & Huang, 2015; Nyweide & Bynum, 2017).

In Taiwan' universal healthcare system where insurance is not a barrier to access, patients' freedom to choose from all providers somehow hinders the COC, which could lead to inappropriate use of services. In 1995, Taiwan implemented a compulsory National Health Insurance (NHI) program to provide universal health care coverage to all the residents. Due to no compulsory referral mechanism, patients in Taiwan can visit any physician under the contract with NHI out of their own choices. Though there is a 4-level co-payment scheme for physician visits at facilities of different level, the highest co-payment is still easily affordable to many patients (Cheng et al., 2011). As a result, doctor-shopping and making unnecessary visits are prominent features of Taiwan's health care market. The average annual physician visits were 12 per person in 2012, which was significantly higher than the median for OECD countries (6.3) (Cheng, n.d.). Under such circumstances, the COC might be jeopardized by fragmented physician visit patterns if patients tend to seek care from various physicians. Research has demonstrated that higher hospital admissions were associated with lower COC among the general population (Cheng et al., 2010), diabetes patients (C. C. Chen, Tseng, & Cheng, 2013; W. Lin, Huang, Wang, Yang, & Yaung, 2010), and chronic obstructive pulmonary disease (COPD) patients (I. Lin et al., 2015) in Taiwan.

However, the consequences of fragmented post-discharge follow-up care on patient outcomes were under-evaluated. Research studies examining the continuity of post-discharge care were among different populations, and were mainly focused on the outcomes in short period, such like 30-days readmission (Field, Ogarek, Garber, Reed, & Gurwitz, 2015; Lawlor et al., 2009; Tung, Chang, Chang, & Yu, 2017).. The reason of the frequently used 30-days readmission outcomes in research was largely due to the launch of the CMS's hospital readmission reduction program (HRRP) (Center for Medicare & Medicaid Services, 2017) that use 30-days readmission rates for measuring hospital care quality and penalization standards. The risk of a hospitalized patient experiencing adverse events that would require hospital care extends beyond 30 days (Khot et al., 2018). An Agency for Healthcare Research and Quality (AHRQ) study showed that near one-fifth of the patients admitted to hospital with preventable admissions had at least one preventable readmission within six months (Friedman & Basu, 2004). In addition, the examination of post-discharge continuity of care was limited to the measures of short-term measures, such as early physician follow-up (7-day), or same physician follow-up. Therefore, it is worth investigating whether the long-term continuity the post-discharge care would affect hospital utilization during a longer period of follow-up.

The purpose of this study is to examine the relationship between post-discharge COC and the hospitalizations for patients admitted for different conditions, including acute myocardial infarction (AMI), congestive heart failure (CHF), asthma, COPD, and diabetes mellitus (DM). These conditions were selected because AMI, CHF, and COPD are the target conditions of CMS's HRRP (Center for Medicare & Medicaid Services, 2017). Meanwhile, asthma, COPD, DM, and CHF are considered to be ACSCs, which could be potentially avoided with higher-quality outpatient care and disease management (Agency for Healthcare Research and Quality, n.d.). The hypothesis was that patients with higher post-discharge COC would experience fewer hospitalization after discharge, because better COC ensures the continuity of treatments, therefore reduces the risk of disease reoccurrence and the needs for intensive inpatient care.

4.2 Methods

4.2.1 Data

This study used the Longitudinal Health Insurance database 2005 (LHID2005), provided by the National Health Research Institutes in Taiwan. This database consists of multiple years of insurance claims data on health care utilization for 1 million beneficiaries randomly sampled from the entire NHI enrollee profile at the end of 2005. It is a nationally representative sample, as there are no significant differences between the LHID2005 and the nationwide population database in terms of the distribution of age, sex, and average insurance premium. The database contains subsets that could be linked through the unique encoded patient, provider and facility identifiers. All the outpatient and inpatient visits were recorded with detailed information such as visit dates, providers, facilities, diagnosis codes, expense claims, etc. Because the study was an analysis of secondary data that have been de-identified for patients' real-life identities, the institutional review was waived for conducting this study by the University of Nebraska Medical Center.

4.2.2 Study design and population

This study adopted a retrospective cohort design. Five cohorts of patients admitted for AMI, CHF, asthma, COPD, and DM were selected using the inpatient utilization data from 2006 to 2008. Each patient must be 18 years and older during the index admission. The index hospitalization for each individual patient was defined as the first acute care (marked as 'acute bed') hospital admission over the past year (365 days). The index admission occurred between January 1, 2006 and December 31, 2008, with a principle diagnosis codes (9th revision clinical modification, ICD-9-CM) listed in Appendix 4 under each cohort. Hence, the patients must not have been hospitalized due to any condition over the past 12 months prior to the index admission, otherwise, they will be excluded. This exclusion criterion was applied in order to ensure the index admissions identified were not readmissions for previous acute care. For patients who have multiple eligible index admission from 2006 to 2008, only the first-time index admission was included. Meanwhile, to ensure every subject included was given proper treatment during the index admission, and equally followed up for one year after discharge, patients who were discharged against medical advice, discharged due to terminal condition, escaped from the hospitals, or died during the index admission or within one year after discharge were also excluded from the study. Another reason for excluding patients who died within one year after discharge was that their pattern of hospital utilization during the terminal stage of life might be significantly different from others.

4.2.3 Measures

4.2.3.1 Outcome variables

Two measures of hospital utilization within the follow-up year were examined: (1) all-cause hospitalization, which was defined as the total number of hospitalizations due to any condition in the follow-up year; (2) condition-specific hospitalization, representing the number of the hospitalizations due to the same disease as index admission. The diagnostic codes (Appendix 4) of each hospitalization was used to decide if the hospitalization was counted as all-cause or condition-specific hospitalization.

4.2.3.2 Primary explanatory variable

Outpatient COC within one year after the discharge was the primary independent variable in this study. There are 5 types of COC measures, including duration, density, dispersion, sequence and subjective measures (Cabana & Jee, 2004). Usual provider of care (UPC) index, sequential continuity (SECON) index, and "continuity of care index" (COCI) were commonly used to measure the density, variety, and dispersion of physician visits when using claim datasets. Given the high variation and dispersion of physician visits in Taiwan (average 15 times per person per year), COCI was chosen to represent the COC in this study, since it was considered to be less sensitive to the number of physician visits compared to UPC and SECON (Smedby, Eklund, Eriksson, & Smedby, 1986). Developed by Bice and Boxerman (Bice, Thomas & Boxerman, 1977), it was an index for measuring the dispersion of patient-physician encounters. It ranges from 0 to 1, with a higher value representing greater COC. Hence, COCI is higher if a patient visits the same physician more frequently than others. The formula for calculating COCI is:

$$COCI = \frac{\sum_{j=1}^{M} {n_j}^2 - N}{N(N-1)}$$

where N is the total number of outpatient physician visits for follow-up; n_j is the number of visits to physician j; and M is the number of physicians visited by the patients throughout the follow-up year. Given the various types of outpatient services documented in Taiwan, only 4 types of non-traditional-Chinese-Medicine physician visits were included: common cases, chronic cases (tuberculosis excluded), medication prescription for chronic diseases, and specialty cases. To make sure the COCI calculated for each patient was valid and meaningful, patients who had less than three outpatient visits during the one year follow-up period were excluded, following the previous studies (Cheng et al., 2010, 2011). Finally, each cohort was categorized into three equal tertiles COCI group: low, medium, and high.

4.2.3.3 Covariates

Several confounding factors affecting hospital utilization were controlled in the final regression models based on studies on COC, as well as the availability of the variables that can be computed from the current claim data (C. C. Chen et al., 2013; Cheng et al., 2010; Chu et al., 2012; I. Lin et al., 2015; W. Lin et al., 2010). Patient demographics included age and gender. Age was set for three categories, 18 - 65 years, 65 - 80 years, and > 80 years. Socioeconomic status was majorly reflected by the patient's insurance enrollment category, which was based on their family income, and the amount of their insurance premium. The category was categorized into four groups, including New Taiwan Dollar (NTD) 40K+, < NTD 40K, Farmers and fishermen/member of the occupational union, and low-income household). Patient's rural or urban residence was computed from the variables the available in NHI, followed the previous method (Chu et al., 2012). Charlson Comorbidity Index (CCI) was computed and classified in three levels (0, 1 - 2, > 2) based on patient's previous outpatient diagnoses to reflect disease burdens (Charlson, Pompei, Ales, & MacKenzie, 1987). The number of outpatient visits during the one year prior to the index hospitalization was tracked and categorized as low (<5 times), medium (5-9 times) and high (>9 times). Length of stay (LOS) of index admission was classified into three levels (less than 5 days, 5 to 9 days, and 10 days and above), reflecting disease severity. Post-discharge outpatient care characteristics were also considered. Patient's most frequently visited outpatient site during follow-up was identified as the usual source of care (USC), and categorized as academic medical center, regional hospital, district hospital, and clinic. The teaching status (Yes or No) and location (Taipei, Northern, Central, Southern, Kaoping-Eastern) of USC were also included. Lastly, the year of the index admission was adjusted, since we enrolled hospitalized patients from three years.

4.2.4 Statistical Analysis

For each cohort, we conducted bivariate analyses to test the difference in each outcome among COCI groups, using one-way ANOVA tests. Multivariable generalized estimation equation (GEE) model with a negative binomial distribution and log link was used for the final analysis for each cohort and each outcome variable separately, to control the potential cluster effect among patients from the same hospital (Hanley, Negassa, Edwardes, & Forrester, 2003). Patient demographics, index hospitalization, and post-discharge USC characteristics were controlled. Marginal effects (MEs) were reported at three significance levels (5%, 1%, and 0.1%). Statistical analysis was performed in July 2017, using STATA software (STATA/SE version 14.2; StataCorp, College Station, Texas 77845 USA).

4.3 Results

4.3.1 Characteristics of the study populations

The characteristics of patient demographics, index hospitalizations, and post-discharge USC were displayed percentage-wise for each cohort in Table 4.1. Overall, in our study of randomly sampled one million beneficiaries, there were 1124, 681, 1016, 2692, 3166 patients admitted for AMI, CHF, Asthma, COPD, and DM in 2006-2008, respectively. Patients admitted to hospitals for the five conditions had a slightly different proportional distribution of the characteristics in terms of demographics, CCI level, prior usage of outpatient services, and LOS. There were predominant differences on the post-discharge USC type and teaching status. For example, around 40% of the AMI patients visited academic medical centers, while around 40% of the asthma patients admitted in regional hospitals. Nearly 80% of the AMI patients got their post-discharge outpatient care from teaching facilities, while about half of asthma and COPD patients got their care at non-teaching facilities.

4.3.2 Post-discharge COC and hospitalizations

Table 4.2 displayed the distribution of post-discharge COCI scores, the average number of all-cause hospitalizations, and condition-specific hospitalizations by COCI groups for each cohort. The one-way ANOVA tests showed that for all cohorts except for AMI cohort, there were at least two COCI groups that had significant differences on the two outcomes (all $p<0.05$). However, the AMI-specific hospitalizations were not significantly different among the three COCI groups ($p=0.576$).

4.3.3 All-cause hospitalizations

Table 4.3 displays the results of the negative binomial GEE regression models with the all-cause hospitalization as the outcome for each cohort, adjusting for covariates. For all the cohorts, AMI, CHF, Asthma, COPD and DM, patients with medium (ME -0.70, -1.21, -0.91, -0.87, -0.93 respectively, all $p<0.01$) and high post-discharge outpatient COC (ME -0.61, -3.51, -2.09, -1.79, -1.46 respectively, all $p<0.01$) had significant lower all-cause hospitalizations during the 1-year follow-up period. The dose-response effects were observed from all cohorts except for AMI patients, that the marginal effects were larger in absolute values among patients with the highest level of COC comparing to patients from the medium COC group.

4.3.4 Condition-specific hospitalizations

Nevertheless, for condition-specific hospitalizations, only Asthma, COPD and DM patients with medium COC (ME -0.16, -0.20, -0.11 respectively, all $p<0.05$) and high COC (ME -0.34, -0.40, -0.21 respectively, all $p<0.001$) had significant lower hospitalizations for the same condition as compared to their low COC counterparts (Table 4.4). Similarly, the dose-response effects were observed for the three cohorts, that the marginal effects were larger in absolute values among patients with the highest level of COC comparing to patients from the medium COC group. For CHF cohort, only those with high COC had significant lower CHF-specific hospitalizations (ME -

1.23, p<0.001), compared with their low COC counterpart. However, AMI patients who had medium and high post-discharge COC was not associated with AMI-specific hospitalizations (both p>0.05).

4.4 Discussions

This study examined the effect of post-discharge outpatient COC on hospital utilization during the 1-year follow-up period for patients hospitalized for five conditions. We found significant dose-response effects among all five cohorts that the higher level of post-discharge COC, the lower overall hospitalizations encountered by patients during one-year follow-up, after controlling for confounders. Discharged patients who went to the same physicians for the follow-up care were more likely to establish trusty and long-term relationship with their physicians, hence to have better medication adherence and consistent management of disease (Mainous, Baker, Love, Gray, & Gill, 2001). The results on all-cause hospitalization were consistent with previous literature among other populations. A study conducted in an adult population from an integrated delivery system suggests that greater continuity of care was independently associated with lower hospital utilization for seniors with multiple chronic medical conditions (Bayliss et al., 2015). Cheng et al. examined the effects of three COC indices on the number of hospital admissions following a representative sample of Taiwan population, and found significant protective effects of COC on overall hospital admissions with dose-response trends (Cheng et al., 2010). Retrospective cohort study on Medicare beneficiaries with CHF, COPD and DM also found significant lower overall hospitalizations among patients with higher levels of continuity (Hussey et al., 2014). Supplementing previous evidence, our results suggested that better long-term post-discharge COC could potentially lower the overall hospital utilization for patients discharged from acute care settings for the five conditions.

The effects of post-discharge COC on condition-specific hospitalizations were in different patterns among the five cohorts. Patients admitted for asthma, COPD, DM who had medium and high post-discharge COC had fewer hospitalizations for the same reason as index admission. The same positive effect only showed in CHF patients with high COC. The results were explainable since asthma, COPD, CHF and DM are considered as ACSCs. These types of hospitalizations can be potentially prevented if given better ambulatory care, which was represented by better post-discharge continuity of care in our study. Hence, strategies to improve the continuity of their post-discharge care, such as building trust and long-term relationship with the same physician for follow-up care and prescription management, could significantly reduce the same-cause hospitalizations for ACSCs. The different impact of post-discharge COC on ACSCs and non-ACSCs admissions suggested that different strategies might be needed for reducing same-cause admissions for different cohorts of patients. Literature has suggested that interventions such as health education and telemonitoring could prevent COPD readmission in 6-12 months (Yang et al., 2017). Hospital-initiated case management programs were effective to reduce unplanned hospital readmissions for CHF, diabetes and COPD patients, which pointed out the importance of the involvement of hospitals in managing their discharged patients (Huntley, Johnson, King, Morris, & Purdy, 2016; Martínez-González, Berchtold, Ullman, Busato, & Egger, 2014). For AMI and CHF patients, higher discharge planning quality (Henke, Karaca, Jackson, Marder, & Wong, 2017), early discharge follow-up (7-day, and 14-day) (Tung et al., 2017), and follow up with a familiar physician were also proved to be effective in preventing 30-day same-cause readmissions (McAlister et al., 2013). The interventions mentioned above were mostly focused on ensuring a smooth transition of care from inpatient to outpatient, and some were resource consuming and required extra efforts from the hospitals. The outcomes measured were mostly short-termed, such as 30 days readmissions. Though the long-term cost-effectiveness of these interventions requires further investigation, they are successful practices for preventing hospital episodes for discharged patients who bear high risk of being readmitted after discharge if lack of transition of care. Therefore, financial incentives might also be needed to encourage hospitals' active participation in managing discharged cases in Taiwan, such as the HRRP implemented by CMS (Center for Medicare & Medicaid Services, 2017). As the results showed in our study, post-discharge COC did not seem to independently affect the susceptibility of being hospitalized for AMI cohort during the follow-up year. In addition, a recent study on 1-year readmission among AMI population found that 5% of AMI patients accounted nearly half of 1-year readmissions. The readmission peaked during the first 15 days of discharge, with most of them due to cardiovascular reasons, while the majority of 1-4 month readmissions due to non-cardiovascular diseases (Khot et al., 2018). Hence, besides urging patients to do follow-ups with the same doctor, more interventions that facilitate the better transition of care, such as discharge planning, telemonitoring, and referral to rehabilitation facility, and risk management through routine check-ups and chronic disease management might be needed for AMI patients to prevent their future adverse events after discharge.

The results of the study also led to the reconsideration for the appropriateness of the measures for the HRRPs, which use readmission as a quality-of-care measure. Starting from October 2012, hospitals in the U.S. who treat Medicare patients will be penalized if readmission rates exceeding certain standards for five conditions: AMI, COPD, HF, Pneumonia, Coronary Artery Bypass Graft (CABG) surgery, and Elective Primary Total Hip Arthroplasty and/or Total Knee Arthroplasty (THA/TKA) (Center for Medicare & Medicaid Services, 2017). The HRRP data will be publicly available on Hospital Compare in January 2019. These readmissions are believed to be preventable and hospitals are held responsible for readmissions. In order to avoid financial loss, hospitals were forced to develop strategies to reduce readmission rates, and many interventions have emerged. However, a 2011 system review discovered that out of 31 eligible studies, the median proportion of avoidable readmissions was only 27.1%, which was lower than the 76% reported by the Medicare Payment Advisory Commission. Hence, more research is needed to set the appropriate guidelines for preventable readmissions. Because access issues in certain U.S. population groups, strategies were needed to improve the post-discharge care and ensure the continuous treatment. Moreover, most of the current hospital-initiated interventions were actually focused on patient education as well as improving the transition and the collaboration between hospital and the post-discharge care (Van Walraven, Bennett, Jennings, Austin, & Forster, 2011). Our study also added to the evidences by demonstrating that even under a system that does not have major financial access issues, better post-discharge continuity of care solely did not led to fewer readmissions for all conditions. The continuity of follow-up visits and the medication compliance were also proved to be essential factors of readmissions, (C. C. Chen et al., 2013; Dilokthornsakul, Thoopputra, Patanaprateep, Kongsakon, & Chaiyakunapruk, 2016). These self-manage health practices from patients' side should not be neglected when developing programs to reduce readmissions.

As a cross-sectional cohort design, this study possesses several limitations. Firstly, the patients that had eligible index admission therefore were enrolled in the analysis could be at different stage of the disease progress or different stage of life. Their needs for hospital services could vary dramatically, hence biased the outcomes because of the extreme cases. The criterion of only including patients who did not have any hospitalizations during the 12 months prior to the index admissions also reduced the potential bias caused by the frequent hospital users who were. Meanwhile, the LOS of the index admission and the comorbidity index were adjusted in the model, which could reflect the severity of the index admission and the disease burden. Secondly, we did not differentiate if the patient's regular post-discharge follow-up was with the same physician as the hospitalist. Although choosing the hospitalists as their follow-up care providers are common in Taiwan, there are also patients who would choose physicians near their residence for follow-ups instead of the hospitalists they saw. As COCI gauges the dispersion of physician visits, COCI score should be higher if they visited a same physician more frequently than others. Moreover, the situation that the most frequent visits a patients generated were not for caring the same conditions as their index admissions was not able to ruled out in this study. However, we assumed that the possibility was subtle to cause major biases to the results, since the culture of follow-up visits for renewing and adjusting their medication are prevalent in Taiwan. Thirdly, to compare the results among different cohorts, we kept the covariates the same in all models and did not include any clinical treatment factors, which could also confound the risk of encountering hospitalizations after discharge. Last but not the least, there could be reverse causation between the post-discharge outpatient visits that we used to calculate COCI and the post-discharge hospitalizations that we used as outcomes, as they were both measures from the same period. Therefore, we controlled the outpatient use during the one year prior to index admission to minimize the bias caused by those frequent outpatient users, and our results should not be interpreted as causal relationships but only associations.

Despite those limitations, the study highlighted that the long-term post-discharge outpatient COC could improve patient outcomes in terms of lowering the all-cause hospitalizations among the five cohorts of patients, and lowering the same-cause hospitalizations for patients admitted for COPD, DM, CHF and asthma, which are ASCS conditions. As there is no referral requirement in Taiwan's healthcare system, patients who have been discharged from hospitals need more guidance on the timing and locations of their follow-up care for better continuity and outcomes. The lesson that could learn from the U.S. is the promising patient-centered medical home and accountable care organization models, which are designed to improve the continuity of care through team-based care, interdisciplinary communication, disease management, and information exchange supported by health information technology (O'Malley, Reschovsky, & Saiontz-Martinez, 2015) .

4.5 Conclusions

In Taiwan's universal coverage health system where patients have the freedom to choose physicians, better post-discharge COC could largely reduce fragmentation of follow-up care, and prevent the patients from returning to hospitals. Our study demonstrated that increased post-discharge outpatient COC appears to have potential to reduce all-cause hospitalizations for all five conditions, but only reduce condition-specific hospitalizations for ACSCs. For AMI patients, approaches other than increasing the post-discharge COC, such as case management and discharge planning, might also be needed to prevent post-discharge hospital utilization.

4.6 Figures and Tables

Table 4.1 Characteristics of patient demographics, index hospitalizations, and post-discharge USC of the sample population that hospitalized in 2006 - 2008 by condition

Variables	AMI N = 1124	CHF N = 681	Asthma N = 1016	COPD N = 2692	DM N = 3166
Age, y [Mean (SD)]	65.10 (13.52)	73.38 (12.49)	62.26 (18.66)	75.31 (10.73)	63.97 (14.76)
Age, y [N (%)]					
18 - 65	543 (48.31)	153 (22.47)	479 (47.15)	392 (14.56)	1465 (46.27)
65 - 80	387 (34.43)	278 (40.82)	338 (33.27)	1276 (47.40)	1246 (39.36)
> 80	194 (17.26)	250 (36.71)	199 (19.59)	1024 (38.04)	455 (14.37)
Gender [N (%)]					
Male	801 (71.26)	281 (41.26)	423 (41.63)	2010 (74.67)	1586 (50.09)
Female	323 (28.74)	400 (58.74)	593 (58.37)	682 (25.33)	1580 (49.91)
Patient residence [N (%)]					
Urban	854 (75.98)	445 (65.35)	665 (65.45)	1635 (60.74)	2253 (71.16)
Rural	270 (24.02)	236 (34.65)	351 (34.55)	1057 (39.26)	913 (28.84)
NHI enrollment category [N (%)]					
NTD 40,000 +	196 (17.44)	76 (11.16)	97 (9.55)	226 (8.40)	344 (10.87)
< NTD 40,000	193 (17.17)	80 (11.75)	153 (15.06)	257 (9.55)	465 (14.69)
Farmers and fishermen	451 (40.12)	307 (45.08)	457 (44.98)	1159 (43.05)	1407 (44.44)
Low-income household	14 (1.25)	10 (1.47)	40 (3.94)	119 (4.42)	66 (2.08)
Others	270 (24.02)	208 (30.54)	269 (26.48)	931 (34.58)	884 (27.92)
CCI [N (%)]					
0	504 (44.84)	159 (23.35)	349 (34.35)	486 (18.05)	573 (18.10)
1 - 2	431 (38.35)	312 (45.81)	525 (51.67)	1575 (58.51)	1432 (45.23)
> 2	189 (16.81)	210 (30.84)	142 (13.98)	631 (23.44)	1161 (36.67)
Outpatient visits 1-year prior to index hospitalization [N (%)]					
Low (< 5)	361 (32.12)	214 (31.42)	411 (40.45)	802 (29.79)	1065 (33.64)
Medium (5 - 9)	368 (32.74)	236 (34.65)	266 (26.18)	834 (30.98)	1019 (32.19)
High (> 9)	395 (35.14)	231 (33.92)	339 (33.37)	1056 (39.23)	1082 (34.18)
LOS of index hospitalization, d [N (%)]					
< 5	441 (39.23)	312 (45.81)	473 (46.56)	924 (34.32)	1288 (40.68)
5 - 9	371 (33.01)	216 (31.72)	329 (32.38)	915 (33.99)	962 (30.39)
> 9	312 (27.76)	153 (22.47)	214 (21.06)	853 (31.69)	916 (28.93)
Year of index hospitalization [N (%)]					
2006	324 (28.83)	245 (35.98)	363 (35.73)	961 (35.70)	1140 (36.01)
2007	410 (36.48)	245 (35.98)	353 (34.74)	1004 (37.30)	1040 (32.85)
2008	390 (34.70)	191 (28.05)	300 (29.53)	727 (27.01)	986 (31.14)
USC type [N (%)]					
Academic Medical Center	458 (40.75)	129 (18.94)	122 (12.01)	387 (14.38)	797 (25.17)
Regional Hospital	384 (34.16)	273 (40.09)	273 (26.87)	718 (26.67)	1060 (33.48)
District Hospital	106 (9.43)	147 (21.59)	258 (25.39)	826 (30.68)	620 (19.58)
Clinic	176 (15.66)	132 (19.38)	363 (35.73)	761 (28.27)	689 (21.76)
USC teaching status [N (%)]					
No	246 (21.89)	228 (33.48)	551 (54.23)	1368 (50.82)	1100 (34.74)
Yes	878 (78.11)	453 (66.52)	465 (45.77)	1324 (49.18)	2066 (65.26)
USC location [N (%)]					
Taipei	379 (33.72)	186 (27.31)	263 (25.89)	666 (24.74)	923 (29.15)
Northern	143 (12.72)	113 (16.59)	155 (15.26)	330 (12.26)	435 (13.74)
Central	174 (15.48)	152 (22.32)	231 (22.74)	616 (22.88)	655 (20.69)
Southern	198 (17.62)	126 (18.50)	115 (11.32)	447 (16.60)	569 (17.97)
Kaoping-Eastern	230 (20.46)	104 (15.27)	252 (24.80)	633 (23.51)	584 (18.45)

Notes: *LHID2005, Longitudinal Health Insurance Database 2005; AMI, Acute Myocardial Infarction; CHF, Congestive heart failure; COPD, Chronic Obstructive Pulmonary Disease; DM, Diabetes Mellitus; NHI, National Health Insurance; NTD, New Taiwan Dollar; CCI, Charlson Comorbidity Index; LOS, Length of Stay; USC, Usual Source of Care (of all the after-discharge outpatient visits).*

Table 4.2 Interest variables for each cohort by COCI tertile groups, and one-way ANOVA test results for bivariate analyses for all-cause and condition-specific hospitalizations among three groups

Index hospitalization	Interest Variables	Total	COCI (Low)	COCI (Medium)	COCI (High)	P
AMI	N (%)	1124 (100)	376 (33.45)	383 (34.07)	365 (32.48)	
	COCI (Mean ± SD)	0.48 ± 0.28	0.21 ± 0.05	0.40 ± 0.07	0.83 ± 0.19	
	All-cause hospitalizations (Mean ± SD)	1.98 ± 3.47	2.96 ± 4.23	1.67 ± 2.83	1.29 ± 2.95	<0.001
	AMI-specific hospitalization (Mean ± SD)	0.86 ± 2.02	0.94 ± 1.87	0.84 ± 1.56	0.79 ± 2.54	0.576
CHF	N (%)	681 (100)	238 (34.95)	220 (32.31)	223 (32.74)	
	COCI (Mean ± SD)	0.40 ± 0.27	0.17 ± 0.05	0.32 ± 0.05	0.72 ± 0.23	
	All-cause hospitalizations (Mean ± SD)	4.01 ± 7.23	5.91 ± 10.14	4.00 ± 5.52	1.99 ± 3.49	<0.001
	CHF-specific hospitalization (Mean ± SD)	1.57 ± 5.29	2.12 ± 8.07	1.77 ± 3.45	0.79 ± 1.84	0.021
Asthma	N (%)	1016 (100)	345 (33.96)	365 (35.93)	306 (30.11)	
	COCI (Mean ± SD)	0.38 ± 0.27	0.16 ± 0.04	0.31 ± 0.06	0.71 ± 0.23	
	All-cause hospitalizations (Mean ± SD)	2.45 ± 4.56	3.25 ± 4.96	2.35 ± 4.91	1.66 ± 3.36	<0.001
	Asthma-specific hospitalization (Mean ± SD)	0.51 ± 1.74	0.74 ± 2.08	0.45 ± 1.76	0.32 ± 1.18	0.007
COPD	N (%)	2692 (100)	903 (33.54)	894 (33.21)	895 (33.25)	
	COCI (Mean ± SD)	0.39 ± 0.26	0.16 ± 0.04	0.32 ± 0.05	0.70 ± 0.23	
	All-cause hospitalizations (Mean ± SD)	3.92 ± 5.37	5.09 ± 5.97	3.83 ± 5.35	2.82 ± 4.44	<0.001
	COPD-specific hospitalization (Mean ± SD)	1.32 ± 2.96	1.65 ± 3.36	1.30 ± 2.95	1.01 ± 2.46	<0.001
DM	N (%)	3166 (100)	1125 (35.53)	1003 (31.68)	1038 (32.78)	
	COCI (Mean ± SD)	0.4 ± 0.26	0.18 ± 0.05	0.34 ± 0.05	0.72 ± 0.22	
	All-cause hospitalizations (Mean ± SD)	2.27 ± 4.07	3.38 ± 4.88	1.95 ± 3.59	1.38 ± 3.19	<0.001
	DM-specific hospitalization (Mean ± SD)	0.51 ± 1.55	0.66 ± 1.78	0.48 ± 1.44	0.36 ± 1.36	<0.001

Notes: *AMI, Acute Myocardial Infarction; CHF, Congestive heart failure; COPD, Chronic Obstructive Pulmonary Disease; DM, Diabetes Mellitus; COC, continuity of care; COCI, continuity of care index. P value was reported for the one-way ANOVA test among three COCI group for each cohort and each outcome variable separately; SD, standard deviation.*

Table 4.3 Negative binomial generalized estimation equation for the effect of COC on all-cause hospitalizations during the follow-up year by admission condition

	Average Marginal Effect				
Variables	**AMI**	**CHF**	**Asthma**	**COPD**	**DM**
COCI (Ref: Low)					
Medium	-0.70***	-1.21**	-0.91***	-0.87***	-0.93***
High	-0.61**	-3.51***	-2.09***	-1.79***	-1.46***
Age, y (Ref: 18 - 65 y)					
65 - 80	0.61**	0.12	0.55*	-0.07	0.14
> 80	0.95***	0.02	1.03***	0.42	0.37*
Gender (Ref: Male)					
Female	-0.16	-0.55	-0.70**	-0.58**	0.23*
Patient residence (Ref: Urban)					
Rural	0.16	0.62	-0.03	-0.18	-0.42**
NHI enrollment category (Ref: NTD 40,000 +)					
< NTD 40,000	-0.46	-0.84	0.78	-0.44	-0.08
Farmers and fishermen	0.00	-0.76	0.58	-0.13	0.34
Low-income household	2.78***	1.15	1.59**	1.97***	1.63***
Others	0.01	-0.42	1.35**	0.38	0.67***
CCI (Ref: 0)					
1 - 2	0.33	-0.39	-0.46*	-0.24	-0.37*
> 2	0.33	0.03	0.45	-0.25	0.12
Outpatients visits 1 year prior to index hospitalization (Ref: Low < 5)					
Medium (5 - 9)	0.67**	1.26**	-1.24***	1.79***	0.86***
High (> 9)	1.93***	2.32***	0.16	2.91***	1.61***
LOS of index hospitalization, d (Ref: <5d)					
5 - 9	0.31	-0.45	1.13***	0.54*	0.44***
> 9	0.72***	1.22*	1.68***	1.38***	1.05***
Year of index hospitalization (Ref: 2006)					
2007	-0.47*	0.16	-0.33	-0.32	-0.13
2008	-0.92***	-0.68	-0.28	-1.02***	-0.24
USC type (Ref: Academic medical center)					
Regional hospital	0.11	1.09*	-0.66	0.35	0.58***
District hospital	0.08	0.40	-0.08	1.25**	0.82***
Clinic	-0.68	-1.81	-0.15	-0.66	-0.08
USC teaching status (Ref: No)					
Yes	-0.03	-1.37	0.94	0.16	-0.14
USC location (Ref: Taipei)					
Northern	0.18	-0.20	-0.66	0.03	-0.46*
Central	-0.04	0.33	0.96	0.96**	0.42*
Southern	0.15	0.95	0.59	0.20	0.38*
Kaoping & Eastern	0.13	-0.33	0.57	0.05	0.24

Notes: *AMI, Acute Myocardial Infarction; CHF, Congestive heart failure; COPD, Chronic Obstructive Pulmonary Disease; DM, Diabetes Mellitus; COCI, continuity of care index; NHI, National Health Insurance; NTD, New Taiwan Dollar; CCI, Charlson Comorbidity Index; LOS, Length of Stay; USC, Usual Source of Care (of all the after-discharge outpatient visits). * P<0.05, ** P<0.01, *** P<0.001.*

Table 4.4 Negative binomial generalized estimation equation for the effect of continuity of care on condition-specific hospitalizations during the follow-up year by admission condition

	Average Marginal Effect				
Variables	**AMI**	**CHF**	**Asthma**	**COPD**	**DM**
COCI (Ref: Low)					
Medium	0.01	-0.13	-0.16*	-0.20*	-0.11**
High	0.09	-1.23***	-0.34***	-0.40***	-0.21***
Age, y (Ref: 18-65)					
65 - 80	0.19*	-0.69**	-0.07	-0.08	-0.17***
> 80	0.14	-0.75**	-0.17	-0.22	-0.16**
Gender (Ref: Male)					
Female	-0.27**	-0.72***	-0.13*	-0.54***	-0.01
Patient residence (Ref: Urban)					
Rural	0.18	0.40	0.11	0.03	-0.15***
NHI enrollment category (Ref: NTD 40,000+)					
< NTD 40,000	-0.14	0.13	0.34*	-0.23	-0.14*
Farmers and fishermen	-0.01	0.01	0.22	-0.22	0.07
Low-income household	1.42***	0.58	0.53**	0.72	0.28**
Others	-0.12	0.92**	0.44**	0.08	0.11
CCI (Ref: 0)					
1 - 2	0.03	-0.25	0.14	0.09	-0.06
> 2	-0.19	-0.11	0.40***	-0.38**	-0.07
Outpatients visits 1 year prior to index hospitalization (Ref: Low)					
Medium (5 - 9)	0.43***	0.99***	0.16	0.82***	0.17***
High (> 9)	0.93***	1.02***	0.41***	1.30***	0.23***
LOS of index hospitalization, d (Ref: <5d)					
5 - 9	-0.17	-0.41	0.29***	0.15	0.07
> 9	-0.25*	0.32	0.35***	0.60***	0.27***
Year of index hospitalization (Ref: 2006)					
2007	-0.18	-0.16	-0.05	-0.19***	-0.16***
2008	-0.25	0.16	-0.10	-0.32***	-0.03
USC type (Ref: Academic medical center)					
Regional hospital	0.01	0.47	0.08	0.35**	0.07
District hospital	-0.02	-0.60	0.27*	0.07	0.19**
Clinic	-0.05	-1.21*	0.48**	-0.49**	-0.05
USC teaching status (Ref: No)					
Yes	0.34	-0.90*	0.32*	-0.26	-0.08
USC location (Ref: Taipei)					
Northern	0.10	-0.24	-0.32**	-0.04	0.05
Central	-0.03	0.83**	0.05	0.19	0.11*
Southern	-0.15	0.27	-0.03	0.03	0.22***
Kaoping & Eastern	0.02	-0.37	0.08	0.05	0.11*

Notes: *AMI, Acute Myocardial Infarction; CHF, Congestive heart failure; COPD, Chronic Obstructive Pulmonary Disease; DM, Diabetes Mellitus; COCI, continuity of care index; NHI, National Health Insurance; NTD, New Taiwan Dollar; CCI, Charlson Comorbidity Index; LOS, Length of Stay; USC, Usual Source of Care (of all the after-discharge outpatient visits). * P<0.05, ** P<0.01, *** P<0.001.*

CHAPTER 5. THE EFFECTS OF INPATIENT PALLIATIVE CONSULTATION ON IMPROVING THE END-OF-LIFE OUTCOMES AND REDUCING THE INTENSIVE HOSPITAL CARE AND COST

5.1 Introduction

Approximate 5% of the US population accounted for 50% of the nation's total health care expenditures (Aldridge & Kelley, 2015; Cohen, 2014). Much of the high spending was incurred by patients who are approaching the end of their lives, since around 80% of them are considered as high-need and high-cost patients (Blumenthal & Abrams, 2016). However, past research has found that in certain population groups that the that increased use of health care resources does not necessarily result in improved survival or quality of life at the end of life (Golan et al., 2018). Studies on overall end-of-life (EOL) care has shown unnecessary use of intensive treatments during the EOL phase (Neuberg, 2009; Sathitratanacheewin et al., 2018). Therefore, most of the discussion has been focused on the appropriate management of EOL care in order to ensure that patients receive both high-quality and cost-effective care at their EOL.

In recent decades, palliative care has been greatly promoted as an alternative of curative care to patients at their EOL because it can improve patients' quality of life, and also reduce the cost by decreasing aggressive treatments (Abrahm, 2011). Research has shown that the initiation of palliative care can result in significant savings to Medicaid, without undermining the quality of care (Zhang et al., 2009). Another study estimated that if every hospital with 150 or more beds had a fully operational palliative care consultation team and 2%-6% of Medicaid patients received inpatient palliative consultation (IPC), it would reduce Medicaid hospital spending by $84 million to $252 million, respectively, in New York State (Morrison et al., 2011). Research using 7-year oncology live discharge data from a large tertiary cancer hospital showed that IPC combined with hospice discharge was associated with a lower predicted probability of 30-day readmission, compared with usual care with discharge to non-hospice post-acute care (DiMartino et al., 2018). A national study among stroke patients demonstrated that the use of IPC is increasing nationally, and stroke decedents who received IPC had shorter length-of-stay (LOS) compared to those who didn't (Singh, Peters, Tirschwell, & Creutzfeldt, 2017).

The time of palliative care has also affected the EOL care. Studies on overall EOL care among Medicare population have shown that shifting to palliative care earlier during the course of EOL care will reduce costs by reducing the unnecessary treatments (Greer et al., 2012; Neuberg, 2009). A prospective cohort study also demonstrated that earlier consultation is associated with the larger scale of cost-saving among the Medicare population with advanced cancer (May et al., 2015). A population-based study conducted in Australia showed that initiation of community-based palliative care before the last six months of life was associated with a lower rate of unplanned hospitalizations and lower costs comparing with initiation within six months of death (Wright, Youens, & Moorin, 2018).

According to the Nebraska Hospice & Palliative Care Association, half of the Nebraskans know little or nothing about hospice and its benefits. Moreover, while nine of ten Nebraskans say they want to die at home, less than 20% of them do (Nebraska Hospice & Palliative Care Association, n.d.). In fact, hospice programs are usually eligible for terminal patients or those with six months of life, while palliative care can be received by patients at any time and at any stage of illness. Since many of decedents would experience emergency department (ED) or inpatient episodes before death, palliative care consultation offered in the acute care units can serve as a useful resource for patients and their families to get more options that comfort them and help with the physical, psychological, social and spiritual problems (Bajwah et al., 2017). Therefore, it's important to investigate the current utilization of IPC in Nebraska, and its impacts on hospice care, place of death, and high-intensity care utilization and costs at the EOL. We selected the decedents of the top six leading causes of death in Nebraska and conducted whole- and sub-cohort analyses because patients died for different reasons might have distinctive EOL care patterns. The enrollment of decedents from several years of death allowed us to detect the time trends on those EOL events and outcomes. Factors associated with high utilization and costs were also identified since they could serve as important implications for controlling healthcare spending at EOL along with the implementation of IPC. We hypothesized that different time of IPC might have different effects on the place of death, hospice discharge, the receipt of high-intensity care and costs at the EOL, and the effects could vary among sub-cohorts.

5.2 Methods

5.2.1 Data source and study population

The primary data sources were the Nebraska Death Certificate (2013-2016) provided by Nebraska Department of Health and Human Services (DHHS), and the Nebraska Hospital Discharge Data (HDD) (2009-2016) provided by Nebraska Hospital Association (NHA). Two datasets were linked together by decedents' unique identities using Link Plus software (Version 2.0, Division of Cancer Prevention and Control, Centers for Disease Control and Prevention). The linked database includes 53,305 Nebraska decedents of all ages from 2013 to 2016 who had acute hospital discharge record(s) during five years prior to death, which consists of 82.45% (out of 64,648 decedents) of the death population in Nebraska from January 2013 to December 2016.

For this part of the dissertation thesis, only 33,248 decedents of the top six leading causes of death in 2013-2016 from the linked database were included in the analyses. The six cohorts were decedents of cancer, heart disease (HD), chronic lung disease (CLD), cerebrovascular disease (CD), Alzheimer's disease (AD) and diabetes mellitus (DM). Though the total number of decedents of accidents were more than decedents of DM, they were excluded in our analysis, considering their health service utilization patterns might be different from patients with chronic diseases and also vary significantly by the accident types. Besides, this group of decedents is less relevant to the objectives of examining if the use of IPC can reduce the EOL acute care burden. The six death cohorts were identified via the ACME (Automated Classification of Medical Entities) selected underlying cause of death ICD-10 code (Appendix 5.1), which are collected as part of national vital statistics by the National Center for Health Statistics (NCHS).

Prior to any analyses, the reliability and steadiness of the merged dataset were tested by comparing match rates by cohort and by year of death. The match rate was calculated using the numbers of decedents in the linked dataset divided by Nebraska official-reporting death numbers. The rates indicated the percentage of the death population captured by this study, since the decedents in our merged dataset had at least one acute hospital discharge record during the last 5 years of life. The overall match rate of the six cohorts combined was 85.1%, which was a little higher than the overall matching rate for decedents of all the causes in Nebraska (82.45%). The match rates were relatively steady within each cohort over the years with minor fluctuation (Appendix 5.2). Patients who died from cancer, CLD, and cerebrovascular diseases had the highest match rates around (90.0%), while only 67.1% AD decedents would utilize acute inpatient services in the last five years of their life.

A total of 33,248 decedents were used for the descriptive results such as the recommended EOL services, place of death and high-intensity care at the EOL. After excluding decedents with missing values on the covariates, a total of 33,106 subjects were enrolled in the final regression analyses. The regression analyses on the outcomes of life-sustaining treatment, LOS and total charges at the EOL were restricted to a total of 17,201 decedents who had at least one hospital discharge during the last month of life because only they had the possibility of encountering these outcomes.

5.2.2 Measures

5.2.2.1 Recommended EOL services

5.2.2.1.1 Inpatient palliative consultation

Inpatient palliative consultation (IPC) was one of the recommended EOL services. Decedent was considered having had IPC if their discharge records contained the diagnostic codes of palliative care consultation (Hua, Li, Clancy, Morrison, & Wunsch, 2017) (Appendix 5.3). The time of IPC was the primary independent variable in this study. The discharge date of the hospitalization with IPC was regarded as the approximate time of receiving IPC. It was first categorized by the time prior to death date under a more detailed classification (0-3 days, 4-30 days, 1-3 months, 3-6 months, >6 months) in order to conduct a descriptive analysis of the frequency of the time of IPC. The latest IPC time was used if decedents had more than one admission that recorded the use of IPC because the latest IPC was considered to be more influential of the EOL health services utilization. In regression analyses, the time of IPC was re-categorized as never, late IPC (IPC was received during the hospitalization discharged within three days prior to death), and early IPC (IPC before three days prior to death). This re-group was due to the statistical consideration since the frequency analysis showed that the majority of our sample population received late IPC. We combined the rest of the IPC groups that had the small sample size and defined it as 'early IPC' group relative to 'late IPC'. The 'early IPC' does not mean clinical sense of early IPC, of which the time is often measured from the diagnosis or progress of some terminal diseases.

5.2.2.1.2 Hospice discharge

Hospice discharge was an indicator of receipt of hospice care, which is also recommended for patients at their end of lives. Decedents were considered to have hospice care if they ever had an admission with discharge status coded as hospice home or hospice medical facility. The time of hospice discharge was categorized by the discharge date prior to death date, same as the categorization of IPC and frequency analysis was performed to describe the time of hospice discharge. For decedents with multiple hospice discharges, the latest time of hospice discharge was used, due to the same rationale for the multiple IPC. In regression analyses, the time of IPC was re-categorized as a binary variable with 1 indicating decedent had been discharged to hospice before death and 0 indicating never been discharged to hospice care.

5.2.2.2 Place of death

Place of death (POD) was originally a variable from Nebraska death certificate, with the categories including inpatient, Emergency Department (ED)/outpatient, dead on arrival, home, hospice facility, nursing home/long term care (LTC) facility, other, unknown. Since many of the outcomes in this study were associated with inpatient services, POD was re-computed into a binary categorical variable with 1 indicating death in inpatient and 0 including all the other places.

5.2.2.3 EOL high-intensity care

End-of-life (EOL) period was defined as 30 days prior to death in this study, based on previous empirical findings that 78% of the costs in the final year of life were spent on acute care in the final 30 days of life (Yu, n.d.). Receipt of intensive care and receipt of life-sustaining treatment at the EOL were two outcome variables to reflect EOL high-intensity care. Intensive care was a binary variable derived from the number and LOS of EOL hospitalizations. If the hospital discharge happened within EOL period, we counted as one EOL acute hospitalization. From the admission source variable in HDD, we also identified the number of ED visits leading to admission if the admission source was from ED. Following previous studies (Margolis et al., 2017), decedent was considered to have received intensive care at the EOL if he/she experienced two or more acute hospitalization discharges, or two or more ED visits leading to admissions, or any admission with more than 14-day LOS during the last month of life.

The receipt of any life-sustaining treatment was also a binary variable if any of decedent's EOL discharge contained any of the life-sustaining treatment listed in Appendix 5.3. The choice of life-sustaining treatments followed previous studies (P. J. Chen et al., 2018; Kim et al., 2018; McDermott et al., 2017).

5.2.2.4 EOL acute inpatient care utilization and cost

The total LOS of all EOL acute inpatient hospitalizations was chosen as a more proper utilization outcome variable since it could reflect the intensity of care received by decedents comparing with the number of hospitalizations. It was calculated by adding all LOS of each hospitalization during EOL. The total charges of all EOL admissions were chosen to represent the inpatient costs since data on hospital cost-to-charge ratios were not readily available at the time of the study. Similarly, it was calculated by adding all the total charges of each EOL admission.

5.2.3 Covariates

The covariates adjusted in regression models included decedents' demographic and socioeconomic characteristics, health insurance, disease burden, year of death, and cause of death. Specifically, decedents' age, gender, race, education level, marital status, year of death, cause of death were retrieved from Death certificate data. Age was classified as <50 years, 50-64 years, 65-79 years, and 80 years and older. The median household income was retrieved from Census data (2013 American Community Survey 1-year estimates) using decedent's residence zip codes. The quartiles of median household income were computed and used. The rurality was defined using decedent's residence zip-code to match with Rural-Urban Commuting Area (RUCA) codes 2010 (United States Department of Agriculture, n.d.). It was classified as a three-level categorical variable, which includes urban (metropolitan), micropolitan, and small town/rural (Appendix 5.4). The insurance was the most frequent insurer of decedent's 5-year inpatient admissions prior to death. Charlson comorbidity index (CCI) is a commonly used indicator of disease burden (Charlson et al., 1987; Elixhauser, Steiner, Harris, & Coffey, 1998). It was calculated using all the diagnoses codes captured from decedent' discharge records in the last five years of life, via a user-written Stata command "Charlson" (Stagg, 2017). The mix-effects models also included decedents' residence county health resources since they also have potential influences on the outcomes examined. The county health resource data were based on decedent's residence county derived from zip code, and they were all continuous variables retrieved from Area Health Resource File (AHRF).

5.2.4 Statistical Analyses

The two recommended EOL services were descriptively analyzed by the time of receipt among six death cohorts and overall. Place of death was also described using the original categories. Each individual EOL high-intensity service was also descriptively analyzed among sub-cohort and overall. The demographic characteristics of the overall population enrolled in the regression analyses (with no missing values on all covariates) were descriptively analyzed by sub-cohort and overall.

Mixed-effect logistic regression models were used to analyze the impact of time of IPC on hospice discharge, and on the place of death. In addition to decedents' demographic characteristics, their residence county health resources were also controlled in the models because they reflect the availability of the health services that offered in decedents' residence county, which might affect the discharge location and the place of death. The enrolled county health resource variables were different for the two outcomes. Specifically, the number of hospice facility, the number of short-term general hospitals that have hospice care were adjusted in modeling the outcome of hospice discharge. For the outcome of death in inpatient, hospital beds per 1,000 population, the number of skilled nursing facility, nursing home beds per 1,000 population, and long-term hospital beds per 1,000 population were adjusted additionally.

Logistic regression models were used to analyze the impact of time of IPC on receiving life-sustaining treatment, and on intensive care utilization. It worth mentioning that modeling receipt of life-sustaining treatment was restricted to the population who had at least one admission at the EOL since only they were eligible of receiving any of those treatments. Both models also controlled decedents' demographic characteristics. Binary variable place of death and the receipt of life-sustaining treatment were also controlled for the outcome of intensive care utilization.

For modeling EOL inpatient LOS, negative binomial regression was used. Hospice discharge, EOL events including the number of hospitalizations, having long LOS (>14d) admission, place of death, as well as the individual life-sustaining treatment were controlled in the model, in addition to decedents' demographics. Generalize linear model (GLM) with log link and gamma distribution was used to model the total inpatient charges. The GLM can justify the skewness in the distribution of expenditures without requiring the retransformation of the results from the required log scale when log costs are used. Different in the adjusted covariates, EOL inpatient LOS replaced the binary variable of having long LOS admission, and the binary variable indicating intensive care utilization was added in the model, as the covariates reflecting the intensity of the services received at the EOL. All the regression analyses above were also performed among the individual death cohort.

The database consolidation was completed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA) and all analyses were completed using Stata 14.2 (StataCorp LLC., College Station, TX, USA). The University of Nebraska Medical Center Institutional Review Board approved this study (IRB# 807-18-EP).

5.3 Results

5.3.1 Descriptive results for EOL services, events and costs

5.3.1.1 Inpatient palliative consultation

Among all decedents of the six cohorts, only 11.00% of them have ever received inpatient palliative consultation (IPC) during their inpatient services. For the time of the IPC, most of them (6.43% out of the total population, and 58.45% out of those who had IPC) received the IPC during the hospitalizations that were discharged 0-3 days prior to their death, which was considered as late IPC in the following analyses. Among all six death cohorts, CVD decedents had the highest percentage (17.29%) of having IPC, and most were considered as late (13.33% out of all CVD decedents). On the opposite, only 6.66% of the AD decedents received IPC (Table 5.1).

5.3.1.2 Discharged to hospice care

Among all the 33,248 decedents of the six leading causes of death who had inpatient admission record(s) within 5 years prior to death, a total of 15.84% of them have ever been discharged to hospice care. For the time of discharge, most of the patients (8.71% out of the total population, or 54.99% out of those who had been discharged to hospice care) were discharged to hospice during 4-30 days prior to their death. When separately calculated by the cause of death, cancer decedents had the highest percentage (21.96%) of ever being discharge to hospice care, while only 10.49% patients died from HD were discharged to hospice care. Similarly, most of the decedents in every death cohort were discharged to hospice during 4-30 days prior to their death (Table 5.1).

5.3.1.3 Place of death

The distributions of the place of death by death cohort were summarized in Table 5.2. Among all decedents, the largest proportion of them (32.75%) died in a nursing home or LTC facility, followed by 29.96% of decedents died in hospitals, and 21.70% died at home. HD and CLD decedents' top three places of death were the same pattern as abovementioned. AD decedents had the highest percentage (63.91%) of death in a nursing home or LTC. CVD decedents had the highest percentage (45.26%) of death in inpatient units. Though most cancer decedents (31.08%) died at home, 7.74% of them died in a hospice facility, which was the highest amongst all six cohorts when comparing the percentage of death in a hospice facility.

5.3.1.4 EOL High-intensity care

Table 5.3 summarized the high-intensity care received at the EOL (the last month of life) by cohort. Among the total population, 51.97% had at least one acute inpatient admission, and 12.29% had two or more admissions at the EOL. CVD decedents had the highest percentage (65.29%) of having at least one admission, while cancer decedents had the highest percentage (14.74%) of having two or more admission at the EOL. AD decedents had the lowest percentage of being admitted in hospitals at the EOL amongst all death cohorts.

A total of 31.64% of the decedents had at least one ED visit that leads to hospital admission, with CVD decedents having the highest percentage (42.17%) among all cohorts. A total of 5.17% of the total population had one inpatient episode with 14 days or longer LOS at the EOL. Cancer decedents had the highest percentage (6.48%) of having 14 days or longer LOS.

The utilization of the ten life-sustaining treatments and medical imaging services were summarized by cohort in Table 5.3. Invasive Mechanical ventilation, blood transfusion, intubation were the top three life-sustaining treatments that were received by all decedents at the EOL (15.96%, 15.47%, 11.75%, respectively). When compared among six cohorts, CVD decedents had the highest percentage of receiving Invasive mechanical ventilation (30.62), intubation (20.79%), enteral or parenteral infusion of concentrated nutritional substances (6.65%), and medical imaging (0.58%). Cancer decedents had the highest utilization of blood transfusion (22.49%), chemotherapy (4.37%), and radiation (3.42%). CLD decedents had the highest utilization of non-Invasive mechanical ventilation (19.89%). HD decedents had the highest utilization of cardiopulmonary resuscitation (7.96%). DM decedents had the highest utilization of hemodialysis (15.13%) at their EOL. The distributions of EOL events received by individual cohort w displayed in Figure 5.1, and the time trends of EOL events among all cohorts were displayed in Figure 5.2 (data was summarized in Appendix 5.5).

5.3.1.5 EOL total LOS and total inpatient charges

Table 5.4 displayed the total EOL inpatient LOS and total inpatient charges among the decedents who had at least one EOL admission by death cohort and overall. On average, decedents of all cohorts had 8.09 (Standard Deviation/SD 8.47) days of LOS. Those who never had IPC, who had late IPC, and those who had early IPC had 7.97 (SD 8.41), 8.92 (SD 9.32), and 8.03 (SD 9.32) days of LOS, respectively. Comparing among cohorts, AD decedents had the shortest total LOS (mean

5.85, SD 5.58). The total EOL inpatient charges were $66,073 (SD $97,718). The total charges for those who never had IPC, who had late IPC, and those who had early IPC were $66,083 (SD $99,868), $72,582 (SD $95,080, and $50,976 (SD $62,564), respectively. Comparing among cohorts, AD decedents had the lowest EOL total inpatient charges of $27,522 (SD $23,244), while HD decedents had the highest EOL total inpatient charges of $70,283 (SD $126,926). The detailed EOL total inpatient LOS and charges by cohort were displayed in Figure 5.3 and 5.4, and their time trends were displayed in Figure 5.5. The detailed LOS by cohort was displayed in Figure 5.2. Extra data on EOL events, service utilization and costs were also summarized by year of death and by each cohort in Appendix 5.6 and Appendix 5.7.

5.3.2 Characteristics of the decedents in final regression analyses

After excluding those who had missing values, the characteristic of the decedents in the final regression models by cohort and overall were summarized in Table 5.5. More than half (51.03%) of the decedents were 80 years and older, and only 3.29% were less than 50 years old. Most of the decedents were non-Hispanic white (93.43%). The largest proportion of decedents were high school and general equivalency diploma level education (49.45%). The largest proportion of them was married (42.04%), lived in the metropolitan area (51.45%), and had Medicare (80.73%) as their frequent insurance. It’s worth mentioning that 24.81% of cancer decedents had commercial insurance as their frequent insurance, which was much higher than the other five cohorts. Most decedents’ CCIs were in the range of 2-5, which was also true in the sub-cohort population except cancer and AD decedents. Most cancer decedents (60.81%) had CCI higher than 5, while most AD decedents (62.25%) had CCI within 1. The time trends of death were inconsistent among different cohorts, therefore are not described here.

5.3.3 The impact of different time of IPC on EOL events

5.3.3.1 The impact of different time of IPC on hospice discharge

The mixed-effect logistic regression results in Table 5.6 showed that decedents who had late IPC were 0.66 times (Odds Ratio [OR]: 1.66p<0.001) more likely to have hospice discharge comparing with those who never had IPC. The odds ratio (OR) for decedents who received early IPC was much higher (OR 8.36, p<0.001), compared with those who never had IPC.

Other factors that significantly affect decedents' likelihood of having hospice discharge include age, gender, income, rurality, CCI, cause of death, and the number of hospice care in decedents' residence county. Briefly, older, female decedents, decedents of the highest quartile of median household income, and with higher CCI were more likely to have hospice discharge (Appendix 5.8). Compared with urban decedents, decedents lived in a micropolitan, small town or rural area were less likely to have hospice discharge. Also, the number of hospice care in decedents' residence county positively affected the likelihood of having hospice discharge (OR 1.02, p=0.03). When comparing with cancer decedents, all the other cohorts except for CVD decedents were all less likely to have hospice discharge.

The results in sub-cohort analysis in Table 5.7 showed consistent results as the whole population analysis. No matter when decedents received IPC, their odds of having hospice discharge were significantly higher than their no-IPC counterparts.

5.3.3.2 The impact of different time of IPC on the place of death

Compared with those who never had IPC, decedents who had late IPC were 15.34 times (OR 16.34, p<0.001) more likely to die in inpatient units, while decedents who received early IPC were 0.42 times (OR 0.58, p<0.001) less likely to die in inpatient units (Table 5.6).

Other factors that affected decedents' likelihood of death in inpatient include the last time of hospice discharge, age, race, marital status, rurality, CCI and cause of death. Decedents were less likely to die in inpatient units if they had hospice discharge, no matter when the hospice discharge happened (Appendix 5.9). Older, single or widowed decedents were less likely to die in inpatient, while non-Hispanic Black, Hispanic and other race decedents, decedents lived in a small town or rural area, with higher CCI were more likely to die in hospital. Compared with cancer cohort, decedents of HD, CLD, and CVD were more likely, while AD and DM decedents were less likely, to die in hospital. Decedents' residence county health resource did not significantly affect the outcome.

The sub-cohort analysis (Table 5.7) show that the late IPC increased the likelihood of death in the hospital were consistent with the whole population analysis across all cohorts. However, only cancer and HD decedents who received early IPC were less likely to die in hospital compared with their no-IPC counterparts.

5.3.3.3 The impact of different times of IPC on receiving intensive care at the EOL

Compared with those who never had IPC, decedents who had late IPC were 1.06 times (OR 2.06, $p<0.001$) more likely to have intensive care at their EOL, while decedents who received early IPC were 0.32 times (OR 0.68, $p<0.001$) less likely to receive intensive care at their EOL (Table 5.6). The time of being discharged to hospice also associated with intensive care utilization. Decedents who were discharged to hospice at the EOL were more likely (OR 10.36, $p<0.001$), and decedents who had hospice discharges prior to the EOL were less likely (OR 0.40, $p<0.001$), to receive intensive care at EOL.

Other factors that affected decedents' likelihood of receiving intensive care include the place of death, life-sustaining treatment, age, gender, rurality, CCI and cause of death (Appendix 5.10). Older than 80 years, female decedents were less likely to receive intensive care compared with their counterparts. Decedents who died in hospital, received life-sustaining treatment at the EOL, who lived in small town or rural area, with CCI higher than 2, were more likely to receive intensive care. Compared with cancer cohort, only CLD decedents were more likely (OR 1.35, $p<0.001$) to receive intensive care at their EOL.

The sub-cohort analysis (Table 5.7) show that the impact of late IPC increasing the likelihood of receiving intensive care were consistent across all cohorts except for CVD decedents. Only cancer, HD, and CLD decedents who received early IPC were less likely to receive intensive care comparing with their no-IPC counterparts.

5.3.3.4 The impact of different times of IPC on receiving life-sustaining treatment at the EOL

Compared with those who never had IPC, decedents who had late IPC were 0.31 times (OR 1.31, $p<0.001$) more likely to have life-sustaining treatment at their EOL, while decedents who received early IPC were 0.26 times (OR 0.74, $p<0.001$) less likely to receive life-sustaining treatment at their EOL (Table 5.6).

Other factors that affected decedents' likelihood of receiving life-sustaining treatment include the last time of hospice discharge, age, race, marital status, rurality, CCI and cause of death. Decedents were less likely to receive life-sustaining treatment if they had hospice discharge, no matter when the hospice discharge happened (Appendix 5.11). Older than 65, single or widowed decedents, decedents who lived in the micropolitan area, small town or rural area, decedents with CCI higher than 5 were less likely to receive life-sustaining treatment. Non-Hispanic Black decedents were more likely to receive life-sustaining treatment comparing to their non-Hispanic White counterparts. Compared to cancer cohort, decedents of HD, CLD, and CVD were more likely, while AD decedents were less likely, to receive life-sustaining treatment at their EOL.

The sub-cohort analysis (Table 5.7) show that the impact of late IPC increasing the likelihood of receiving life-sustaining treatment were consistent across all cohorts except for AD and DM decedents. Only HD and DM decedents who received early IPC were less likely to receive life-sustaining treatment comparing with their no-IPC counterparts.

5.3.4 The impact of different times of IPC on inpatient LOS and total inpatient charges at the EOL

5.3.4.1 The impact of different times of IPC on inpatient LOS at the EOL

Only a total of 17201 decedents who had at least one admission at the EOL were included in the analysis. Compared with those who never had IPC, decedents who had late IPC had 0.40 less (95%CI -0.63 to -0.16, p = 0.001) day of inpatient LOS, while decedents who received IPC during the admissions that discharged before three days prior to death had 0.44 less (95%CI -0.78 to -0.10, p = 0.010) day of inpatient LOS at their EOL (Table 5.6).

Other factors that affected decedents' inpatient LOS at the EOL include the number of hospitalizations at the EOL, having one admission that had 14 and more days of LOS at EOL, place of death, having life-sustaining treatments at the EOL, race, rurality, CCI and cause of death (Appendix 5.12). Briefly, decedents who had a greater number of hospitalizations at the EOL, who had one admission with 14 and more days of LOS, who had life-sustaining treatments except for intubation and CPR, who were Hispanic, who had CCI higher than 1, had longer inpatient LOS at EOL (marginal effects were positive values, all $p<0.05$), compared with their counterparts. Compared to cancer decedents, CLD decedents had 0.66 more days (95%CI 0.36 to 0.95, $p<0.001$) of inpatient LOS at the EOL, while CVD decedents had 0.65 less days (95%CI -0.92 to -0.37, $p<0.001$) of inpatient LOS at the EOL.

The sub-cohort analysis (Table 5.7) show that the impact of late IPC decreasing the inpatient LOS at the EOL was only shown in HD and CVD cohorts (marginal effect -0.4 and -0.8, respectively, both p<0.05). Only cancer decedents who received early IPC had less inpatient LOS (marginal effect -0.50, p<0.05) at the EOL compared to those who never had IPC.

5.3.4.2 The impact of different times of IPC on total inpatient charges at the EOL

The results of the impact of IPC on total inpatient charges at the EOL were displayed in. Only 17201 decedents who had at least one admission at the EOL were included in the analysis. Compared with those who never had IPC, decedents who had late IPC had $284,516 less (95%CI -$412,111 to -$156,921, p < 0.001) total inpatient charges inpatient LOS, while decedents who received IPC during the admissions that discharged before three days prior to death had $267,738 less (95%CI -$422,861 to -$112,616, p <0.01) total inpatient charges at their EOL (Table 5.6).

Other factors that affected decedents' total inpatient charges at the EOL include the number of hospitalizations at the EOL, LOS at the EOL, place of death, having life-sustaining treatments at the EOL, age, gender, marital status, rurality, CCI, year of death, and cause of death (Appendix 5.13). Briefly, decedents who had a greater number of hospitalizations, and longer LOS at the EOL, who had life-sustaining treatments except for intubation, gastrostomy tube insertion (GTI), tracheostomy, and medical imaging, would have higher total inpatient charges at the EOL when compared to their counterparts. Decedents who were 65 years and older, female, single or widowed, lived in micropolitan, small town and rural area, who had CCI higher than one, would have lower total inpatient charges (marginal effects were negative values, all p<0.05), compared with their counterparts.

The sub-cohort analysis results were summarized in Table 5.7. The impact of late IPC decreasing the total inpatient charges at the EOL was only shown in cancer, CVD and AD cohorts (marginal effect -$26,265, -$15,435 and -$9,090, respectively, all p<0.05). Only cancer and CLD decedents who received early IPC had less total inpatient charges (marginal effect -$33,988 and -$29,175, respectively, both p<0.05) at the EOL compared to those who never had IPC.

5.4 Discussions

According to the 2015 state-by-state report card from Center to Advance Palliative Care (CAPC), the prevalence of palliative care programs in Nebraska rated 'A', with 87.5% (14/16) hospitals with ≥50 beds, 100% hospitals (4/4) with >300 beds, and 9% hospitals (2/23) with <50 beds reporting palliative care teams (Center to Advance Palliative Care, n.d.). Compared to 2008 when Nebraska was rated 'C' with 55.6% (10/18) hospitals reporting palliative care programs, there has been significant growth in the number of palliative care programs. Nevertheless, our study discovered that there is still plenty room for the promotion of palliative care utilization in acute hospitals in Nebraska, using inpatient discharge data on Nebraska decedents of the six top leading causes of death from 2013 to 2016.

Descriptive data showed that only 11.00% of the enrolled decedents have ever received IPC, and 15.84% had hospice discharge at some time before death (Table 5.1). These results were similar to the study conducted among ovarian carcinoma patients with extreme risk of dying, which found out that 22% of them were discharged to hospice and 11% received documented palliative care services (Uppal, Rice, Beniwal, & Spencer, 2016). There were variations among different cohorts, as we observed that the use of palliative care and hospice discharge among cancer, CLD, and CVD cohorts were above the average percentage of recipients of all six cohorts, while the HD, AD and DM decedents were below the average. It is also worth noting that in our study, more than half of the IPCs (58.45%) were initiated close to death (0-3 days), and more than half of the hospice discharges (55.00%) happened during 4-30 days prior to death. Similar pattern was also found among young cancer and female Medicare uterine cancer decedents, that they were less likely to receive palliative care or hospice discharge, or receive them very close to their deaths (Keim-Malpass, Erickson, & Malpass, 2014; McDermott et al., 2017; Singh et al., 2017). This is the major reason why we separately analyzed the impacts of IPC on EOL outcomes by the time of receiving IPC.

The distribution of place of death suggested that one third (29.96%) of Nebraska decedents died in hospital (Table 5.2). The percentage was higher than the national figure of 19.8% among the Medicare fee-for-service population in 2015 (Teno et al., 2018), but lower than the figure of 37.2% among all US population in 2014 (The Centers for Disease Control and Prevention, 2016). It was not surprising that our analysis detected a sub-cohort difference that more than 30% of HD, CLD and CVD patients died in hospital, while only 5.95% of AD patients died in hospital, as the former cohorts might have more severe symptoms and needs for seeking acute care during EOL.

The sub-cohort variations also existed on their high-intensity care utilization, total inpatient LOS and total charges. Very few AD decedents (3.23%) had more than one admission, more than one ED visit, or long LOS admission during the EOL compared to the average of 15.96% for all cohorts. Similarly, among decedents admitted to inpatient during the EOL, only 14.57% AD decedents received life-sustaining treatment, while around 40% decedents of other cohorts received life-sustaining treatment (Table 5.3, Figure 5.1). For AD decedents, the mean total EOL inpatient LOS for was 5.85 days, which was shorter than the other five cohorts (Figure 3). The mean total EOL inpatient charges for AD decedents who were admitted at least once cohort was $27,522, while similar decedents from other cohorts spent at least $60,000 in the hospital during the EOL (Table 5.4, Figure 5.4). The variations demonstrated that even though AD is among the top 6 causes of death in Nebraska, the AD patients did not seem to be high-risk and high-cost patients during their EOL, comparing to other cohorts.

The time trends for EOL events and outcomes in Nebraska were also worth comparing with other populations. Nationally, the percentage of deaths occurred in hospital declined from 50.2% in 2000 to 37.2% in 2014, due to the development of palliative care and hospice care (Salemi et al., 2017). Two studies conducted among ovarian carcinoma patients and adult metastatic cancer patients using National Inpatient Sample (NIS) from different years showed similar time trends of the increasing use of IPC and hospice discharge and decreasing in-hospital mortality year over year

(Keim-Malpass et al., 2014; Salemi et al., 2017). Another study among chronic obstructive pulmonary disease patients using NIS from 2005 to 2014 showed positive compound annual growth rates for hospital cost, intensive medical procedures, and palliative care. It also demonstrated that the volume of intensive procedures is the biggest driver for cost increase, but the researchers also found a cost-saving effect from greater use of palliative care (P. J. Chen et al., 2018). A study on patients with chronic illness from a large university medical network found decreasing trends on EOL admissions for all patients, as well as Intensive Care Unit (ICU) admissions for 65 years and older from 2010 to 2015 (Sathitratanacheewin et al., 2018). The utilization of high-intensity care among female Medicare uterine cancer patients were found to be steady from 2000 to 2011, but the median spending for high-intensity care users increased significantly over the years, and it was four times as high compared to non-users (McDermott et al., 2017). Study among commercial insured cancer patients in Western Washington State found declining trends on hospitalizations, use of opioid, chemotherapy, radiation, and medical imaging at the last 90 days of life, but also suggested the existence of overuse of aggressive care and underuse of palliative care and hospice care (Kim et al., 2018). Among our study cohorts, the use of IPC and life-sustaining treatment showed slightly decreasing over years, while the percentage of hospice discharge, inpatient death, and the intensive care utilization remained steady over time (Figure 5.2). The inpatient LOS and charges didn't show linear trends, and both peaked in 2015 (Figure 5). The different patterns of these EOL events and outcomes reflected the needs for promoting IPC and hospice care and mitigating the intensity of EOL care in Nebraska.

Our full regression model analyses demonstrated that IPC generally had positive impacts on improving the EOL outcomes in terms of increasing the likelihood of having hospice discharge and reducing the length and costs of acute care. Specifically, IPC received at any time could increase the likelihood of having hospice discharge, and reduce the EOL inpatient LOS and the inpatient charges (Table 5.6). These results were in consistency with studies conducted in other populations.

Morrison et al. examined 2004-2007 Medicaid patients at four New York State hospitals and found that IPC recipients incurred $6,900 less in hospital costs per admission comparing with matched patients who received usual care, though the scale of reduction differed for those discharged alive or died in the hospital. Moreover, IPC recipients had shorter stay in intensive care unit (ICU), were less likely to die there, and more likely to have hospice referrals than the matched counterparts (DiMartino et al., 2018). A study among stroke decedents in hospitals using 2010-2012 NIS showed that LOS was shorter (6.2 versus 7.5 days) for decedents who had palliative care encounter, compared with decedents without palliative care encounter (Singh et al., 2017). A recent study among Medicare beneficiaries with end-stage kidney disease (ESKD) showed that IPC was associated with 21% shorter LOS and 14% lower hospitalization costs among patients who died in the hospital, but no associations were detected among those discharged alive. Patients who received IPC, no matter their discharge status (dead or alive), had a higher likelihood to use hospice care and a lower likelihood of readmission in the 30-day post-discharge period (Chettiar et al., 2018). Our study compared the two IPC groups with the same non-IPC group and found the ORs of having hospice discharge for earlier IPC group were much higher than ORs for late IPC group, in overall and sub-cohort analyses. Though both late IPC group and earlier IPC group found shorter LOS and lower inpatient charges at the EOL among those hospital users, the effects of IPC were not found dose-related by the time of receiving it.

Nevertheless, the time of IPC mattered in the outcomes of inpatient death and the aggressive care received at EOL. Generally, decedents who received late IPC were more likely to die in hospital, and more likely to receive life-sustaining treatment, and experience intensive care (>1 admission, >1 ED visit, or admission >14 days LOS) at their EOL, compared with those who never had IPC. These results were not surprising as we assumed decedents who received IPC close to death might have already experienced curative and aggressive treatment but didn't find improvement on their conditions. In this scenario, IPC did not really help patients and families making more cost-effective medical decisions and reducing the unnecessary aggressive care during EOL, but rather served as the last resort to get symptom relief or transition to hospice. It is also the reason why many research studies tried to demonstrate the importance of the timing of palliative care by proving that early palliative care was more cost-effective than late PC. A prospective cohort study among patients with advanced cancer demonstrated that the cost reduction effect was larger (-$2,280 vs. -$1,312) in earlier IPC (intervention within 2 days) than late IPC group (within 6 days) (Wright et al., 2018). A recent study conducted among palliative care patients in the community hospital setting demonstrated that patients received early IPC intervention (days to IPC ≤3 days) had shorter LOS (6.09 days versus 16.5 days) and realized a significant cost reduction compared to late IPC (>3 days). The early intervention group had an earlier transition to more appropriate levels of care such as outpatient hospice and did not have a negative effect on mortality (Fitzpatrick et al., 2018). They used days to IPC as a criterion for defining early and late IPC, and the comparison groups were also different from our study. Similarly, another study on brain metastases decreases patients defined early palliative care groups as those who had palliative care encounter within 8 weeks of diagnosis, and found out that early palliative care group had fewer inpatient visits, ED visits, and medical imaging services without any difference in overall survival compared with late palliative care group (Habibi et al., 2018). A randomized clinical study discovered that among newly diagnosed metastatic non-small-cell lung cancer patients, those received early palliative care integrated with standard oncologic care had a better quality of life score (98.0 vs. 91.5) and longer median survival time (11.6 vs. 8.9 months) than those assigned to standard care alone. Fewer patients in the early palliative care group had depressive symptoms (16% vs. 38%) and received aggressive EOL care (33% vs. 54%) (Temel et al., 2010). Patients in the early palliative care group were less likely to receive chemotherapy within 60 days prior to death, had a longer interval between the last dose of intravenous chemotherapy and death, and higher enrollment in hospice care for longer than one week (Greer et al., 2012). Though the definition of early palliative care was different from the previous studies, our study also found that receiving palliative care earlier than three days prior to death could reduce the odds of dying in hospital and using aggressive care at EOL, while receiving late PC, oppositely, increased those odds compared with decedents who never received IPC.

It was noted that there were some variations existing in the sub-cohort regression analyses (Table 5.7). These variations might due to many reasons. For patients who died of different conditions, the variations in age distribution, disease burden, the urgency of the showing symptoms, and the expectancy from patients and their families would make the EOL care patterns very different from others. Furthermore, the chance, timing, and purpose of IPC could also vary among cohorts, thus the receipt of IPC did not significantly impact the inpatient death, life-sustaining treatment, inpatient LOS and charges in some cohorts. Lastly, small sample sizes could also make the effects undetectable when conducting sub-cohort analyses.

Like many retrospective studies, this study had several limitations. Firstly, we could not differentiate the time of receiving IPC during the admissions, due to the fact that the time of IPC was retrieved from diagnosis code in discharge data. As we mentioned before, there could be different situations that decedents received IPC earlier in their admissions and did not have aggressive care during the admissions, or they have had intense treatment before they got IPC. The two situations would be classified as the same category if the discharge dates fell in the same period prior to their deaths. To minimize the influence of this potential bias, we controlled other variables such as the number of hospitalizations, long LOS (>14d) admission during the last month of life. Because for those who had long LOS and also late IPC, the scenarios would more likely to be that decedents had first received intensive care during the admission and then IPC before they were discharged. Secondly, the categorical variable hospice discharge could not represent the real hospice care and its intensity received by decedents. We used it because discharge status being hospice facility or hospice home was the only variable available in the HDD that contains information on hospice care, and the receipt of hospice care affects most of our outcomes. Thirdly, the effect of palliative care received outside the hospital could not be adjusted since we did not have the information. As different degree of hospice and palliative care involvement might lead to different care seeking behaviors at the EOL, we could only make a conclusion on the impact of IPC that we observed, not palliative care in particular. Fourthly, the EOL total LOS and inpatient charges were calculated based on all hospital discharges with the discharge dates fell into the 30-day prior to death period. It worth noted that those admitted prior to 30 days but discharged at the EOL were also counted as EOL hospitalizations in our study. The use of long LOS admission as a covariate in the analyses of EOL total LOS and inpatient charges could also help to minimize the bias caused by extremely long LOS hospitalizations that admitted prior to 30 days. Moreover, we used inpatient charges as a representative of inpatient costs, because we do not have hospital-specific cost-to-charge ratios data readily in hand at the time of analyses. Noted that we cannot infer any conclusion on cost reduction since hospital costs are not equal to charges. Lastly, the impacts of IPC could only imply associations rather than causations.

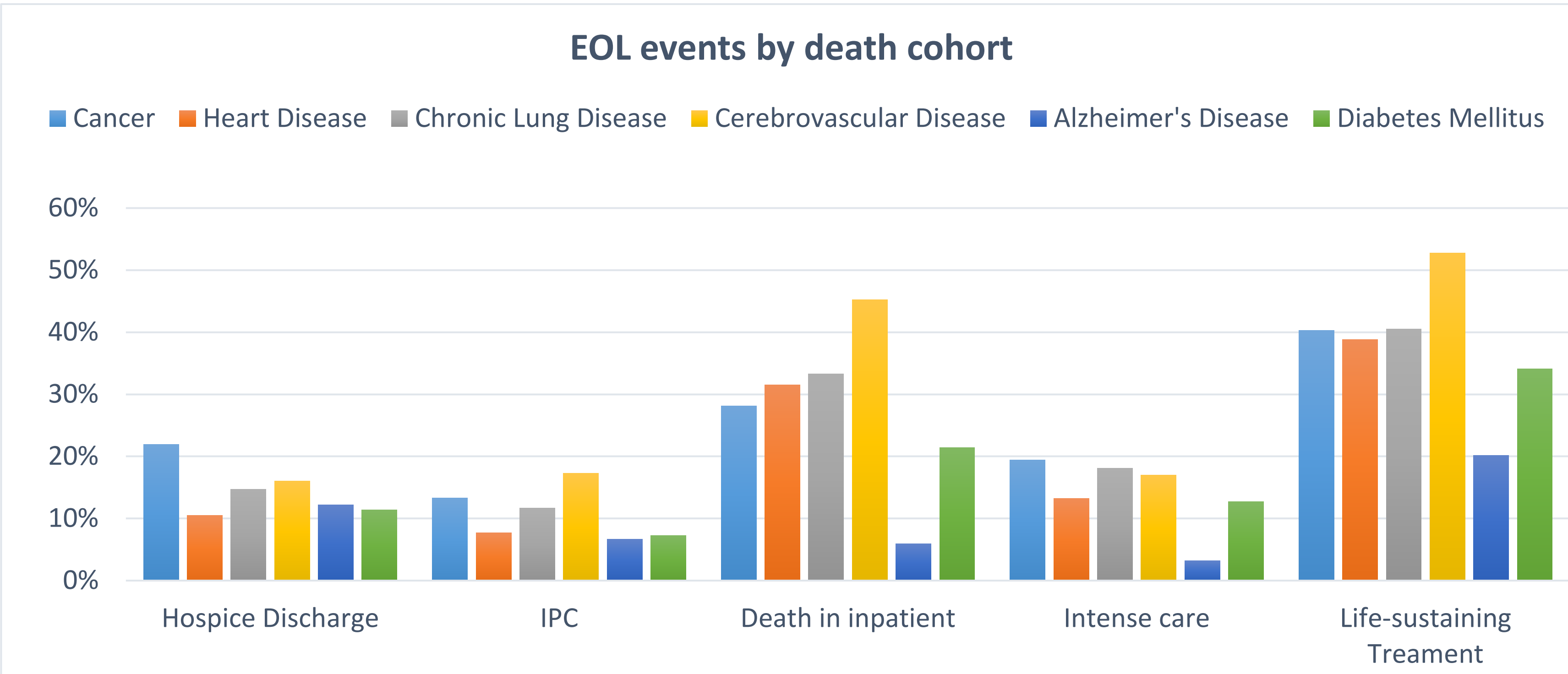
Despite these limitations, this study embedded many strengths. To our best knowledge, this is the first study to describe the utilization of IPC among Nebraska decedents of the top six causes of death from the recent years and to examine the impacts of IPC received at a different time on EOL outcomes, as well as demonstrating their time trends. In contrast to other studies that used data from a single hospital (Habibi et al., 2018), or used a national sample (P. J. Chen et al., 2018; Keim-Malpass et al., 2014; May et al., 2015), we used 6 cohorts of decedents from Nebraska excluding those with missing variables as study subjects, which reflected the real situation in Nebraska. Our results hence can serve as powerful evidence for promoting the early use of IPC for patients with high risk of dying, in order to mitigate the use of aggressive care, to encourage the transition to hospice, and to reduce the high costs at their EOL in Nebraska, despite that the inference to other states or other population is uncertain. Moreover, while previous studies usually focus on a certain disease population, the preemptive selection of decedents of six causes of death enabled us to find variations in the sub-cohort analyses. Last but not least, our study used multivariable regressions in advanced analyses, which enabled us to identify other patient-level and system-level factors that were also associated with the EOL outcomes. These variations and factors also provide references on prioritizing population for the gradual implementation of IPC in real practice. Adding on previous research, it is evident that the early use of IPC can provide psychosocial and spiritual support and help patients receive more comfortable and more effective EOL care, while achieving cost reduction via utilizing less aggressive care and transitioning more quickly to appropriate care such as hospice. Nevertheless, a hospital-level study suggested that hospital-based palliative care programs alone may not be sufficient to impact ICU LOS or hospice length of enrollment (Horton et al., 2016). Hence, more research is needed to understand the barriers of early palliative care involvement, examine the effects of palliative care inside and outside the hospitals, and capture the resource utilization and costs across different healthcare sectors at the EOL among the different population in Nebraska.

5.5 Conclusion

This study investigated the utilization, time trends, and associations of IPC and EOL events among six cohorts of Nebraska decedents of recent years. The results demonstrated that IPC received at any time was associated with higher odds of having hospice discharge, shorter inpatient LOS, and lower inpatient charges at last month of life. However, only IPC received before three days prior to death would benefit patients at their EOL in terms of lowering the odds of dying in hospital and the use of high-intensity care at the EOL, while late IPC was associated with higher odds of inpatient death and more aggressive EOL care. The utilization of IPC and its impact varied among different sub-cohorts, but not changed dramatically over time. As only one out of ten decedents in our study ever received IPC, it prompted the opportunity for early IPC to improve the EOL care for Nebraskan. Ultimately, we hope these findings will inform the implementation of early IPC targeted towards high-risk and high-cost population, with the long-term objectives of optimizing the quality of EOL care for patients and their families at the EOL, while reducing the costs and discomforts caused by aggressive approaches.

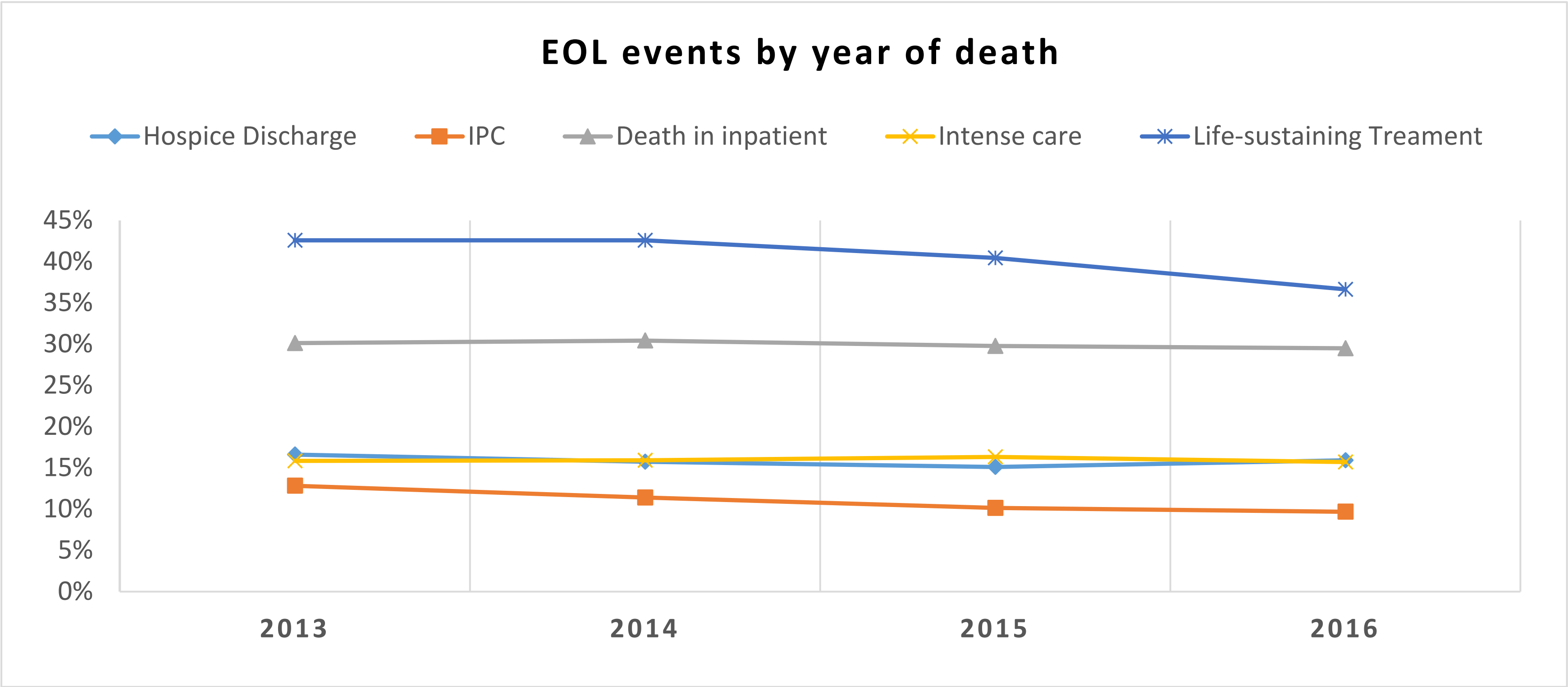
5.6 Figures and Tables

Figure 5.1 EOL events received by the decedents of six top causes of death (Nebraska decedents 2013-2016)



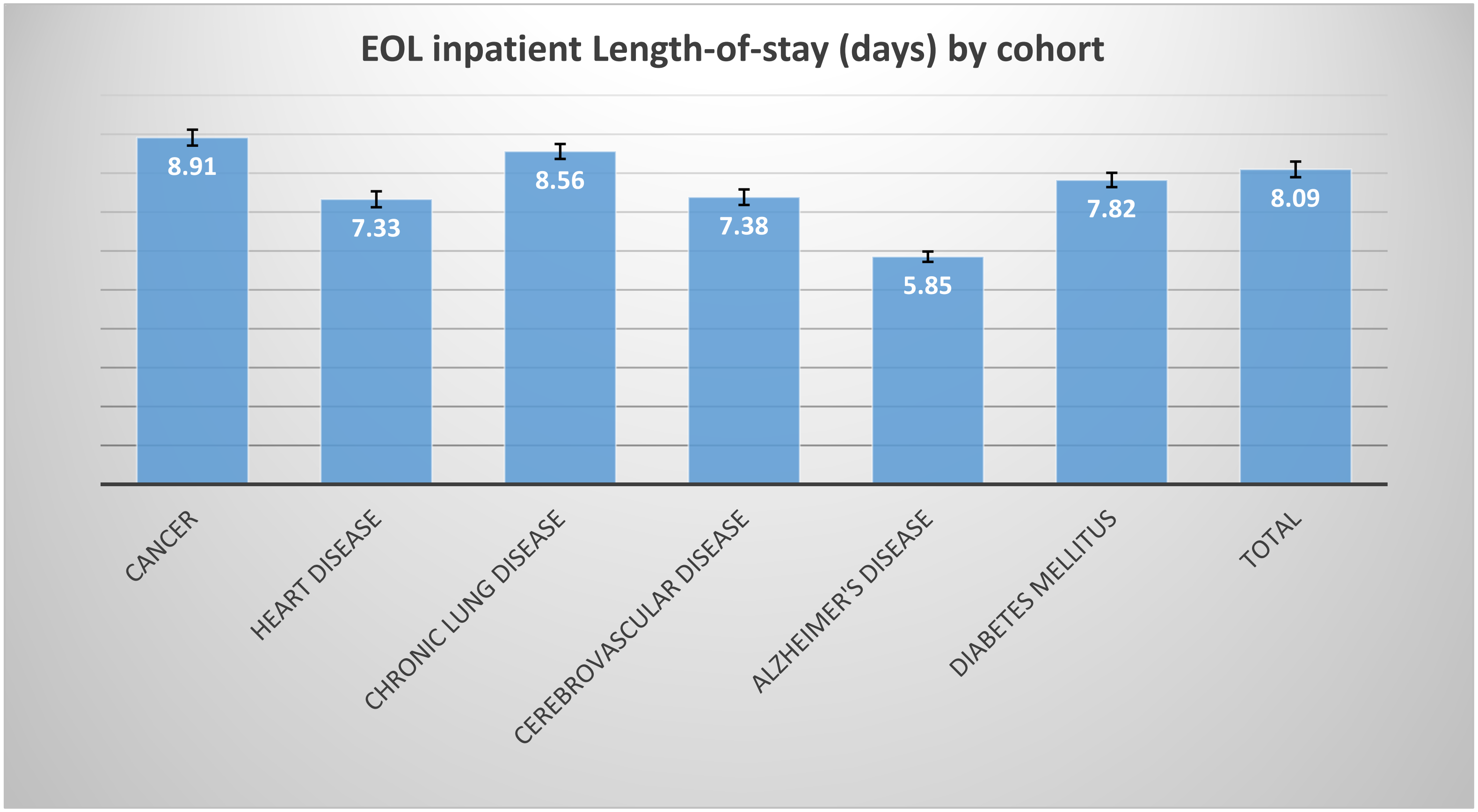
Notes: *EOL, end-of-life; IPC, inpatient palliative consultation. The percentage of life-sustaining treatment was calculated by using the number of decedents who had at least one hospital admission as denominators.*

Figure 5.2 Time trends for EOL events among Nebraska decedents 2013-2016 of the top six causes of death)



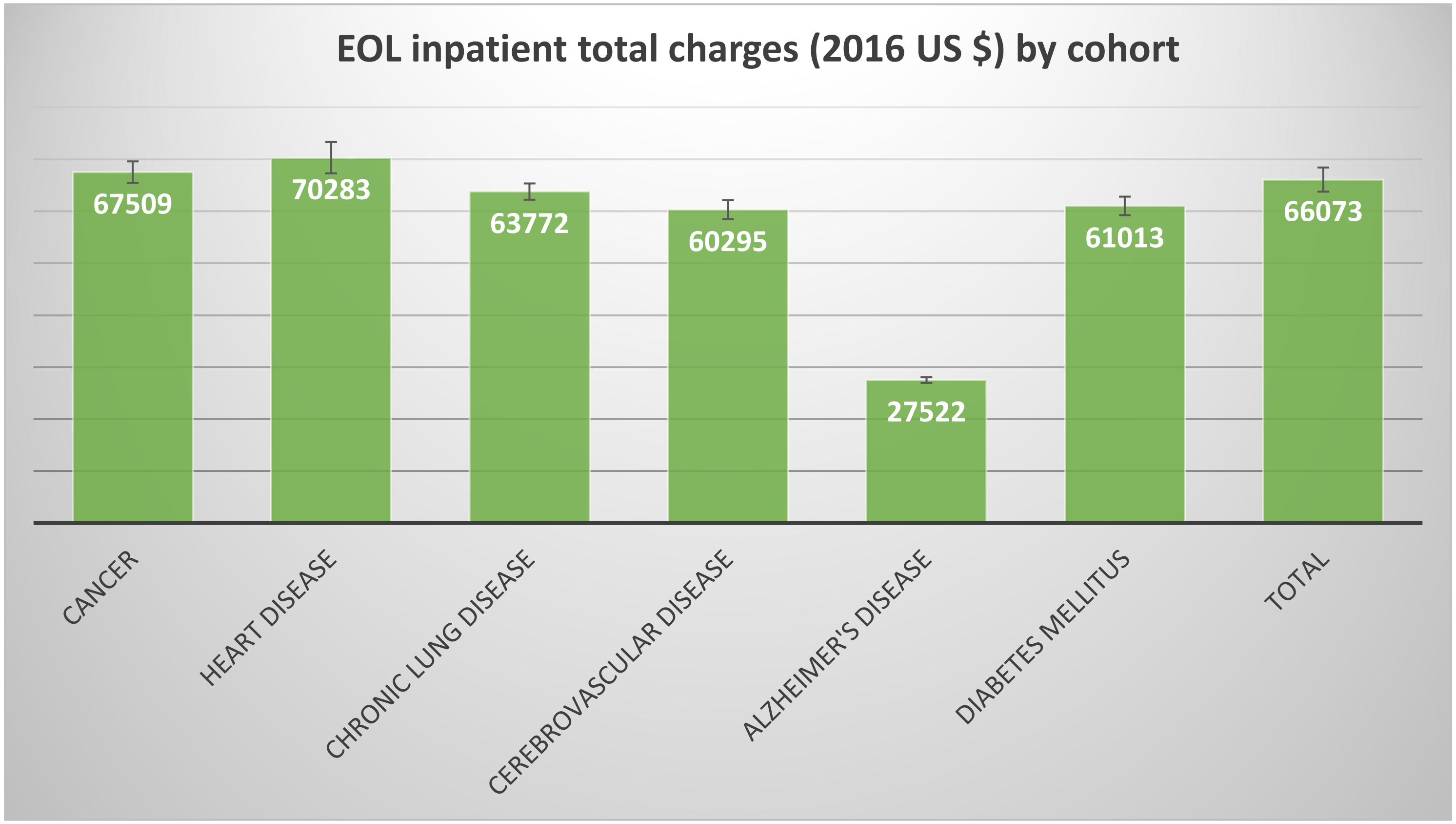
Notes: *EOL, end-of-life; IPC, inpatient palliative consultation. The percentage of life-sustaining treatment was calculated by using the number of decedents who had at least one hospital admission as denominators.*

Figure 5.3 EOL inpatient Length-of-stay by death cohort



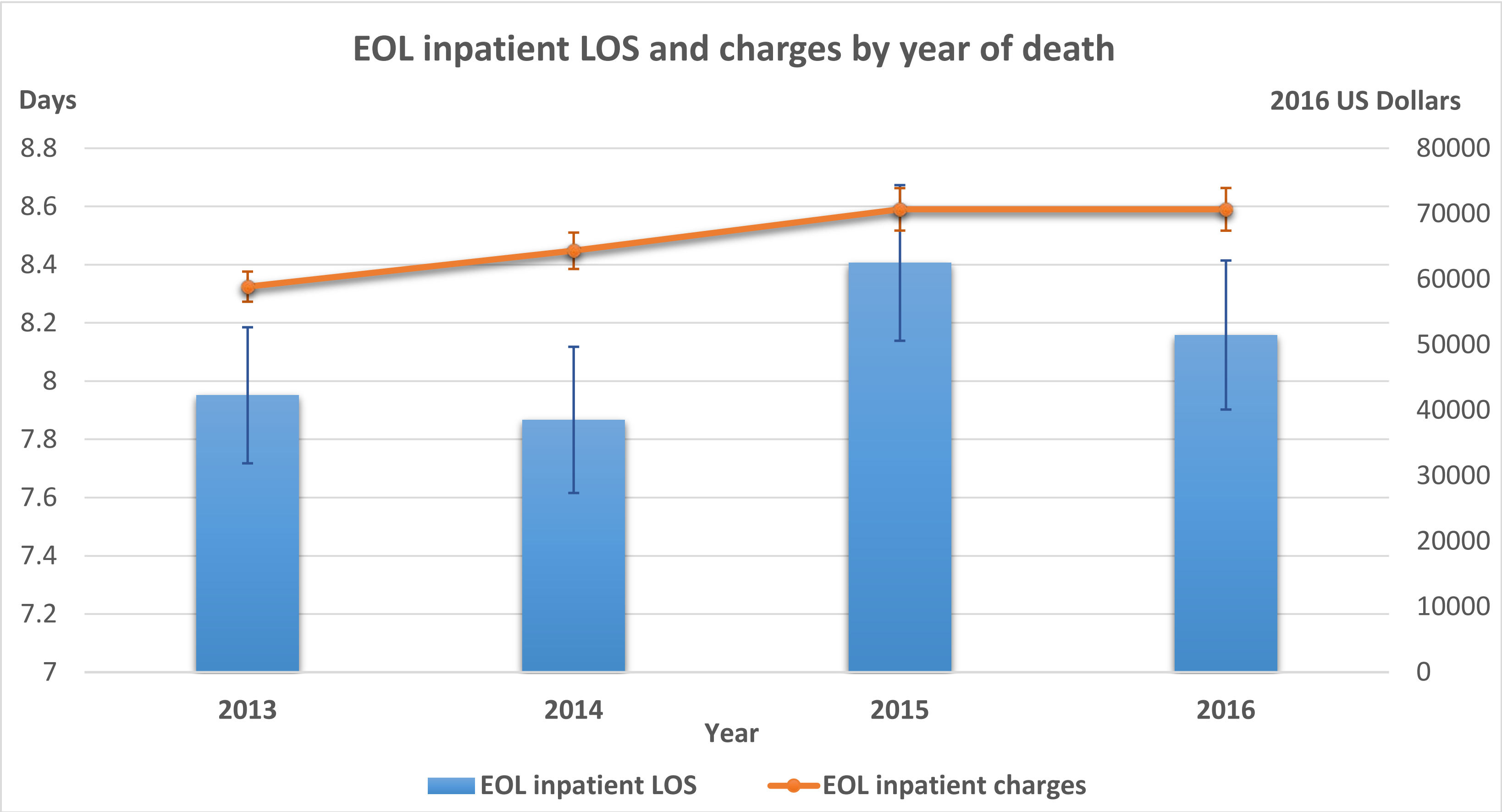
Notes: *Data were calculated based on the eligible population, which were Nebraska decedents of the top six causes of death 2013-2016 who were admitted at the EOL. The error bars displayed the 95% Confidence Interval.*

Figure 5.4 EOL total inpatient charges (adjusted to 2016 US dollars) by death cohort



Notes: *Data were calculated based on the eligible population, which were Nebraska decedents of the top six causes of death 2013-2016 who were admitted at the EOL. The error bars displayed the 95% Confidence Interval.*

Figure 5.5 Time trends for EOL total inpatient LOS and charges



Notes: *EOL, end-of-life; LOS, Length-of-stay.* ***Notes:*** *Data were calculated based on the eligible population, which were Nebraska decedents of the top six causes of death 2013-2016 who were admitted at the EOL. The error bars displayed the 95% Confidence Interval.*

Table 5.1 Recommended EOL services by the time of receiving the services among Nebraskan decedents of the top six causes of death and overall (2013-2016)

Recommended EOL Services	Cause of Death													
	Cancer		Heart Disease		Chronic Lung Disease		Cerebrovascular Disease		Alzheimer's Disease		Diabetes Mellitus		Total	
	n = 12396		n = 11044		n = 3761		n = 2881		n = 1546		n = 1620		n = 33248	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Inpatient palliative consultation														
Never	10750	86.72	10191	92.28	3321	88.30	2383	82.71	1443	93.34	1502	92.72	29590	89.00
Ever	1,646	13.28	853	7.72	440	11.70	498	17.29	103	6.66	118	7.28	3,658	11.00
0-3 days	845	6.82	552	5.00	264	7.02	384	13.33	34	2.20	60	3.70	2,139	6.43
4-30 days	449	3.62	132	1.20	78	2.07	77	2.67	30	1.94	30	1.85	796	2.39
1-3 months	214	1.73	64	0.58	35	0.93	13	0.45	13	0.84	8	0.49	347	1.04
3-6 months	60	0.48	33	0.30	20	0.53	8	0.28	7	0.45	6	0.37	134	0.40
> 6 months	78	0.63	72	0.65	43	1.14	16	0.56	19	1.23	14	0.86	242	0.73
Hospice discharge														
Never	9,674	78.04	9,886	89.51	3,209	85.32	2,419	83.96	1,357	87.77	1,436	88.64	27,981	84.16
Ever	2,722	21.96	1,158	10.49	552	14.68	462	16.04	189	12.23	184	11.36	5,267	15.84
0-3 days	517	4.17	297	2.69	150	3.99	142	4.93	29	1.88	60	4.18	1,195	3.59
4-30 days	1,644	13.26	559	5.06	242	6.43	267	9.27	100	6.47	84	5.85	2,896	8.71
1-3 months	382	3.08	146	1.32	76	2.02	28	0.97	20	1.29	18	1.11	670	2.02
3-6 months	105	0.85	66	0.60	33	0.88	8	0.28	10	0.65	11	0.68	233	0.70
> 6 months	74	0.60	90	0.81	51	1.36	17	0.59	30	1.94	11	0.68	273	0.82

Notes: *EOL, End-of-Life, the last month of life in this study; Time of hospice discharge/inpatient palliative consultation was defined as the last time of service for those who had multiple records of receiving the service.*

Table 5.2 Place of death among Nebraskan decedents of the top six causes of death and overall (2013-2016)

Place of Death	Cause of Death													
	Cancer		**Heart Disease**		**Chronic Lung Disease**		**Cerebrovascular Disease**		**Alzheimer's Disease**		**Diabetes Mellitus**		**Total**	
	n = 12396		n = 11044		n = 3761		n = 2881		n = 1546		n = 1620		n = 33248	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Inpatient	3,489	28.15	3,478	31.49	1,251	33.26	1,304	45.26	92	5.95	347	21.42	10,105	29.96
ER/Outpatient	175	1.41	915	8.29	130	3.46	80	2.78	5	0.32	132	8.15	1,453	4.32
Home	3,853	31.08	1,855	16.80	759	20.18	219	7.60	147	9.51	383	23.64	7,301	21.70
Hospice Facility	959	7.74	218	1.97	102	2.71	115	3.99	41	2.65	29	1.79	1,483	4.40
Nursing Home/LTC	3,165	25.53	3,758	34.03	1,308	34.78	1,026	35.61	988	63.91	643	39.69	11,082	32.75
Other	755	6.09	820	7.42	211	5.61	137	4.76	273	17.66	86	5.31	2,282	6.86

Notes: *ER, Emergency room; Inpatient, acute inpatient hospitals; LTC, Long term Care.*

Table 5.3 EOL High-intensity care among Nebraskan decedents of the top six causes of death and overall (2013-2016)

EOL High-intensity Care	Cause of Death													
	Cancer		Heart Disease		Chronic Lung Disease		Cerebrovascular Disease		Alzheimer's Disease		Diabetes Mellitus		Total	
	n = 12,396		n = 11,044		n = 3,761		n = 2,881		n = 1,546		n = 1,620		n = 33,248	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Intensive care	2,413	19.47	1466	13.27	682	18.13	489	16.97	50	3.23	206	12.72	5,306	15.96
Acute hospitalization														
1	4,995	40.30	4,289	38.84	1,525	40.55	1,520	52.76	312	20.18	552	34.07	13,193	39.68
≥2	1,827	14.74	1,166	10.56	531	14.12	361	12.53	38	2.46	162	10.00	4,085	12.29
At Least one	6,822	55.03	5,455	49.39	2,056	54.67	1,881	65.29	350	22.64	714	44.07	17,278	51.97
ED visit lead to admission														
1	3,363	27.13	2,822	25.55	1,094	29.09	1,099	38.15	252	16.30	386	23.83	9,016	27.12
≥2	619	4.99	427	3.87	263	6.99	116	4.03	19	1.23	60	3.70	1,504	4.52
At Least one	3982	32.12	3249	29.42	1357	36.08	1215	42.17	271	17.53	446	27.53	10520	31.64
Long LOS (>14d) admission	803	6.48	432	3.91	210	5.58	192	6.66	16	1.03	65	4.01	1718	5.17
Life-sustaining treatment*														
Any of the following	2,797	41.00	2,132	39.08	909	44.21	823	43.75	51	14.57	301	42.16	7,013	40.59
Intubation	548	8.03	700	12.83	309	15.03	391	20.79	6	1.71	77	10.78	2,031	11.75
IMV	679	9.95	1,003	18.39	400	19.46	576	30.62	8	2.29	92	12.89	2,758	15.96
NIMV	351	5.15	398	7.30	409	19.89	70	3.72	14	4.00	34	4.76	1,276	7.39
CPR	119	1.74	434	7.96	56	2.72	28	1.49	1	0.29	43	6.02	681	3.94
EN/PN	436	6.39	128	2.35	70	3.40	125	6.65	9	2.57	21	2.94	789	4.57
GTI	45	0.66	18	0.33	9	0.44	13	0.69	0	0.00	2	0.28	87	0.50
Blood Transfusion	1,534	22.49	616	11.29	223	10.85	178	9.46	23	6.57	99	13.87	2,673	15.47
Hemodialysis	99	1.45	173	3.17	32	1.56	18	0.96	1	0.29	108	15.13	431	2.49
Tracheostomy	64	0.94	57	1.04	24	1.17	26	1.38	2	0.57	6	0.84	179	1.04
Chemotherapy	298	4.37	4	0.07	4	0.19	5	0.27	0	0.00	3	0.42	314	1.82
Radiation	233	3.42	1	0.02	2	0.10	0	0.00	0	0.00	0	0.00	236	1.37
Medical Imaging	29	0.43	6	0.11	4	0.19	11	0.58	0	0.00	2	0.28	52	0.30

Notes: *EOL, End-of-Life, the last month of life in this study; ED, emergency department; LOS, length-of-stay; IMV, Invasive mechanical ventilation; NIMV, Non-Invasive mechanical ventilation; CPR, Cardiopulmonary resuscitation; EN/PN, Enteral or parenteral infusion of concentrated nutritional substances; GTI, Gastrostomy tube insertion. Intensive care included the following scenarios, that decedent had two or more hospital discharges, or two or more emergency department visits that end up with hospital admissions, or long LOS (>14d) admission, which means the admission had more than 14-day length-of-stay during the last month of life. Late hospice discharge indicates that the decedent was discharged within 3 days prior to death. *The percentage of life-sustaining treatment was calculated by using the number of decedents who had at least one hospital admission as denominators.*

Table 5.4 EOL total inpatient LOS and total inpatient charges (adjusted to 2016 US dollars) by the time of IPC among Nebraskan decedents who had at least one EOL admission by death cohort and overall (2013-2016)

EOL inpatient utilization and Cost	Cause of Death													
	Cancer n = 6,792		Heart Disease n = 5,427		Chronic Lung Disease n = 2,046		Cerebrovascular Disease n = 1,875		Alzheimer's Disease n = 349		Diabetes Mellitus n = 712		Total n = 17,201	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total inpatient LOS	8.91	8.59	7.33	8.61	8.56	8.07	7.38	8.39	5.85	5.58	7.82	7.75	8.09	8.47
Never had IPC	8.73	8.30	7.28	8.78	8.38	8.06	7.50	8.46	5.86	5.77	7.58	7.62	7.97	8.41
Late IPC	10.48	10.64	7.61	7.61	9.81	8.52	6.98	8.59	5.82	5.28	9.22	8.96	8.92	9.32
IPC before 3 days prior to death	8.30	7.42	7.57	6.88	8.26	6.46	7.26	6.00	5.79	4.34	9.65	7.44	8.03	7.04
Total inpatient charges	67509	87420	70283	126926	63772	65880	60295	77073	27522	23244	61013	75095	66073	97718
Never had IPC	66911	87256	70466	129818	62913	66597	61789	77144	28291	24133	60975	77327	66083	99868
Late IPC	80570	100337	74203	110203	72070	63037	58216	82343	25470	22002	66239	67765	72582	95080
IPC before 3 days prior to death	52321	58768	52187	88521	56375	59266	44091	39502	23217	15605	53300	41481	50976	62564

Notes: *EOL, End-of-Life, the last month of life in this study; IPC, Inpatient palliative consultation; Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death; SD, Standard Deviation. The total inpatient charges were adjusted to 2016 US dollars, and displayed as integer.*

Table 5.5 Characteristics of the enrolled population in final regression models by cause of death and overall (Nebraska decedents 2013-2016)

Characteristics	Cause of Death													
	Cancer n = 12,344		Heart Disease n = 11,000		Chronic Lung Disease n = 3,741		Cerebrovascular Disease n = 2,871		Alzheimer's Disease n = 1,539		Diabetes Mellitus n = 1,615		Total n = 33,110	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Age														
<50	632	5.12	267	2.43	26	0.70	73	2.54	0	0.00	91	5.63	1,089	3.29
50-64	2,860	23.17	1,030	9.36	374	10.00	292	10.17	13	0.84	271	16.78	4,840	14.62
65-79	4,813	38.99	2,539	23.08	1,449	38.73	702	24.45	218	14.17	563	34.86	10,284	31.06
≥80	4,039	32.72	7,164	65.13	1,892	50.57	1,804	62.84	1,308	84.99	690	42.72	16,897	51.03
Gender														
Male	6,453	52.28	5,490	49.91	1,819	48.62	1,252	43.61	501	32.55	828	51.27	16,343	49.36
Female	5,891	47.72	5,510	50.09	1,922	51.38	1619	56.39	1,038	67.45	787	48.73	16,767	50.64
Race														
NH White	11,461	92.85	10,344	94.04	3,596	96.12	2633	91.71	1,478	96.04	1,423	88.11	30,935	93.43
NH Black	410	3.32	306	2.78	87	2.33	107	3.73	42	2.73	91	5.63	1,043	3.15
Hispanic	231	1.87	134	1.22	19	0.51	68	2.37	8	0.52	55	3.41	515	1.56
Other	242	1.96	216	1.96	39	1.04	63	2.19	11	0.71	46	2.85	617	1.86
Education														
Less than high school	1,695	13.73	2,070	18.82	691	18.47	488	17.00	267	17.35	271	16.78	5,482	16.56
High school and GED	5,818	47.13	5,515	50.14	2,030	54.26	1,430	49.81	753	48.93	827	51.21	16,373	49.45
College or associate Degree	4,094	33.17	2,898	26.35	909	24.30	805	28.04	428	27.81	453	28.05	9,587	28.95
Advanced degree	667	5.40	441	4.01	80	2.14	128	4.46	82	5.33	57	3.53	1,455	4.39
Unknown	70	0.57	76	0.69	31	0.83	20	0.70	9	0.58	7	0.43	213	0.64
Marital Status														
Married	6,441	52.18	4,017	36.52	1,303	34.83	1081	37.65	472	30.67	604	37.40	13,918	42.04
Single	2,841	23.02	1,966	17.87	904	24.16	519	18.08	158	10.27	466	28.85	6,854	20.70
Widowed	3,030	24.55	4,993	45.39	1,526	40.79	1268	44.17	908	59.00	543	33.62	12,268	37.05

Unknown	32	0.26	24	0.22	8	0.21	3	0.10	1	0.06	2	0.12	70	0.21
Median Household Income														
Quartile 1 (Lowest)	2,997	24.28	2,866	26.05	985	26.33	730	25.43	244	15.85	473	29.29	8,295	25.05
Quartile 2	2,967	24.04	2,855	25.95	942	25.18	729	25.39	386	25.08	408	25.26	8,287	25.03
Quartile 3	3,045	24.67	2,787	25.34	972	25.98	726	25.29	440	28.59	364	22.54	8,334	25.17
Quartile 4	3,335	27.02	2,492	22.65	842	22.51	686	23.89	469	30.47	370	22.91	8,194	24.75
Rurality														
Metropolitan	6,655	53.91	5,250	47.73	1,948	52.07	1472	51.27	865	56.21	845	52.32	17,035	51.45
Micropolitan	2,209	17.90	2,045	18.59	711	19.01	482	16.79	297	19.30	294	18.20	6,038	18.24
Small town/Rural	3,480	28.19	3,705	33.68	1,082	28.92	917	31.94	377	24.50	476	29.47	10,037	30.31
Insurance														
Medicare	8,560	69.35	9,610	87.36	3,332	89.07	2451	85.37	1,465	95.19	1,311	81.18	26,729	80.73
Commercial	3,062	24.81	981	8.92	294	7.86	283	9.86	61	3.96	198	12.26	4,879	14.74
Medicaid and other government programs	448	3.63	197	1.79	69	1.84	65	2.26	10	0.65	64	3.96	853	2.58
Others	274	2.22	212	1.93	46	1.23	72	2.51	3	0.19	42	2.60	649	1.96
Charlson Comorbidity Index														
0-1	971	7.87	3,178	28.89	922	24.65	880	30.65	958	62.25	230	14.24	7,139	21.56
2-5	3,866	31.32	6,360	57.82	2328	62.23	1654	57.61	548	35.61	870	53.87	15,626	47.19
>5	7,507	60.81	1,462	13.29	491	13.12	337	11.74	33	2.14	515	31.89	10,345	31.24
Year of Death														
2013	3,086	25.00	2,731	24.83	882	23.58	731	25.46	379	24.63	394	24.40	8,203	24.77
2014	3,119	25.27	2,695	24.50	948	25.34	731	25.46	341	22.16	384	23.78	8,218	24.82
2015	3,107	25.17	2,864	26.04	998	26.68	700	24.38	385	25.02	450	27.86	8,504	25.68
2016	3,032	24.56	2,710	24.64	913	24.41	709	24.70	434	28.20	387	23.96	8,185	24.72

Notes: *NH, Non-Hispanic; GED, General Equivalency Diploma.*

Table 5.6 The impact of IPC on the likelihood of EOL events, and inpatient LOS and charges among Nebraska decedents of the top six causes of death 2013-2016

EOL Outcome	Applicable Sample	Model	Coefficient	Inpatient palliative consultation		
				Never	Late IPC	Early IPC
EOL events						
Hospice discharge	33106	Mixed-effect logistic regression	OR	(Ref)	1.66***	8.36***
Death in hospital	33106	Mixed-effect logistic regression	OR		16.34***	0.58***
Receiving intensive care	33106	Logistic regression	OR		2.06***	0.68***
Receiving any life-sustaining treatment	17201	Logistic regression	OR		1.31***	0.74***
EOL inpatient LOS	17201	Negative binomial regression	ME		-0.4**	-0.44**
EOL total inpatient charges	17201	Generalized linear regression (log link, gamma distribution)	ME		-284517***	-267739***

Notes: *IPC, Inpatient palliative consultation; EOL, end of life; LOS, length of stay. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death. Early IPC indicates that the IPC was received before 3 days prior to death. OR, Odds Ratio; ME, Marginal Effect. Individual model was fitted for each of the outcomes separately. Individual level factors were controlled in all the models, which include age, gender, race, education, marital status, median household income level, rurality, insurance, Charlson comorbidity index, year of death and cause of death. Regional level factors were only controlled in mixed-effect models, selected from decedent's residence county health resource, including hospital beds per 1,000, # of hospice facility, # of short term general hospitals with hospice care, # of Skilled nursing facility, Nursing home beds per 1,000, and Long term hospital beds per 1,000. The regional data was retrieved from Area Health Resource File.*

Table 5.7 The sub-cohort analyses on the impact of IPC on the likelihood of EOL events, and inpatient LOS and charges by death cohort of Nebraska decedents 2013-2016

EOL Outcome	Cancer	Heart Disease	Chronic Lung Disease	Cerebrovascular Disease	Alzheimer's Disease	Diabetes Mellitus
Applicable sample N	*12,343*	*10,999*	*3,733*	*2,867*	*1,515*	*1,612*
Hospice discharge						
Late IPC	1.31**	2.06***	1.68**	1.60**	4.45***	5.94***
Early IPC	6.71***	9.22***	8.29***	10.04***	19.79***	13.65***
Death in hospital						
Late IPC	16.76***	20.12 ***	17.05***	11.73***	67.30***	8.34***
Early IPC	0.61***	0.50 **	0.69	0.36**	Omitted	0.87
Receiving intensive care						
Late IPC	2.48***	1.80***	1.80***	1.32	6.19***	2.85**
Early IPC	0.62***	0.66*	0.66*	0.67	0.49	1.44
Applicable sample N	*6,792*	*5,427*	*2,046*	*1,873*	*323*	*712*
Receiving any life-sustaining treatment						
Late IPC	1.18*	1.44***	1.32*	1.54**	2.39	1.64
Early IPC	0.84	0.62*	0.78	0.58	0.69	0.39*
EOL inpatient LOS						
Late IPC	-0.3	-0.4*	0.10	-0.8**	-0.55	0.13
Early IPC	-0.5 *	-0.6	-0.5	-0.5	-0.39	1.35
Total inpatient charges						
Late IPC	-26265.5**	-701288.5	-12710.5	-15435.3***	-9090.4**	-10198.9
Early IPC	-33988.3***	-736086.9	-29175.8*	2264.4	-3883.5	-8406.8

Notes: *IPC, Inpatient palliative consultation; EOL, end of life; LOS, length of stay. Late IPC indicates that the decedent received the IPC during the acute hospitalization that discharged within 3 days prior to death. Early IPC indicates that the IPC was received before 3 days prior to death. The reference group were decedents who never received IPC. Individual model was fitted for each of the outcomes separately. Individual level factors were controlled in all the models, which include age, gender, race, education, marital status, median household income level, rurality, insurance, Charlson comorbidity index, year of death and cause of death. Regional level factors were only controlled in mixed-effect models, selected from decedent's residence county health resource, including hospital beds per 1,000, # of hospice facility, # of short term general hospitals with hospice care, # of Skilled nursing facility, Nursing home beds per 1,000, and Long term hospital beds per 1,000. The regional data was retrieved from Area Health Resource File.*

CHAPTER 6

CONCLUSIONS

This dissertation thesis worked on examining three factors that have been proposed to reduce the utilization of costly hospital services among various populations. The three approaches are the PCMH, better continuity of care and early use of palliative care at the EOL. The results have demonstrated that the highest level of PCMH, better COC, and the early use of inpatient palliative consultation was associated with lower utilization of costly hospital care among the certain population.

The first paper examined the effect of PCMH on preventable hospitalization and ED visits among the U.S. adult population with a usual source of primary care. The results demonstrated that adults with the highest level of PCMH were less likely to have any ACSC hospital admissions and ED visits at the second year, comparing to those with USC classified as non-PCMH. Moreover, we found that the individual PCMH attributes alone did not affect the likelihood of ACSC, which illustrated the fact that all the attributes contribute to the better quality of primary care.

The second paper examined the effect of COC on the all-cause and condition-specific hospitalizations during the follow-up year among Taiwan patients admitted due to five conditions: asthma, COPD, CHF, AMI, and DM. We found that better post-discharge outpatient COC was associated with reduced all-cause readmissions for patients discharged due to all of the five conditions examined, but the reductions on condition-specific readmissions were only found in patients admitted for ACSCs, which excluded AMI cohort.

Lastly, the last paper focused on the examination of EOL hospital services utilization, which demonstrated the positive effects of inpatient palliative consultation on reducing the hospital services offered at the EOL. Specifically, the results pointed out the importance of the timing of inpatient palliative consultation. Comparing to patients who did not receive any inpatient palliative services, only patients who received inpatient palliative consultation before three days prior to death had better outcomes, including having a higher likelihood of being discharged to hospice care, lower likelihood of death in the hospital, receiving high-intensity care or life-sustaining treatment, and lower hospital charges. Not much significant effects were found when comparing patients who had late IPC to the reference group.

The three studies were conducted under the same conceptual framework because they shared the same essence of examining the factors that can affect the utilization of health services and associated costs. They all controlled as many covariates as possible during the modeling process, as they are potential confounders that influence the health care utilization in Andersen's model. These covariates include an individual's demographic characteristics, socioeconomic status, insurance status, health status and previous health care utilization, etc. Only after controlling these confounding factors, is it reliable to affirm the relationships between the primary independent variables and the outcomes.

Though the three studies were conducted among different populations, they still have general implications to the U.S. population and health system, and many other health care systems who are facing similar issues. With adequate patient-centered primary care and better continuity of care, patients are less likely to end up in the ED and hospital settings because their chronic conditions have been well-managed. The palliative care consultation transfer the focus on pursuing costly curative care to the focus on improving the quality of life through improved physical symptoms, patient and family satisfaction and decreased caregiver burden at their EOL. The three examined approaches affected the outcomes via improving the quality of care received outside or inside the hospital settings so that patients' needs for these costly care decrease, especially those high-need patients who are vulnerable in consuming these costly hospital services. Hence, they are applicable to any health care system to design cost reduction intervention through the employment of low-cost but high-value initiatives that focus on prevention and quality improvement.

To sum up, this dissertation thesis contributes to the current literature body in advancing the exploration of solutions for reducing the high medical expenditure while improving health care quality. Further in-depth research on evaluating these initiatives are also needed to advance the current analyses and evidence. As the whole health system evolving and transforming from volume- to value-oriented, the initiatives that can offer opportunities to achieve a better quality of care while addressing the high expenditure issue. These approaches are replicable to any value-based programs for cost-reduction and quality improvement, and they will definitely be the resolutions to improve population health from the health care perspective.

APPENDICES

Appendix 3.1 Factor Analysis result for selecting appropriate survey questions for Patient-centered Medical home attributes (MEPS Panel 12-14)

Survey Question	Variable Name	Factor1	Factor2	Factor3	Factor4
USC had office hours at night or on the weekend *	offhou2	0.0193	-0.009	-0.2083	0.2315
Difficulty of accessing USC provider after hours†	afthou2	0.0092	-0.0024	0.0222	0.6295
Difficulty of accessing USC provider by phone †	phnreg2	0.0121	-0.0043	0.1521	0.5619
USC provider asked about prescription medications and treatments other doctors may give *€	treatm2	0.0163	-0.001	-0.0666	0.0472
How often the USC provider showed respect for medical, traditional, and alternative treatments that the person is happy with ‡	respct2	0.0117	0.0128	0.5688	0.0684
How often does the USC provider ask the person to help make decisions between a choice of treatments ‡	decide2	-0.0109	-0.0039	0.5773	0.0775
USC provider present and explain all options to the person *	explop2	-0.0421	0.0105	0.2107	0.0638
USC provided care for new health problems *	minorp2	-0.0062	0.6788	0.0042	-0.0157
USC provided preventive healthcare *	preven2	0.0076	0.7093	0.0127	-0.0137
USC provided referrals to other health professionals *	reffrl2	0.0052	0.6603	-0.0071	-0.006
USC provided care for ongoing health problems *	ongong2	-0.0064	0.6802	-0.0058	0.0311
How often USC provider listened carefully to you‡	adlist2	0.7944	-0.0039	0.0058	0.0052
How often USC provider explained things in a way that was easy to understand ‡	adexpl2	0.7829	0.0004	-0.0104	0.0078
How often USC provider showed respect for what you had to say ‡	adresp2	0.8099	0.0005	-0.0082	-0.0217
How often USC provider spent enough time with you ‡	adprtm2	0.7598	0.004	0.0036	0.0211
Variance		54.32%	37.95%	30.25%	25.72%

Notes: *MEPS, Medical Expenditure Panel Survey; USC, Usual Source of Care. *Questions with original binary answers 1=Yes and 0=No, which were recoded as 2=Yes and 0=No in "Shared decision making" and "Enhanced Access" domain to obtain same weight as other questions. †Questions with original 4-level answers rating the difficulty, which were recoded as 2=Not at all difficult, 1=Not too difficult, 0=Somewhat difficult/Very difficult. ‡Questions with original 4-level answers rating frequency, which were recoded as 2=Always, 1=Usually, 0= Sometimes/Never. €Though the factor analysis did not provide enough evidence, this item was still incorporated in factor 3 base on previous literature and the relativeness of the item to the attribute it represents.*

Appendix 3.2 Acute and Chronic Ambulatory Care Sensitive Conditions Coding List

PQI #	Condition Name	ICD-9 CODE
Acute ACSC		
PQI #10	Dehydration	276.5, 276.50, 276.51, 276.52, 276.0, 88, 90, 91, 92, 93, 861, 862, 863, 864, 865, 866, 867, 869, 558.9, 584.5, 584.5, 584.6, 584.7, 584.8, 584.9, 586, 997.5
PQI #11	Bacterial Pneumonia	481, 485, 486, 482.2, 482.9, 483.0, 483.1, 483.8, 482.30, 482.31, 482.32, 482.39, 482.41, 482.42
PQI #12	Urinary Tract Infection	590.2, 590.3, 590.9, 595.0, 595.9, 599.0, 590.10, 590.11, 590.80, 590.81
Chronic ACSC		
PQI #1	Short-Term Complications from Diabetes	250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33
PQI #3	Long-Term Complications from Diabetes	250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93
PQI #5	Chronic Obstructive Pulmonary Disease (COPD) or Asthma in Older Adults	491.21, 491.22, 491.8, 491.9, 492.8, 493.2, 493.21, 493.22, 496, 518.81*, 518.82*, 518.84*, 799.1*
PQI #8	Congestive Heart Failure	428.0, 428.1, 398.91, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9
PQI #14	Uncontrolled Diabetes	250.02, 250.03
PQI #16	Lower Extremity Amputation among Patients with Diabetes	841.0, 841.2, 841.3, 841.4, 841.5, 841.6, 841.7, 841.8, 841.9, 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93,

Notes: *ACSC, Ambulatory Care Sensitive Conditions. PQI, Prevention Quality Indicators; * Must be accompanied by a secondary diagnosis code of acute exacerbation chronic obstructive pulmonary disease (AECOPD) 491.21, 491.22, 493.21, 493.22. Source: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/2014-ACSC-MIF.pdf*

Appendix 4. International Classification of Diseases, 9th Revision, Clinical Modification, Diagnosis Codes for each condition used in this study

Index admission condition	ICD-9-CM codes
Acute Myocardial Infarction (AMI)	410.00, 410.01, 410.10, 410.11, 410.20, 410.21, 410.30, 410.31, 410.40, 410.41, 410.50, 410.51, 410.60, 410.61, 410.70, 410.71, 410.80, 410.81, 410.90, 410.91
Congestive heart failure (CHF)	402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9
Asthma	493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.90, 493.91, 493.92
Chronic Obstructive Pulmonary Disease (COPD)	491.21, 491.22, 491.8, 491.9, 492.8, 493.2, 493.21, 493.22, 496, 518.81*, 518.82*, 518.84*, 799.1*
Diabetes Mellitus (DM)	250.XX

* *Must be accompanied by a secondary diagnosis code of acute exacerbation chronic obstructive pulmonary disease (AECOPD) 491.21, 491.22, 493.21, 493.22.*

Appendix 5.1 ICD-10 codes of ACME selected underlying cause of death used in identifying the six death cohorts in Nebraska

Cause of death	ICD-10 codes
Cancer	C00-C97
Heart Disease (all forms)	I00-I09, I11, I13, I50, I51, I20-I51
Chronic Lung Disease	J44, J47
Cerebrovascular Diseases	I60-I69
Alzheimer's Disease	G30
Diabetes Mellitus	E10-E14

Notes: *ICD, International Classification of Diseases; ACME, Automated Classification of Medical Entities. Only the first 3 digits were used and displayed here.*

Appendix 5.2 Numbers and match rates compared to official reports for death cohorts of six leading causes by year.

Cause of death	2013			2014			2015			2016			Total		
	Reported	Matched	%	Reported	Matched	%	Reported	Matched	%	Reported	Matched	%	Reported	Matched	%
Cancer	3,458	3,099	89.6	3,459	3,135	90.6	3,511	3,117	88.8	3,474	3,045	87.7	13,902	12,396	89.2
Heart Disease (all forms)	3,378	2,744	81.2	3,290	2,705	82.2	3,587	2,876	80.2	3,318	2,719	81.9	13,573	11,044	81.4
Chronic Lung Disease	957	888	92.8	1,028	951	92.5	1,097	1,003	91.4	1,032	919	89.1	4,114	3,761	91.4
Cerebrovascular Diseases	817	732	89.6	797	736	92.3	776	702	90.5	784	711	90.7	3,174	2,881	90.8
Alzheimer's Disease	557	381	68.4	515	343	66.6	597	387	64.8	634	435	68.6	2,303	1,546	67.1
Diabetes Mellitus	472	396	83.9	472	384	81.4	552	453	82.1	501	387	77.2	1,997	1,620	81.1
Total	9,639	8,240	85.5	9,561	8,254	86.3	10,120	8,538	84.4	9,743	8,216	84.3	39,063	33,248	85.1

Notes: *% Match rate = Matched case # / Reported death #. Matched cases are decedents who had inpatient service utilization (discharge records) within 5 years prior to death. The match rates for the 6 death cohorts were examined in each year to check the quality of linked data in terms of the proportion of dead patients who utilized inpatient services in the last five years of their lives. Matched cases were decedents who had inpatient service utilization (discharge records) within 5 years prior to death. The match rate was calculated using the decedent numbers in the linked dataset divided by officially reported death numbers.*

Appendix 5.3 ICD codes used in identification of palliative care consultation and intensive treatment analysis.

	ICD-9 codes		ICD-10 codes							
Palliative care consultation	V667*		Z515*							
Intubation	96.0	96.03	0BH17EZ	0B718DZ	0BH172Z	0BH18YZ	0BHL7YZ	09HN8BZ	0DH57BZ	
	96.01	96.04	0BH18EZ	0BH07DZ	0BH17YZ	0BHK7YZ	0BHL8YZ	0CHY7BZ	0DH58BZ	
	96.02	96.05	0B717DZ	0BH07YZ	0BH182Z	0BHK8YZ	09HN7BZ	0CHY8BZ	0WHQ7YZ	
Invasive Mechanical ventilation	96.7	96.71	5A19054	5A1945Z						
(IMV)	96.70	96.72	5A1935Z	5A1955Z						
Non-invasive Mechanical	93.90		5A09357	5A09457	5A09557					
ventilation (NIMV)										
Cardiopulmonary resuscitation	99.60	99.63	5A12012	5A12012	3E073GC	3E083GC				
(CPR)	93.93	37.91	5A19054	02QA0ZZ	3E074GC	3E084GC				
	99.62	37.92	5A2204Z	3E070GC	3E080GC					
Enteral or parenteral infusion of	96.6		0DH67UZ	3E0G36Z	3E0536Z	3E0436Z				
concentrated nutritional	99.15		0DH68UZ	3E0336Z	3E0636Z					
substances (EN/PN)										
Gastrostomy tube insertion (GTI)	96.07		0D9670Z	0D9680Z						
Blood Transfusion	99.00	99.06	30233H0	30233H1	30233M1	30263N1	30233W1	30263V1	30243M1	3E033GC
	99.01	99.07	30233N0	30243H1	30263J1	30263P1	30243T1	30263W1	30253J1	3E043GC
	99.02	99.08	30243H0	30253H1	30233N1	30233R1	30243V1	30233J1	30253K1	3E053GC
	99.04	99.09	30243N0	30263H1	30233P1	30243R1	30243W1	30233K1	30253L1	3E063GC
	99.05		30253H0	30233W0	30243N1	30253R1	30253T1	30233L1	30253M1	30233Q1
			30253N0	30243W0	30243P1	30263R1	30253V1	30243J1	30263K1	30243Q1
			30263H0	30253W0	30253N1	30233T1	30253W1	30243K1	30263L1	30253Q1
			30263N0	30263W0	30253P1	30233V1	30263T1	30243L1	30263M1	30263Q1
Hemodialysis	39.95	V45.11*	5A1D70Z	5A1D90Z	Z992*					
		V56.0*	5A1D80Z		Z4931*					
Chemotherapy	00.10	V58.1*	XW03351	3E03305	3E0F305	3E0H305	3E0K305	3E0M705	3E0P805	3E0S305
	99.25	V58.11*	XW033B3	3E04305	3E0F705	3E0H705	3E0K705	3E0N305	3E0Q005	3E0V305
	99.28	V58.12*	XW033C3	3E00X05	3E0F805	3E0H805	3E0K805	3E0N705	3E0Q305	3E0W305
			XW04351	3E01305	3E0G305	3E0J305	3E0L305	3E0N805	3E0Q705	3E0Y305
			XW043B3	3E02305	3E0G705	3E0J705	3E0L705	3E0P305	3E0R305	3E0530M
			XW043C3	3E0A305	3E0G805	3E0J805	3E0M305	3E0P705	3E0Y705	3E06303
			Z51.11*	3E00X0M	3E0230M	3E0330M	3E0430M	3E0630M	3E05303	3E04303
			Z51.12*	3E0130M	3E03303					

Notes: ** indicates diagnosis code, otherwise code is procedure code. ICD-9, International Classification of Diseases, version 9. ICD-10, International Classification of Diseases, version 10. CT, computed tomography. MRI, magnetic resonance imaging.*

(Appendix 5.3 Continued)

	ICD-9 codes		ICD-10 codes
Tracheostomy	31.1	31.73	A total of 242 **codes** will be provided upon request.
	31.21	31.74	
	31.29	31.75	
	31.30	31.79	
	31.45	31.92	
	31.49	31.94	
	31.50	31.99	
	31.71	31.72	
Radiation	92.20	92.26	A total of 1791 codes will be provided upon request.
	92.21	92.27	
	92.22	92.28	
	92.23	92.29	
	92.24	V580*	
	92.25	Z51.0*	
Medical Imaging (CT/MRI/Bone Scans)	92.14	88.94	A total of 247 codes will be provided upon request.
	87.41	88.95	
	88.01	88.96	
	88.91	88.97	
	88.92		
	88.93		

Notes: ** indicates diagnosis code, otherwise code is procedure code. ICD-9, International Classification of Diseases, version 9. ICD-10, International Classification of Diseases, version 10. CT, computed tomography. MRI, magnetic resonance imaging.*

Appendix 5.4 The rurality classification based on Rural-Urban Commuting Area (RUCA) codes 2010

3-level Rurality	Classification Description
Urban/Metropolitan	1 Metropolitan area core: primary flow within an urbanized area (UA)
	1.0 No additional code
	1.1 Secondary flow 30% to 50% to a larger UA
	2 Metropolitan area high commuting: primary flow 30% or more to a UA
	2.0 No additional code
	2.1 Secondary flow 30% to 50% to a larger UA
	3 Metropolitan area low commuting: primary flow 10% to 30% to a UA
	3.0 No additional code
Micropolitan	4 Micropolitan area core: primary flow within an urban cluster of 10,000 to 49,999 (large UC)
	4.0 No additional code
	4.1 Secondary flow 30% to 50% to a UA
	5 Micropolitan high commuting: primary flow 30% or more to a large UC
	5.0 No additional code
	5.1 Secondary flow 30% to 50% to a UA
	6 Micropolitan low commuting: primary flow 10% to 30% to a large UC
	6.0 No additional code
Small town/Rural	7 Small town core: primary flow within an urban cluster of 2,500 to 9,999 (small UC)
	7.0 No additional code
	7.1 Secondary flow 30% to 50% to a UA
	7.2 Secondary flow 30% to 50% to a large UC
	8 Small town high commuting: primary flow 30% or more to a small UC
	8.0 No additional code
	8.1 Secondary flow 30% to 50% to a UA
	8.2 Secondary flow 30% to 50% to a large UC
	9 Small town low commuting: primary flow 10% to 30% to a small UC
	9.0 No additional code
	10 Rural areas: primary flow to a tract outside a UA or UC
	10.0 No additional code
	10.1 Secondary flow 30% to 50% to a UA
	10.2 Secondary flow 30% to 50% to a large UC
	10.3 Secondary flow 30% to 50% to a small UC

Appendix 5.5 EOL events and services utilization and cost by the year of death (Nebraska decedents 2013-2016)

EOL events and services utilization and cost	2013 n = 8240		2014 n = 8254		2015 n = 8538		2016 n = 8216	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Hospice Discharge	1,369	16.61	1,301	15.76	1,290	15.11	1,307	15.91
IPC	1,057	12.83	941	11.40	865	10.13	795	9.68
Death in inpatient	2,483	30.13	2,512	30.43	2,542	29.77	2,424	29.50
Intensive care	1,306	15.85	1,315	15.93	1,394	16.33	1,291	15.71
Decedents who had ≥1 EOL inpatient admission	4,337	52.63	4,348	52.68	4,350	50.95	4,243	51.64
Life-sustaining Treatment	1,847	42.59	1,852	42.59	1,759	40.44	1,555	36.65
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
EOL inpatient LOS	7.95	7.85	7.87	8.45	8.41	9.00	8.16	8.51
EOL inpatient charges	58869.3	77257.6	64345.7	93448.6	70670.2	108977.6	70674.9	108259.9

Notes: *EOL, end-of-life; IPC, inpatient palliative consultation, LOS, length-of-stay. The percentage of life-sustaining treatment was calculated by using the number of decedents who had at least one hospital admission as denominators. EOL inpatient LOS and charges were calculated among those who had at least one inpatient discharge at the EOL.*

Appendix 5.6 EOL services and events by the year of death among each death cohort (Nebraska decedents 2013-2016)

EOL service and events	Cancer n = 12396		Heart Disease n = 11044		Chronic Lung Disease n = 3761		Cerebrovascular Disease n = 2881		Alzheimer's Disease n = 1546		Diabetes Mellitus n = 1620	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Hospice Discharge												
2013	702	22.65	313	11.41	137	15.43	124	16.94	48	12.60	45	11.36
2014	696	22.20	273	10.09	131	13.77	117	15.90	43	12.54	41	10.68
2015	655	21.01	287	9.98	153	15.25	106	15.10	40	10.34	49	10.82
2016	669	21.97	285	10.48	131	14.25	115	16.17	58	13.33	49	12.66
IPC												
2013	464	19.36	241	8.78	131	14.75	151	20.63	35	9.19	35	8.84
2014	431	17.67	214	7.91	118	12.41	131	17.80	20	5.83	27	7.03
2015	384	15.60	208	7.23	102	10.17	114	16.24	19	4.91	38	8.39
2016	367	15.45	190	6.99	89	9.68	102	14.35	29	6.67	18	4.65
Death in inpatient												
2013	894	37.30	825	30.07	311	35.02	337	46.04	30	7.87	86	21.72
2014	894	36.65	845	31.24	321	33.75	348	47.28	19	5.54	85	22.14
2015	869	35.30	899	31.26	338	33.70	323	46.01	17	4.39	96	21.19
2016	832	35.02	909	33.43	281	30.58	296	41.63	26	5.98	80	20.67
Intensive care												
2013	596	24.86	343	12.50	177	19.93	124	16.94	18	4.72	48	12.12
2014	611	25.05	368	13.60	178	18.72	109	14.81	9	2.62	40	10.42
2015	613	24.90	392	13.63	184	18.34	137	19.52	4	1.03	64	14.13
2016	593	24.96	363	13.35	143	15.56	119	16.74	19	4.37	54	13.95

Notes: *EOL, end-of-life; IPC, inpatient palliative consultation, LOS, length-of-stay. Intensive care included any acute hospitalization during the last month of life, any ED visit led to admission during the last month of life, and any hospital stay that had longer than 14 days of LOS.*

Appendix 5.7 EOL events and services utilization and cost among decedents who had EOL inpatient admission by the year of death among each death cohort (Nebraska decedents 2013-2016)

EOL service utilization and cost	Cancer n = 6822		Heart Disease n = 5455		Chronic Lung Disease n = 2056		Cerebrovascular Disease n = 1881		Alzheimer's Disease n = 350		Diabetes Mellitus n = 714	
	N	***%***	***N***	***%***	***N***	***%***	***N***	***%***	***N***	***%***	***N***	***%***
Life-sustaining Treatment												
2013	741	43.31	536	39.94	244	47.75	227	45.77	16	16.00	83	46.89
2014	760	43.58	531	39.42	241	46.08	219	45.72	15	19.23	86	48.59
2015	690	41.14	557	39.53	246	45.56	180	39.65	6	8.11	80	40.82
2016	606	35.86	508	37.44	178	36.93	197	43.58	14	14.29	52	31.71
	Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***
EOL inpatient LOS												
2013	8.73	8.18	7.04	7.08	8.83	8.24	7.39	8.56	6.04	4.65	7.47	7.36
2014	8.74	8.93	7.30	8.93	8.32	7.02	6.78	7.65	5.08	3.95	6.45	5.56
2015	9.29	8.68	7.56	9.85	8.67	8.26	7.92	8.58	5.16	3.91	8.59	8.67
2016	8.91	8.52	7.38	8.28	8.44	8.67	7.46	8.74	6.87	8.04	8.71	8.74
EOL inpatient charges												
2013	62559	86494	58313	77623	63123	61586	51602	62479	26592	20568	53745	72729
2014	66843	88485	69548	120747	61847	57259	54871	68453	24673	16117	50656	51598
2015	70855	89990	76091	146738	64200	63013	70636	97266	26549	24062	64680	74301
2016	70072	84232	77086	149376	66461	80476	64978	75577	31516	28992	75324	94984

Notes: *EOL, end-of-life; IPC, inpatient palliative consultation, LOS, length-of-stay. The percentage of life-sustaining treatment was calculated by using the number of decedents who had at least one hospital admission as denominators. EOL inpatient LOS and charges were calculated among those who had at least one inpatient discharge at the EOL.*

Appendix 5.8 Mixed-effect logistic regression model of the impact of IPC on hospice discharge among Nebraska decedents of the top six causes of death 2013-2016 (n = 33106)

Independent Variables	Odds Ratio	Lower 95% CI	Upper 95% CI	P values
Inpatient palliative consultation				
Never	Reference			
Late IPC	1.66	1.48	1.86	<0.001
IPC before 3 days prior to death	8.36	7.48	9.35	<0.001
Age				
<50	Reference			
50-64	1.26	1.03	1.54	0.02
65-79	1.31	1.06	1.61	0.01
≥80	1.52	1.22	1.88	<0.001
Gender				
Male	Reference			
Female	1.19	1.11	1.27	<0.001
Race				
NH White	Reference			
NH Black	0.86	0.72	1.03	0.10
Hispanic	0.86	0.67	1.12	0.27
Other	0.84	0.65	1.08	0.18
Education				
Less than High School	Reference			
High School and GED	0.91	0.83	1.00	0.06
College or Associate Degree	0.84	0.76	0.93	<0.01
Advanced Degree	0.87	0.73	1.02	0.09
Unknown	0.90	0.59	1.38	0.63
Marital Status				
Married	Reference			
Single	1.00	0.91	1.09	0.96
Widowed	1.00	0.92	1.08	0.95
Unknown	0.89	0.41	1.93	0.77
Median Household Income				
Quartile 1 (Lowest)	Reference			
Quartile 2	1.10	1.00	1.21	0.06
Quartile 3	1.08	0.97	1.19	0.15
Quartile 4	1.16	1.05	1.29	<0.01
Rurality				
Urban	Reference			
Micropolitan	0.64	0.57	0.71	<0.001
Small town/Rural	0.46	0.41	0.51	<0.001
Insurance				
Medicare	Reference			
Commercial	0.93	0.83	1.04	0.22
Medicaid and other government programs	1.12	0.91	1.38	0.29
Others	0.57	0.42	0.76	<0.001
Charlson Comorbidity Index				

0-1	Reference			
2-5	1.95	1.76	2.17	<0.001
>5	2.95	2.63	3.32	<0.001
Year of Death				
2013	Reference			
2014	0.98	0.90	1.07	0.64
2015	0.95	0.87	1.04	0.28
2016	1.00	0.92	1.09	0.99
Cause of Death				
Cancer	Reference			
Heart Disease	0.58	0.53	0.63	<0.001
Chronic Lung Disease	0.77	0.69	0.87	<0.001
Cerebrovascular Disease	0.90	0.80	1.02	0.10
Alzheimer's Disease	0.76	0.63	0.91	<0.01
Diabetes Mellitus	0.54	0.46	0.64	<0.001
Decedent’s residence county health resources				
# of hospice facility	1.02	1.00	1.03	0.03
# of short term general hospitals that have hospice care	1.00	0.95	1.04	0.90

Notes: *IPC, Inpatient palliative consultation; NH, Non-Hispanic; GED, General Equivalency Diploma; CI, Confidence Interval. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death. Variables classified under Decedent’s residence county health resources are all continuous variables and data were retrieved from Area Health Resource File.*

Appendix 5.9 Mixed-effects logistic regression on place of death among Nebraska decedents of the top six causes of death 2013-2016 (n = 33106)

Independent Variables	Odds Ratio	Lower 95% CI	Upper 95% CI	P values
Inpatient palliative consultation				
Never	Reference			
Late IPC	16.34	14.34	18.62	<0.001
IPC before 3 days prior to death	0.58	0.49	0.70	<0.001
Hospice Discharge				
Never	Reference			
Late hospice discharge	0.27	0.23	0.32	<0.001
Hospice discharge before 3 days prior to death	0.16	0.14	0.19	<0.001
Age				
<50	Reference			
50-64	0.79	0.68	0.91	<0.01
65-79	0.67	0.57	0.79	<0.001
≥80	0.42	0.36	0.50	<0.001
Gender				
Male	Reference			
Female	0.98	0.93	1.04	0.57
Race				
NH White	Reference			
NH Black	1.35	1.16	1.58	<0.001
Hispanic	1.34	1.09	1.65	0.01
Other	1.93	1.61	2.31	<0.001
Education				
Less than High School	Reference			
High School and GED	1.07	0.99	1.15	0.09
College or Associate Degree	1.08	0.99	1.18	0.08
Advanced Degree	1.19	1.03	1.38	0.02
Unknown	0.85	0.61	1.21	0.37
Marital Status				
Married	Reference			
Single	0.77	0.72	0.83	<0.001
Widowed	0.71	0.67	0.77	<0.001
Unknown	1.06	0.62	1.81	0.83
Median Household Income				
Quartile 1 (Lowest)	Reference			
Quartile 2	0.97	0.88	1.07	0.51
Quartile 3	0.90	0.81	1.00	0.05
Quartile 4	0.92	0.83	1.02	0.13
Rurality				
Urban	Reference			
Micropolitan	1.10	0.90	1.34	0.36
Small town/Rural	1.29	1.09	1.53	<0.01
Insurance				
Medicare	Reference			

Commercial	1.03	0.93	1.13	0.58
Medicaid and other government programs	1.05	0.88	1.26	0.57
Others	1.10	0.91	1.33	0.32
Charlson Comorbidity Index				
0-1	Reference			
2-5	1.32	1.23	1.42	<0.001
>5	1.56	1.43	1.70	<0.001
Year of Death				
2013	Reference			
2014	0.98	0.91	1.06	0.63
2015	1.00	0.93	1.08	0.94
2016	1.00	0.93	1.08	0.97
Cause of Death				
Cancer	Reference			
Heart Disease	1.58	1.47	1.69	<0.001
Chronic Lung Disease	1.72	1.57	1.89	<0.001
Cerebrovascular Disease	2.75	2.48	3.05	<0.001
Alzheimer's Disease	0.29	0.23	0.36	<0.001
Diabetes Mellitus	0.74	0.65	0.85	<0.001
Decedent's residence county health resources				
hospital beds per 1,000	0.99	0.94	1.03	0.57
# of hospice facility	1.03	0.96	1.11	0.43
# of short term general hospitals with hospice care	1.18	0.89	1.55	0.26
# of Skilled nursing facility	0.98	0.95	1.02	0.43
Nursing home beds per 1,000	1.07	0.98	1.16	0.12
Long term hospital beds per 1,000	0.98	0.61	1.57	0.93

Notes: *IPC, Inpatient palliative consultation; NH, Non-Hispanic; GED, General Equivalency Diploma; CI, Confidence Interval. Place of death was defined as a binary outcome variable with 1 indicating death in hospital and 0 indicating death in other place. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death. Late hospice discharge indicates that the decedent was discharged within 3 days prior to death. Variables classified under Decedent's residence county health resources are all continuous variables and data were retrieved from Area Health Resource File.*

Appendix 5.10 Logistic regression result for the factors that associated with intensive care utilization at the last month of life among Nebraska decedents of the top six causes of death 2013-2016 (n = 33106)

Independent variables	Odds Ratio	Lower 95% CI	Upper 95% CI	P values
Inpatient palliative consultation				
Never	Reference			
Late IPC	2.06	1.85	2.29	<0.001
IPC before 3 days prior to death	0.68	0.58	0.80	<0.001
Hospice Discharge				
Never	Reference			
Discharged to hospice within the last month of life	10.36	9.45	11.35	<0.001
Discharged to hospice before the last month of life	0.40	0.28	0.59	<0.001
Place of death				
Other place	Reference			
Inpatient Unit	3.64	3.36	3.95	<0.001
Received life-sustaining treatment during the last month of life				
No	Reference			
Yes	4.05	3.77	4.36	<0.001
Age				
<50	Reference			
50-64	0.91	0.76	1.09	0.31
65-79	0.86	0.71	1.05	0.13
≥80	0.70	0.57	0.86	<0.01
Gender				
Male	Reference			
Female	0.88	0.82	0.94	<0.001
Race				
NH White	Reference			
NH Black	1.02	0.85	1.23	0.80
Hispanic	0.92	0.71	1.18	0.50
Other	0.72	0.56	0.93	0.01
Education				
Less than High School	Reference			
High School and GED	1.02	0.93	1.13	0.65
College or Associate Degree	0.97	0.87	1.08	0.60
Advanced Degree	0.96	0.80	1.15	0.67
Unknown	1.01	0.66	1.55	0.97
Marital Status				
Married	Reference			
Single	1.08	0.98	1.18	0.11
Widowed	0.98	0.89	1.07	0.60
Unknown	1.45	0.73	2.87	0.29
Median Household Income				
Quartile 1 (Lowest)	Reference			
Quartile 2	1.03	0.93	1.13	0.57

Quartile 3	0.98	0.88	1.08	0.66
Quartile 4	1.10	0.99	1.23	0.07
Rurality				
Urban	Reference			
Micropolitan	1.09	0.99	1.21	0.08
Small town/Rural	1.12	1.02	1.22	0.02
Insurance				
Medicare	Reference			
Commercial	1.01	0.90	1.14	0.81
Medicaid and other government programs	0.86	0.69	1.06	0.16
Others	0.57	0.43	0.75	<0.001
Charlson Comorbidity Index				
0-1	Reference			
2-5	2.24	2.01	2.50	<0.001
>5	2.95	2.61	3.33	<0.001
Year of Death				
2013	Reference			
2014	1.02	0.93	1.12	0.67
2015	1.13	1.03	1.24	0.01
2016	1.15	1.04	1.26	0.01
Cause of Death				
Cancer	Reference			
Heart Disease	1.10	1.00	1.20	0.05
Chronic Lung Disease	1.35	1.20	1.52	<0.001
Cerebrovascular Disease	0.99	0.87	1.13	0.90
Alzheimer's Disease	0.81	0.62	1.06	0.12
Diabetes Mellitus	1.00	0.84	1.18	0.96

Notes: *IPC, Inpatient palliative consultation; NH, Non-Hispanic; GED, General Equivalency Diploma; CI, Confidence Interval. Intensive care utilization was defined as a binary variable with value 1 indicating that decedent had two or more hospital discharges, or two or more emergency department visits that end up with hospital admissions, or any admission with more than 14-day length-of-stay during the last month of life. Life-sustaining treatments include intubation, Invasive mechanical ventilation, non-Invasive mechanical ventilation, cardiopulmonary resuscitation, enteral or parenteral infusion of concentrated nutritional substances, gastrostomy tube insertion, blood transfusion, hemodialysis, tracheostomy, radiation, and medical imaging during the last month of life; and chemotherapy during the last 14 days of life. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death.*

Appendix 5.11 Logistic regression result for the impact of inpatient palliative consultation on receiving any life-sustaining treatment among the decedents who had at least one hospitalization during their last month of life (Nebraska decedents 2013-2016, n = 17,201)

Independent variables	Odds Ratio	Lower 95% CI	Upper 95% CI	P values
Inpatient palliative consultation				
Never	Reference			
Late IPC	1.31	1.19	1.45	<0.001
IPC before 3 days prior to death	0.74	0.64	0.87	<0.001
Hospice Discharge				
Never	Reference			
Any hospice discharge	0.64	0.59	0.69	<0.001
Age				
<50	Reference			
50-64	0.85	0.71	1.02	0.07
65-79	0.59	0.48	0.71	<0.001
≥80	0.29	0.23	0.35	<0.01
Gender				
Male	Reference			
Female	0.96	0.89	1.02	0.20
Race				
NH White	Reference			
NH Black	1.47	1.22	1.76	<0.001
Hispanic	1.27	0.99	1.63	0.06
Other	1.07	0.83	1.40	0.59
Education				
Less than High School	Reference			
High School and GED	0.97	0.88	1.06	0.47
College or Associate Degree	0.97	0.87	1.07	0.52
Advanced Degree	1.10	0.93	1.31	0.27
Unknown	1.10	0.73	1.66	0.66
Marital Status				
Married	Reference			
Single	0.81	0.74	0.88	<0.001
Widowed	0.75	0.69	0.82	<0.001
Unknown	0.92	0.45	1.91	0.83
Median Household Income				
Quartile 1 (Lowest)	Reference			
Quartile 2	1.08	0.98	1.18	0.11
Quartile 3	0.97	0.88	1.07	0.57
Quartile 4	1.01	0.91	1.12	0.85
Rurality				
Urban	Reference			
Micropolitan	0.80	0.73	0.88	<0.001
Small town/Rural	0.58	0.53	0.63	<0.001
Insurance				
Medicare	Reference			

Commercial	0.88	0.79	0.99	0.04
Medicaid and other government programs	0.93	0.76	1.14	0.49
Others	0.83	0.64	1.07	0.15
Charlson Comorbidity Index				
0-1	Reference			
2-5	0.93	0.84	1.03	0.15
>5	0.85	0.76	0.95	<0.001
Year of Death				
2013	Reference			
2014	0.97	0.89	1.06	0.51
2015	0.89	0.81	0.97	0.01
2016	0.74	0.68	0.81	<0.001
Cause of Death				
Cancer	Reference			
Heart Disease	1.17	1.07	1.28	<0.01
Chronic Lung Disease	1.31	1.17	1.47	<0.001
Cerebrovascular Disease	1.34	1.18	1.50	<0.001
Alzheimer's Disease	0.38	0.28	0.52	<0.001
Diabetes Mellitus	1.14	0.96	1.34	0.13

Notes: *IPC, Inpatient palliative consultation; NH, Non-Hispanic; GED, General Equivalency Diploma; CI, Confidence Interval. Life-sustaining treatments include intubation, Invasive mechanical ventilation, non-Invasive mechanical ventilation, cardiopulmonary resuscitation, enteral or parenteral infusion of concentrated nutritional substances, gastrostomy tube insertion, blood transfusion, hemodialysis, tracheostomy, radiation, and medical imaging during the last month of life; and chemotherapy during the last 14 days of life. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death.*

Appendix 5.12 Negative binomial regression on EOL inpatient length of stay among the six cohorts of decedents who had at least one hospital admission during the last month of life in Nebraska 2013-2016 (n = 17201)

Independent variables	Marginal Effect	Lower 95% CI	Upper 95% CI	P values
Inpatient palliative consultation				
Never	Reference			
Late IPC	-0.40	-0.63	-0.16	<0.01
IPC before 3 days prior to death	-0.44	-0.78	-0.10	0.01
Hospice Discharge				
Never	Reference			
Late hospice discharge	-0.06	-0.36	0.25	0.72
Hospice discharge before 3 days prior to death	0.18	-0.06	0.41	0.14
EOL events				
# of hospitalization	4.13	3.97	4.29	<0.001
Long LOS (>14d) admission	10.46	10.16	10.76	<0.001
Place of death	-1.25	-1.43	-1.07	<0.001
Life sustaining treatment				
Intubation	-0.44	-0.79	-0.10	0.01
IMV	1.05	0.74	1.36	<0.001
NIMV	0.86	0.57	1.15	<0.001
CPR	-1.62	-2.04	-1.20	<0.001
EN/PN	2.67	2.33	3.01	<0.001
GTI	1.63	0.62	2.63	<0.01
Blood Transfusion	1.16	0.96	1.37	<0.001
Hemodialysis	1.73	1.26	2.19	<0.001
Tracheostomy	3.59	2.92	4.25	<0.001
Chemotherapy	2.99	2.47	3.51	<0.001
Radiation	1.14	0.53	1.75	<0.001
Medical Imaging	1.86	0.61	3.10	<0.01
Age				
<50	Reference			
50-64	0.21	-0.22	0.64	0.35
65-79	0.31	-0.15	0.78	0.19
≥80	-0.34	-0.82	0.15	0.17
Gender				
Male	Reference			
Female	-0.06	-0.23	0.10	0.43
Race				
NH White	Reference			
NH Black	0.26	-0.16	0.68	0.22
Hispanic	0.87	0.29	1.45	<0.01
Other	-0.40	-1.04	0.23	0.21
Education				
Less than High School	Reference			
High School and GED	0.09	-0.14	0.31	0.44
College or Associate Degree	0.23	-0.01	0.48	0.06
Advanced Degree	0.17	-0.24	0.58	0.43
Unknown	0.89	-0.08	1.86	0.07

Marital Status				
Married	Reference			
Single	0.19	-0.02	0.39	0.08
Widowed	-0.11	-0.31	0.09	0.30
Unknown	0.24	-1.49	1.97	0.79
Median Household Income				
Quartile 1 (Lowest)	Reference			
Quartile 2	-0.02	-0.24	0.19	0.84
Quartile 3	0.03	-0.20	0.25	0.81
Quartile 4	-0.06	-0.30	0.19	0.66
Rurality				
Urban	Reference			
Micropolitan	-0.71	-0.94	-0.48	<0.001
Small town/Rural	-0.94	-1.14	-0.73	<0.001
Insurance				
Medicare	Reference			
Commercial	-0.22	-0.50	0.05	0.11
Medicaid and other government programs	0.09	-0.40	0.58	0.72
Others	-0.96	-1.59	-0.33	<0.01
Charlson Comorbidity Index				
0-1	Reference			
2-5	0.80	0.56	1.04	<0.001
>5	0.79	0.52	1.07	<0.001
Year of Death				
2013	Reference			
2014	-0.06	-0.28	0.15	0.56
2015	0.20	-0.02	0.41	0.07
2016	0.31	0.10	0.53	0.01
Cause of Death				
Cancer	Reference			
Heart Disease	-0.07	-0.28	0.15	0.56
Chronic Lung Disease	0.66	0.36	0.95	<0.001
Cerebrovascular Disease	-0.65	-0.92	-0.37	<0.001
Alzheimer's Disease	-0.37	-0.94	0.21	0.21
Diabetes Mellitus	-0.34	-0.74	0.05	0.09

Notes: *IPC, Inpatient palliative consultation; EOL, End-of-Life, the last month of life; IMV, Invasive mechanical ventilation; NIMV, Non-Invasive mechanical ventilation; CPR, Cardiopulmonary resuscitation; EN/PN, Enteral or parenteral infusion of concentrated nutritional substances; GTI, Gastrostomy tube insertion; NH, Non-Hispanic; GED, General Equivalency Diploma; CI, Confidence Interval. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death. Late hospice discharge indicates that the decedent was discharged within 3 days prior to death. Long LOS (>14d) admission means that decedent had a more than 14-days length-of-stay inpatient admission in the last month of life. Place of death was defined as a binary variable with 1 indicating death in hospital and 0 indicating death in other place. Other variables classified under EOL events and Life-sustaining treatments were all binary variables with 1 indicating decedent had the event/treatment during the last month of life (except for chemotherapy was measured during the last 14 days of life).*

Appendix 5.13 Generalized linear model results on total inpatient charges (adjusted to 2016 US dollars) at last month of life among the six cohorts of decedents who had at least one hospital admission during the last month of life in Nebraska 2013-2016 (n = 17201)

Independent variables	Marginal Effect	Lower 95% CI	Upper 95% CI	P values
Inpatient palliative consultation				
Never	Reference			
Late IPC	-284516.50	-412111.10	-156921.90	<0.001
IPC before 3 days prior to death	-267738.80	-422861.50	-112616.00	<0.01
Hospice Discharge				
Never	Reference			
Late hospice discharge	70861.81	-61518.85	203242.50	0.29
Hospice discharge before 3 days prior to death	-36180.96	-130422.90	58060.94	0.45
EOL events				
# of hospitalization	564989.30	405248.50	724730.10	<0.001
LOS in last month of life	214786.80	139645.20	289928.30	<0.001
Place of death	424111.20	263742.20	584480.20	<0.001
Life sustaining treatment				
Intubation	79073.36	-56288.67	214435.40	0.25
IMV	1059166.00	693128.60	1425204.00	<0.001
NIMV	503900.90	305919.90	701881.90	<0.001
CPR	346848.30	143904.10	549792.60	<0.01
EN/PN	426996.20	239723.50	614268.80	<0.001
GTI	264145.60	-173321.90	701613.10	0.24
Blood Transfusion	439989.90	275625.00	604354.70	<0.001
Hemodialysis	489124.10	241793.00	736455.20	<0.001
Tracheostomy	-102156.90	-410438.30	206124.50	0.52
Chemotherapy	656489.00	355197.20	957780.80	<0.001
Radiation	533037.40	220669.70	845405.10	<0.01
Medical Imaging	-189395.10	-751704.30	372914.00	0.51
Age				
<50	Reference			
50-64	-118868.90	-302591.40	64853.52	0.21
65-79	-266010.60	-474381.40	-57639.79	0.01
≥80	-905985.20	-1255865.00	-556105.50	<0.001
Gender				
Male	Reference			
Female	-161397.60	-245521.80	-77273.37	<0.001
Race				
NH White	Reference			
NH Black	-59541.19	-237311.90	118229.50	0.51
Hispanic	158612.80	-92620.35	409845.90	0.22
Other	5104.80	-252032.70	262242.30	0.97
Education				
Less than High School	Reference			
High School and GED	60184.11	-31367.03	151735.30	0.20
College or Associate Degree	100560.50	-2874.39	203995.50	0.06
Advanced Degree	32676.26	-133630.00	198982.60	0.70

Unknown	40207.15	-360756.80	441171.10	0.84
Marital Status				
Married	Reference			
Single	-100429.50	-191392.70	-9466.29	0.03
Widowed	-196354.20	-298706.70	-94001.77	<0.001
Unknown	220431.10	-498894.90	939757.10	0.55
Median Household Income				
Quartile 1 (Lowest)	Reference			
Quartile 2	9388.70	-77615.68	96393.07	0.83
Quartile 3	-35429.77	-127273.70	56414.12	0.45
Quartile 4	1273.10	-96981.34	99527.54	0.98
Rurality				
Urban	Reference			
Micropolitan	-345983.00	-485681.90	-206284.10	<0.001
Small town/Rural	-768512.70	-1028128.00	-508897.40	<0.001
Insurance				
Medicare	Reference			
Commercial	-28050.42	-142107.30	86006.41	0.63
Medicaid and other government programs	-129828.30	-338886.60	79229.97	0.22
Others	197757.50	-61787.74	457302.60	0.14
Charlson Comorbidity Index				
0-1	Reference			
2-5	-127605.40	-230304.90	-24905.84	0.02
>5	-413445.80	-583998.90	-242892.60	<0.001
Year of Death				
2013	Reference			
2014	167161.90	65490.49	268833.40	<0.01
2015	251363.50	131631.40	371095.50	<0.001
2016	461158.30	290680.60	631635.90	<0.001
Cause of Death				
Cancer	Reference			
Heart Disease	506602.00	323695.20	689508.90	<0.001
Chronic Lung Disease	6875.06	-87101.00	100851.10	0.89
Cerebrovascular Disease	-9925.79	-106255.60	86404.02	0.84
Alzheimer's Disease	-415389.60	-620764.60	-210014.60	<0.001
Diabetes Mellitus	93639.96	-49855.64	237135.60	0.20

Notes: *IPC, Inpatient palliative consultation; EOL, End-of-Life, the last month of life in this study; LOS, length of stay; IMV, Invasive mechanical ventilation; NIMV, Non-Invasive mechanical ventilation; CPR, Cardiopulmonary resuscitation; EN/PN, Enteral or parenteral infusion of concentrated nutritional substances; GTI, Gastrostomy tube insertion; NH, Non-Hispanic; GED, General Equivalency Diploma; CI, Confidence Interval. Late IPC indicates that the decedent received the inpatient palliative consultation during the acute hospitalization that discharged within 3 days prior to death. Late hospice discharge indicates that the decedent was discharged within 3 days prior to death. # of hospitalization and LOS in last month of life were continuous variables. Place of death was defined as a binary variable with 1 indicating death in hospital and 0 indicating death in other place. Other variables classified under EOL events and Life-sustaining treatments were all binary variables with 1 indicating decedent had the event/treatment during the last month of life (except for chemotherapy was measured during the last 14 days of life).*

BIBILIOGRAPHY

Abrahm, J. L. (2011). Advances in Palliative Medicine and End-of-Life Care. *Annual Review of Medicine*, *62*(1), 187–199. https://doi.org/10.1146/annurev-med-050509-163946

Agency for Healthcare Research and Quality. (n.d.). AHRQ - Quality Indicators. Retrieved January 8, 2018, from http://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx

Agency for Healthcare Research and Quality. n.d.. Prevention Quality Indicators Overview. *Agency for Healthcare Research and Quality*. [Online] n.d. [Cited: 12 6, 2018.] http://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx.

Aldridge, M. D., & Kelley, A. S. (2015). The myth regarding the high cost of end-of-life care. *American Journal of Public Health*, *105*(12), 2411–2415. https://doi.org/10.2105/AJPH.2015.302889

American Academy of Family Physicians. 2018. Continuity of care, Definition of. *American Academy of Family Physicians.* [Online] 12 6, 2018. https://www.aafp.org/about/policies/all/definition-care.html.

American Hospital Association. 2016. AHA Fact Sheet: Hospital Readmissions Reduction Program. *American Hospital Association.* [Online] 01 18, 2016. [Cited: 12 6, 2018.] https://www.aha.org/system/files/2018-01/fs-readmissions.pdf.

An. (2016). The Impact of Patient-Centered Medical Homes on Quality of Care and Medication Adherence in Patients with Diabetes Mellitus. *Journal of Managed Care & Specialty Pharmacy JMCP*, *22*(11).

Andersen, R. M. (1995). Revisiting the Behavioral Model and Access to Medical Care : Does it Matter ? *American Sociological Association*, *36*(1), 1–10.

Ansari, Z., Laditka, J. N., & Laditka, S. B. (2006). Access to health care and hospitalization for ambulatory care sensitive conditions. *Medical Care Research and Review*, *63*(6), 719–741. https://doi.org/10.1177/1077558706293637

Auerbach, D. I., & Kellermann, A. L. (2011). A decade of health care cost growth has wiped out real income gains for an average US family. *Health Affairs*, *30*(9), 1630–1636. https://doi.org/10.1377/hlthaff.2011.0585

Bajwah, S., Yi, D., Grande, G., Todd, C., Costantini, M., Murtagh, F. E., … Higginson, I. J. (2017). The effectiveness and cost-effectiveness of inpatient specialist palliative care in acute hospitals for adults with advanced illness and their caregivers. *Cochrane Database of Systematic Reviews*, (3). https://doi.org/10.1002/14651858.CD012780

Barnato, A., Chang, C., Farrell, M., Lave, J., Roberts, M., & Angus, D. (2013). Is Survival Better at Hospitals With Higher " End-of-Life ." *Med Care.*, *48*(2), 125–132. https://doi.org/10.1097/MLR.0b013e3181c161e4.Is

Barrett, M. L., Wier, L. M., Jiang, H. J., & Steiner, C. A. (2015). *All-Cause Readmissions by Payer and Age, 2009-2013: Statistical Brief #199.* Rockville, MD.

Bayliss, E. A., Ellis, J. L., Shoup, J. A., & Mcquillan, D. B. (2015). Effect of Continuity of Care on Hospital Utilization for Seniors With Multiple Medical Conditions in an Integrated Health Care System, 123–129. https://doi.org/10.1370/afm.1739.INTRODUCTION

Beal, A., Hernandez, S., & Doty, M. (2009). Latino access to the patient-centered medical home. *Journal of General Internal Medicine*, *24*(3 SUPPL.), 514–520. https://doi.org/10.1007/s11606-009-1119-1

Benbassat, J., & Taragin, M. (2013a). Hospital Readmissions as a Measure of Quality of Health Care.

Benbassat, J., & Taragin, M. I. (2013b). The effect of clinical interventions on hospital readmissions: A meta-review of published meta-analyses. *Israel Journal of Health Policy Research*, *2*(1). https://doi.org/10.1186/2045-4015-2-1

Bice, Thomas, W., & Boxerman, S. B. . (1977). A Quantitative Measure of Continuity of Care. *Medical Care*, *XV*(4), 347–349.

Blumenthal, D., & Abrams, M. K. (2016). Tailoring complex care management for high-need, high-cost patients. *JAMA - Journal of the American Medical Association*, *316*(16), 1657–1658. https://doi.org/10.1001/jama.2016.12388

Bodenheimer, T., & Berry-Millett, R. (2009). Follow the Money — Controlling Expenditures by Improving Care for Patients Needing Costly Services. *New England Journal of Medicine*, *361*(16), 1521–1523. https://doi.org/10.1056/NEJMp0907185

Boscardin, W. J., Robinson, E. J., Flanders, S. A., Giang, V., Vasilevskis, E. E., Ruhnke, G. W., … Williams, M. V. (2016). Preventability and Causes of Readmissions in a National Cohort of General Medicine Patients. *JAMA Internal Medicine*, *176*(4), 484. https://doi.org/10.1001/jamainternmed.2015.7863

Bowdoin, J. J., Rodriguez-Monguio, R., Puleo, E., Keller, D., & Roche, J. (2016). Associations between the patient-centered medical home and preventive care and healthcare quality for non-elderly adults with mental illness: A surveillance study analysis. *BMC Health Services Research*, *16*(1), 434. https://doi.org/10.1186/s12913-016-1676-z

Burns, T., & Puntis, S. R. (2016). The association between continuity of care and readmission to hospital in patients with severe psychosis illness are seen frequently and consistently in community, 1633–1643. https://doi.org/10.1007/s00127-016-1287-3

Cabana, M. D., & Jee, S. H. (2004). Does continuity of care improve patient outcomes? *Journal of Family Practice*.

California Healthcare Foundation. (2007). *Palliative Care in California : Fundamentals of Palliative Care in California : Fundamentals of Hospital-Based Programs*.

Caminal, J., Starfield, B., Sánchez, E., Casanova, C., & Morales, M. (2004). The role of primary care in preventing ambulatory care sensitive conditions. *European Journal of Public Health*, *14*(3), 246–251.

Carey, K., & Lin, M. Y. (2014). Hospital length of stay and readmission: An early investigation. *Medical Care Research and Review*, *71*(1), 99–111. https://doi.org/10.1177/1077558713504998

Center for Medicare & Medicaid Services. 2017. Readmissions Reduction Program (HRRP). *Center for Medicare & Medicaid Services.* [Online] 11 30, 2017. [Cited: 1 8, 2018.] https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html.

Center to Advance Palliative Care. n.d.. Prevalence and Distribution of Palliative Care Programs in U.S Hospitals by State and U.S. Census Region. [Online] n.d. [Cited: 03 20, 2019.] https://reportcard.capc.org/wp-content/uploads/2015/08/reportcard-2015-table-a.pdf.

Centers for Medicare & Medicaid Services. National Health Expenditure Data - Historical. *Centers for Medicare & Medicaid Services.* [Online] [Cited: 03 21, 2019.] https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/downloads/highlights.pdf.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *Journal of Chronic Diseases*. https://doi.org/10.1016/0021-9681(87)90171-8

Chen, C. C., Tseng, C. H., & Cheng, S. H. (2013). Continuity of care, medication adherence, and health care outcomes among patients with newly diagnosed type 2 diabetes: A longitudinal analysis. *Medical Care*, *51*(3), 231–237. https://doi.org/http://dx.doi.org/10.1097/MLR.0b013e31827da5b9

Chen, P. J., Liang, F. W., Ho, C. H., Cheng, S. Y., Chen, Y. C., Chen, Y. H., & Chen, Y. C. (2018). Association between palliative care and life-sustaining treatments for patients with dementia: A nationwide 5-year cohort study. *Palliative Medicine*, *32*(3), 622–630. https://doi.org/10.1177/0269216317751334

Cheng, Tsung-Mei. n.d.. The Taiwan Health Care System. *International Health Care System Profiles.* [Online] The commonwealth Fund, n.d. [Cited: 4 1, 2019.] https://international.commonwealthfund.org/countries/taiwan/.

Cheng, S. H., Chen, C.-C., & Hou, Y.-F. (2010). A Longitudinal Examination of Continuity of Care and Avoidable Hospitalization. *Arch Internal Medicine*, *170*(18), 1671–1677.

Cheng, S. H., Hou, Y. F., & Chen, C. C. (2011). Does continuity of care matter in a health care system that lacks referral arrangements? *Health Policy and Planning*, *26*(2), 157–162. https://doi.org/10.1093/heapol/czq035

Chettiar, A., Montez-Rath, M., Liu, S., Hall, Y. N., O'Hare, A. M., & Tamura, M. K. (2018). Association of inpatient palliative care with health care utilization and postdischarge outcomes among medicare beneficiaries with end stage kidney disease. *Clinical Journal of the American Society of Nephrology*, *13*(8), 1180–1187. https://doi.org/10.2215/CJN.00180118

Christensen, E. W., Dorrance, K. a., Ramchandani, S., Lynch, S., Whitmore, C. C., Borsky, A. E., … Bickett A, T. (2013). Impact of a Patient-Centered Medical Home on Access, Quality, and Cost. *Military Medicine*, *178*(2), 135–141. https://doi.org/10.7205/MILMED-D-12-00220

Chu, H.-Y., Chen, C.-C., & Cheng, S.-H. (2012). Continuity of care, potentially inappropriate medication, and health care outcomes among the elderly: evidence from a longitudinal analysis in Taiwan. *Medical Care*, *50*(11), 1002–1009. https://doi.org/10.1097/MLR.0b013e31826c870f

Cohen, S. B. (2014). *The Concentration of Health Care Expenditures and Related Expenses for Costly Medical Conditions, 2012. Statistical Brief (Medical Expenditure Panel Survey (US)).*

Cubanski, J., Neuman, T., Griffin, S., & Damico, A. (2014). Medicare Spending at the End of Life: A Snapshot of Beneficiaries Who Died in 2014 and the Cost of Their Care, 1–12.

Curtis, J. R., Engelberg, R. A., Bensink, M. E., & Ramsey, S. D. (2012). End-of-life care in the intensive care unit: Can we simultaneously increase quality and reduce costs? *American Journal of Respiratory and Critical Care Medicine*, *186*(7), 587–592. https://doi.org/10.1164/rccm.201206-1020CP

Dilokthornsakul, P., Thoopputra, T., Patanaprateep, O., Kongsakon, R., & Chaiyakunapruk, N. (2016). Effects of medication adherence on hospitalizations and healthcare costs in patients with schizophrenia in Thailand. *SAGE Open Medicine*, *4,* 205031211663702. https://doi.org/10.1177/2050312116637026

DiMartino, L. D., Weiner, B. J., Hanson, L. C., Weinberger, M., Birken, S. A., Reeder-Hayes, K., & Trogdon, J. G. (2018). Inpatient Palliative Care Consultation and 30-Day Readmissions in Oncology. *Journal of Palliative Medicine*, *21*(1), 62–68. https://doi.org/10.1089/jpm.2017.0172

Doyle, C., Lennox, L., & Bell, D. (2013). A systematic review of evidence on the links between patient experience and clinical safety and effectiveness. *BMJ Open Accessible Medical Research*, *3*(1), 1–19. https://doi.org/10.1136/bmjopen-2012-001570

Dunning, T., & Martin, P. (2017). Palliative and end of life care of people with diabetes: Issues, challenges and strategies. *Diabetes Research and Clinical Practice*, 1–10. https://doi.org/10.1016/j.diabres.2017.09.018

Elixhauser, A., Steiner, C., Harris, D., & Coffey, R. (1998). Comorbidity Measures for Use with Administrative Data Methods Defining Important Comorbidities. *Medical Care*.

Emanuel, E. J. (2012). Where Are the Health Care Cost Savings? *Journal of the American Medical Association*, *307*(1), 39–40.

Field, T. S., Ogarek, J., Garber, L., Reed, G., & Gurwitz, J. H. (2015). Association of Early Post-Discharge Follow-Up by a Primary Care Physician and 30-Day Rehospitalization Among Older Adults. *Journal of General Internal Medicine*, *30*(5), 565–571. https://doi.org/10.1007/s11606-014-3106-4

Fishman, P. A., Johnson, E. A., Coleman, K., Larson, E. B., Hsu, C., Ross, T. R., … Reid, R. J. (2012). Impact on seniors of the patient-centered medical home: Evidence from a pilot study. *Gerontologist*, *52*(5), 703–711. https://doi.org/10.1093/geront/gnr158

Fitzpatrick, J., Mavissakalian, M., Luciani, T., Xu, Y., & Mazurek, A. (2018). Economic Impact of Early Inpatient Palliative Care Intervention in a Community Hospital Setting. *Journal of Palliative Medicine*, *21*(7), jpm.2017.0416. https://doi.org/10.1089/jpm.2017.0416

Flottemesch, T. J., Anderson, L. H., Solberg, L. I., Fontaine, P., & Asche, S. E. (2012). Patient-Centered Medical Home Cost Reductions Limited to Complex Patients. *American Journal of Managed Care*, *18*(11), 677–686.

Friedberg, M. W., Rosenthal, M. B., Werner, R. M., Volpp, K. G., & Schneider, E. C. (2015). Effects of a Medical Home and Shared Savings Intervention on Quality and Utilization of Care. *JAMA Internal Medicine*, *175*(8), 1362. https://doi.org/10.1001/jamainternmed.2015.2047

Friedman, B., & Basu, J. (2004). The rate and cost of hospital readmissions for preventable conditions. *Medical Care Research and Review*. https://doi.org/10.1177/1077558704263799

Gibson, O. R. (2013). The impact of primary health care resourcing on hospitalisation of Aboriginal and Torres Strait Islander adults with type 2 diabetes in far north Queensland , Australia, (August).

Ginsburg, P. B. (2008). High and rising health care costs. *The Synthesis Project. Research Synthesis Report*, (16). https://doi.org/35368

Golan, R., Bernstein, A. N., Gu, X., Dinerman, B. F., Sedrakyan, A., & Hu, J. C. (2018). Increased resource use in men with metastatic prostate cancer does not result in improved survival or quality of care at the end of life. *Cancer*, *124*(10), 2212–2219. https://doi.org/10.1002/cncr.31297

Greer, J. A., Pirl, W. F., Jackson, V. A., Muzikansky, A., Lennes, I. T., Heist, R. S., … Temel, J. S. (2012). Effect of early palliative care on chemotherapy use and end-of-life care in patients with metastatic non-small-cell lung cancer. *Journal of Clinical Oncology*, *30*(4), 394–400. https://doi.org/10.1200/JCO.2011.35.7996

Grunfeld, E., Urquhart, R., Mykhalovskiy, E., Folkes, A., Johnston, G., Burge, F. I., … Dent, S. (2008). Toward population-based indicators of quality end-of-life care: Testing stakeholder agreement. *Cancer*, *112*(10), 2301–2308. https://doi.org/10.1002/cncr.23428

Habibi, A., Wu, S. P., Gorovets, D., Sansosti, A., Kryger, M., Beaudreault, C., … Kondziolka, D. (2018). Early Palliative Care for Patients With Brain Metastases Decreases Inpatient Admissions and Need for Imaging Studies. *American Journal of Hospice and Palliative Medicine*, *35*(8), 1069–1075. https://doi.org/10.1177/1049909118765405

Haggerty, J. L., Roberge, D., Freeman, G. K., & Beaulieu, C. (2013). Experienced continuity of care when patients see multiple clinicians: A qualitative metasummary. *Annals of Family Medicine*, *11*(3), 262–271. https://doi.org/10.1370/afm.1499

Han, B., Yu, H., & Friedberg, M. W. (2017). Evaluating the Impact of Parent-Reported Medical Home Status on Children’s Health Care Utilization, Expenditures, and Quality: A Difference-in-Differences Analysis with Causal Inference Methods. *Health Services Research*, *52*(2), 786–806. https://doi.org/10.1111/1475-6773.12512

Hanley, J. A., Negassa, A., Edwardes, M. D. deB, & Forrester, J. E. (2003). Statistical analysis of correlated data using generalized estimating equations: An orientation. *American Journal of Epidemiology*, *157*(4), 364–375. https://doi.org/10.1093/aje/kwf215

Hansen, L. O., Young, R. S., Hinami, K., Leung, A., & Williams, M. V. (2011). Interventions to Reduce 30-Day Rehospitalization : A Systematic Review. *Annals of Internal Medicine*, *155*(8), 520–528. https://doi.org/10.7326/0003-4819-155-8-201110180-00008

Hasselt, M., Mccall, N., Keyes, V., Wensky, S., & Smith, K. (2010). Total Cost of Care Lower among Medicare Fee-for-Service Bene fi ciaries Receiving Care from Patient-Centered Medical Homes. *Health Services Research*, 253–273. https://doi.org/10.1111/1475-6773.12217

Hayes, S. L., Salzberg, C. A., McCarthy, D., Radley, D. C., Abrams, M. K., Shah, T., & Anderson, G. F. (2016). High-Need, High-Cost Patients: Who Are They and How Do They Use Health Care? A Population-Based Comparison of Demographics, Health Care Use, and Expenditures. *Issue Brief (Commonwealth Fund)*, *26*(August), 1–14.

Health Care Cost Institute. n.d.. ER facility prices grew in tandem with faster-growing charges from 2009-2016. *#HealthyBytes: Byte-sized data points from HCCI.* [Online] n.d. [Cited:

03 20, 2019.] https://www.healthcostinstitute.org/blog/entry/er-facility-prices-charges-2009-2016.

Henke, R. M., Karaca, Z., Jackson, P., Marder, W. D., & Wong, H. S. (2017). Discharge Planning and Hospital Readmissions. *Medical Care Research and Review*, *74*(3), 345–368. https://doi.org/10.1177/1077558716647652

Hoff, T., Weller, W., & DePuccio, M. (2012). The Patient-Centered Medical Home: A Review of Recent Research. *Medical Care Research and Review*, *69*(6), 619–644. https://doi.org/10.1177/1077558712447688

Horton, J. R., Morrison, R. S., Capezuti, E., Hill, J., Lee, E. J., & Kelley, A. S. (2016). Impact of Inpatient Palliative Care on Treatment Intensity for Patients with Serious Illness. *Journal of Palliative Medicine*, *19*(9), 936–942. https://doi.org/10.1089/jpm.2015.0240

Hua, M., Li, G., Clancy, C., Morrison, R. S., & Wunsch, H. (2017). Validation of the V66.7 Code for Palliative Care Consultation in a Single Academic Medical Center. *Journal of Palliative Medicine*, *20*(4), 372–377. https://doi.org/10.1089/jpm.2016.0363

Huntley, A. L., Johnson, R., King, A., Morris, R. W., & Purdy, S. (2016). Does case management for patients with heart failure based in the community reduce unplanned hospital admissions? A systematic review and meta-analysis. *BMJ Open*, *6*(5), e010933. https://doi.org/10.1136/bmjopen-2015-010933

Hussey, P. S., Schneider, E. C., Rudin, R. S., Fox, D. S., Lai, J., & Pollack, C. E. (2014). Continuity and the costs of care for chronic disease. *JAMA Internal Medicine*, *174*(5), 742–748. https://doi.org/10.1001/jamainternmed.2014.245

Jackson, G., Powers, B., Chatterjee, R., Bettger, J., Kemper, A., Hasselblad, V., … Williams, J. (2013). The Patient-Centered Medical Home A Systematic Review. *Annals of Internal Medicine*, *158*(3), 169–178.

Jencks, S. F. (2009). Rehospitalizations among Patients in the Medicare Fee-for-Service Program. *The New England Journal of Medicine*, *360*(14), 1418–1428. https://doi.org/10.1056/NEJMsa0803563.

Kaboli, P. J., Go, J. T., Hockenberry, J., Glasgow, J. M., Johnson, S. R., Rosenthal, G. E., … Vaughan-Sarrazin, M. (2013). Associations Between Reduced Hospital Length of Stay and 30-Day Readmission Rate and Mortality: 14-Year Experience in 129 Veterans Affairs Hospitals. *Annals of Internal Medicine*, *157*(12), 837. https://doi.org/10.7326/0003-4819-157-12-201212180-00003

Kahn, K. L., Timbie, J. W., Friedberg, M. W., Lavelle, T. A., Mendel, P., Ashwood, J. S., … Setodji, C. M. (2015). Evaluation of CMS's federally qualified health center (FQHC) advanced primary care practice (APCP) demonstration: Final second annual report. https://doi.org/10.7249/RR886.2

Keim-Malpass, J., Erickson, J. M., & Malpass, H. C. (2014). End-of-Life Care Characteristics for Young Adults with Cancer Who Die in the Hospital. *Journal of Palliative Medicine*, *17*(12), 1359–1364. https://doi.org/10.1089/jpm.2013.0661

Khot, U. N., Johnson, M. J., Wiggins, N. B., Lowry, A. M., Rajeswaran, J., Kapadia, S., … Blackstone, E. H. (2018). Long-term time-varying risk of readmission after acute myocardial infarction. *Journal of the American Heart Association*, *7*(21). https://doi.org/10.1161/JAHA.118.009650

Kim, S. J., Ph, D., Shen, J., Ph, D., Ko, E., Ph, D., … Yoo, J. W. (2018). Life-Sustaining Procedures , Palliative Care , and Cost Trends in Dying COPD Patients in U . S . Hospitals : 2005 ~ 2014, *21*(1), 23–32.

Kripalani, S., Theobald, C. N., Anctil, B., & Vasilevskis, E. E. (2014). Reducing Hospital Readmission: Current Strategies and Future Directions. *Annu Rev Med*, *65*, 471–485. https://doi.org/10.1146/annurev-med-022613-090415.Reducing

Lawlor, M., Kealy, S., Agnew, M., Korn, B., Quinn, J., Cassidy, C., … O'Donnell, R. (2009). Early discharge care with ongoing follow-up support may reduce hospital readmissions in COPD. *International Journal of COPD*, *4*(1), 55–60. https://doi.org/10.2147/COPD.S4069

Leleu, H., & Minvielle, E. (2013). Relationship between Longitudinal Continuity of Primary Care and Likelihood of Death: Analysis of National Insurance Data. *PLoS ONE*, *8*(8), 2–7. https://doi.org/10.1371/journal.pone.0071669

Leung, K. S., Parks, J., & Topolski, J. (2015). Preventable hospitalizations among adult Medicaid beneficiaries with concurrent substance use disorders. *Preventive Medicine Reports*, *2*, 379–384. https://doi.org/10.1016/j.pmedr.2015.04.022

Lilley, E. J., Scott, J. W., Goldberg, J. E., Cauley, C. E., Temel, J. S., Epstein, A. S., … Cooper, Z. (2018). Survival, Healthcare Utilization, and End-of-life Care among Older Adults with Malignancy-associated Bowel Obstruction. *Annals of Surgery*, *267*(4), 692–699. https://doi.org/10.1097/SLA.0000000000002164

Lin, I., Wu, S.-C., & Huang, S.-T. (2015). Continuity of Care and Avoidable Hospitalizations for Chronic Obstructive Pulmonary Disease (COPD). *The Journal of the American Board of Family Medicine*, *28*(2), 222–230. https://doi.org/10.3122/jabfm.2015.02.140141

Lin, W., Huang, I., Wang, S., Yang, M., & Yaung, C. (2010). Continuity of diabetes care is associated with avoidable hospitalizations : evidence from Taiwan ' s National Health Insurance scheme. *International Journal of Quality in Health Care*, *22*(1), 3–8.

Mainous, A. G., Baker, R., Love, M. M., Gray, D. P., & Gill, J. M. (2001). Continuity of care and trust in one's physician: Evidence from primary care in the United States and the United Kingdom. *Family Medicine*, *33*(1), 22–27.

Margolis, B., Chen, L., Accordino, M. K., Clarke Hillyer, G., Hou, J. Y., Tergas, A. I., … Wright, J. D. (2017). Trends in end-of-life care and health care spending in women with uterine cancer. *American Journal of Obstetrics and Gynecology*, *217*(4), 434.e1-434.e10. https://doi.org/10.1016/j.ajog.2017.07.006

Martin, A. B., Hartman, M., Washington, B., Catlin, A., & Team, T. N. H. E. A. (2019). National Health Care Spending In 2017: Growth Slows To Post–Great Recession Rates; Share Of GDP Stabilizes. *Health Affairs*, *38*(1), 10.1377/hlthaff. https://doi.org/10.1377/hlthaff.2018.05085

Martínez-González, N. A., Berchtold, P., Ullman, K., Busato, A., & Egger, M. (2014). Integrated care programmes for adults with chronic conditions: a meta-review. *International Journal for Quality in Health Care : Journal of the International Society for Quality in Health Care / ISQua*, *26*(5), 561–570. https://doi.org/10.1093/intqhc/mzu071

Martsolf, G. R., Alexander, J. A., Shi, Y., Casalino, L. P., Rittenhouse, D. R., Scanlon, D. P., & Shortell, S. M. (2012). The Patient-Centered Medical Home and Patient Experience. *Health Services Research*, *47*(6), 2273–2295. https://doi.org/10.1111/j.1475-6773.2012.01429.x

May, P., Garrido, M. M., Cassel, J. B., Kelley, A. S., Meier, D. E., Normand, C., … Morrison, R. S. (2015). Prospective cohort study of hospital palliative care teams for inpatients with advanced cancer: Earlier consultation is associated with larger cost-saving effect. *Journal of Clinical Oncology*, *33*(25), 2745–2752. https://doi.org/10.1200/JCO.2014.60.2334

McAlister, F. A., Youngson, E., Bakal, J. A., Kaul, P., Ezekowitz, J., & Walraven, C. Van. (2013). Impact of physician continuity on death or urgent readmission after discharge among patients with heart failure. *Cmaj*, *185*(14), 681–689. https://doi.org/10.1503/cmaj.130048

McDermott, C. L., Fedorenko, C., Kreizenbeck, K., Sun, Q., Smith, B., Curtis, J. R., … Ramsey, S. D. (2017). End-of-Life Services Among Patients With Cancer: Evidence From Cancer Registry Records Linked With Commercial Health Insurance Claims. *Journal of Oncology Practice*, *13*(11), e889–e899. https://doi.org/10.1200/JOP.2017.021683

Morrison, S. R., Dietrich, J., Ladwig, S., Quill, T., Sacco, J., Tangeman, J., & Meier, D. E. (2011). Palliative Care Consultation Teams Cut Hospital Costs For Medicaid Beneficiaries. *Health Affairs*, *30*(3), 454–463. https://doi.org/10.1377/hlthaff.2010.0929

Nebraska Hospice & Palliative Care Association. n.d.. How to Get Involved - Advocate. *Nebraska hospice & palliatve care association.* [Online] n.d. [Cited: 03 18, 2019.] https://www.nehospice.org/page/38.

Neuberg, G. W. (2009). The cost of end-of-life care a new efficiency measure falls short of AHA/ACC standards. *Circulation: Cardiovascular Quality and Outcomes*, *2*(2), 127–133. https://doi.org/10.1161/CIRCOUTCOMES.108.829960

Nielson, M., Olayiwola, J., Grundy, P., & Grumbach, K. (2014). *The Centered Medical Home ' s Impact on Cost & Quality : An Annual Update of the Evidence 2012-2013*. *Millbank Memorial Fund Report*.

Nutting, P. A., Crabtree, B. F., Miller, W. L., Stange, K. C., Stewart, E., & Jaén, C. (2011). Transforming physician practices to patient-centered medical homes: Lessons from the national demonstration project. *Health Affairs*, *30*(3), 439–445. https://doi.org/10.1377/hlthaff.2010.0159

Nyweide, D. J., Anthony, D. L., Bynum, J. P. W., Strawderman, R. L., Weeks, W. B., Casalino, L. P., … MS, B. (2013). Continuity of Care and the Risk of Preventable Hospitalization in Older Adults. *JAMA Internal Medicine*, *173*(20), 1879. https://doi.org/10.1001/jamainternmed.2013.10059

Nyweide, D. J., & Bynum, J. P. W. (2017). Relationship Between Continuity of Ambulatory Care and Risk of Emergency Department Episodes Among Older Adults. *Annals of Emergency Medicine*, *69*(4), 407-415.e3. https://doi.org/10.1016/j.annemergmed.2016.06.027

O'Malley, A. S., Reschovsky, J. D., & Saiontz-Martinez, C. (2015). Interspecialty communication supported by health information technology associated with lower hospitalization rates for ambulatory care-sensitive conditions. *Journal of the American Board of Family Medicine*, *28*(3), 404–417. https://doi.org/10.3122/jabfm.2015.03.130325

Peikes, D., Zutshi, A., Genevro, J., Parchman, M., & Meyers, D. (2012). Early evaluations of the medical home: Building on a promising start. *American Journal of Managed Care*.

Premier Inc. 2019. Premier Inc. Identifies $8.3B Savings Opportunity in the ED with More Preventative and Coordinated Ambulatory Care. *Premier.* [Online] Feb 07, 2019. [Cited: 03 20, 2019.] https://www.premierinc.com/newsroom/press-releases/premier-inc-identifies-8-3b-savings-opportunity-in-the-ed-with-more-preventative-and-coordinated-ambulatory-care.

Prigerson, H. G., Zhang, B., Nilsson, M. E., Earle, C. C., Block, S. D., Wright, A. A., … Maciejewski, M. L. (2009). Health Care Costs in the Last Week of Life. *Archives of Internal Medicine*, *169*(5), 480. https://doi.org/10.1001/archinternmed.2008.587

Romaire, & Bell. (2010). The medical home, preventive care screenings, and counseling for children: Evidence from the medical expenditure panel survey. *Academic Pediatrics*, *10*(5), 338–345. https://doi.org/10.1016/j.acap.2010.06.010

Romaire, Bell, & Grossman. (2012a). Medical Home Access and Health Care Use and Expenditures Among Children With Special Health Care Needs. *Archives of Pediatrics and Adolescent Medicine*, *166*(4), 323–330. https://doi.org/10.1001/archpediatrics.2011.1154

Romaire, M., Bell, J., & Grossman, D. (2012b). Health care use and expenditures associated with access to the medical home for children and youth. *Medical Care*, *50*(3), 262–269.

Rosano, A, Lauria, L., Viola, G., Burgio, A., de Belvis, A. G., Ricciardi, W., … van der Zee, J. (2011). Hospitalization for ambulatory care sensitive conditions and the role of primary care in italian regions. *Italian Journal of Public Health*, *8*(1), 77–88. https://doi.org/10.2427/5648

Rosano, Aldo, Loha, C. A., Falvo, R., Van Der Zee, J., Ricciardi, W., Guasticchi, G., & De Belvis, A. G. (2013). The relationship between avoidable hospitalization and accessibility to primary care: A systematic review. *European Journal of Public Health*, *23*(3), 356–360. https://doi.org/10.1093/eurpub/cks053

Rosenthal, M. B., Alidina, S., Friedberg, M. W., Singer, S. J., Eastman, D., Li, Z., & Schneider, E. C. (2016). A Difference-in-Difference Analysis of Changes in Quality, Utilization and Cost Following the Colorado Multi-Payer Patient-Centered Medical Home Pilot. *Journal of General Internal Medicine*, *31*(3), 289–296. https://doi.org/10.1007/s11606-015-3521-1

Rosenthal, M. B., Friedberg, M. W., Singer, S. J., Eastman, D., Li, Z., & Schneider, E. C. (2013). Effect of a Multipayer Patient-Centered Medical Home on Health Care Utilization and Quality. *JAMA Internal Medicine*, *173*(20), 1907. https://doi.org/10.1001/jamainternmed.2013.10063

Salemi, J. L., Chima, C. C., Spooner, K. K., & Zoorob, R. J. (2017). Unplanned hospitalizations for metastatic cancers: The changing patterns of inpatient palliative care, discharge to hospice care, and in-hospital mortality in the United States. *Family Medicine and Community Health*, *5*(1), 13–28. https://doi.org/10.15212/FMCH.2017.0106

Santomassino, M. (2012). A systematic review on the effectiveness of continuity of care and its role in patient satisfaction and decreased hospital readmissions in the adult patient receiving home care services Executive summary, *10*(21), 1214–1259.

Sathitratanacheewin, S., Engelberg, R. A., Downey, L., Lee, R. Y., Fausto, J. A., Starks, H., … Curtis, J. R. (2018). Temporal Trends Between 2010 and 2015 in Intensity of Care at End-of-Life for Patients With Chronic Illness: Influence of Age Under vs. Over 65 Years. *Journal of Pain and Symptom Management*, *55*(1), 75–81.

https://doi.org/10.1016/j.jpainsymman.2017.08.032

Schneider, E., Abrams, M., Shah, A., Lewis, C., & Shah, T. (2018). *HEALTH CARE IN AMERICA The Experience of People with Serious Illness*.

Schneider, E. C., Sarnak, D. O., Squires, D., Shah, A., & Doty, M. M. (2017). Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care. *The Commonwealth Fund*, *July*(July), 1–30. https://doi.org/10.15868/socialsector.27698

Sia, C., Tonniges, T., Osterhus, E., & Taba, S. (2004). History of the medical home concept. *Pediatrics*, *113*(5), 1473–1478. https://doi.org/10.1542/peds.113.5.S1.1473

Singh, T., Peters, S. R., Tirschwell, D. L., & Creutzfeldt, C. J. (2017). Palliative Care for Hospitalized Patients with Stroke: Results from the 2010 to 2012 National Inpatient Sample. *Stroke*, *48*(9), 2534–2540. https://doi.org/10.1161/STROKEAHA.117.016893

Smedby, Ö., Eklund, G., Eriksson, E. A., & Smedby, B. (1986). Measures of continuity of care: A register-based correlation study. *Medical Care*, *24*(6), 511–518. https://doi.org/10.1097/00005650-198606000-00005

Smith, S., Newhouse, J. P., & Freeland, M. S. (2009). Income, insurance, and technology: Why does health spending outpace economic growth? *Health Affairs*, *28*(5), 1276–1284. https://doi.org/10.1377/hlthaff.28.5.1276

Stange, K. C., Nutting, P. A., Miller, W. L., Jaén, C. R., Crabtree, B. F., Flocke, S. A., & Gill, J. M. (2010). Defining and measuring the patient-centered medical home. *Journal of General Internal Medicine*, *25*(6), 601–612. https://doi.org/10.1007/s11606-010-1291-3

Stagg, Vicki. 2017. CHARLSON: Stata module to calculate Charlson index of comorbidity. *EconPapers.* [Online] 2017. https://econpapers.repec.org/software/bocbocode/S456719.htm.

Stockbridge, E. L., & Philpot, L. M. (2014). Patient-Centered Medical Home Features and Expenditures by Medicare Beneficiaries, *20*(5), 379–385.

Temel, J. S., Greer, J. A., Muzikansky, A., Gallagher, E., Admane, S., Jackson, V., … Lynch, T. J. (2010). Early Palliative Care for Patients with Metastatic Non–Small-Cell Lung Cancer. *Society*, *363*(8), 733–742. https://doi.org/10.1056/NEJMoa1000678

Teno, J. M., Gozalo, P., Trivedi, A. N., Bunker, J., Lima, J., Ogarek, J., & Mor, V. (2018). Site of death, place of care, and health care transitions among US medicare beneficiaries, 2000-2015. *JAMA - Journal of the American Medical Association*, *320*(3), 264–271. https://doi.org/10.1001/jama.2018.8981

Termorshuizena, F., van der Hoornb, B. E. A., Blankena, P., van Hemertd, A. M., Hoeke, H. W., & Hendriksa, V. M. (2012). Continuity of care and risk of hospital readmission among dual diagnosis patients. *Mental Health and Substance Use*, *5*(1), 20–30.

The Centers for Disease Control and Prevention. 2017. Emergency Department Visits. *National Center for Health Statistics.* [Online] Jan 19, 2017. [Cited: 03 20, 2019.] https://www.cdc.gov/nchs/fastats/emergency-department.htm.

The Centers for Disease Control and Prevention. 2016. QuickStats: Percentage Distribution of Deaths, by Place of Death — United States, 2000–2014. *Morbidity and Mortality Weekly*

Report (MMWR). [Online] 04 08, 2016. [Cited: 03 20, 2019.] https://www.cdc.gov/mmwr/volumes/65/wr/mm6513a6.htm.

The Lewin Group. 2008. *Bending the curve: Technical documentation.* s.l. : The Lewin Group, 2008.

Tian, Y., Dixon, A., & Gao, H. (2012). Data briefing - Emergency hospital admissions for ambulatory care-sensitive conditions: identifying the potential for reductions - The King's Fund, April 2012. *The King´s Fund*, (April), 1–13.

Tung, Y.-C., Chang, G.-M., Chang, H.-Y., & Yu, T.-H. (2017). Relationship between early physician follow-Up and 30-Day readmission after acute myocardial infarction and heart failure. *Plos One*, *12*(1), e0170061. https://doi.org/10.1371/journal.pone.0170061

United States Department of Agriculture. n.d.. Rural-Urban Commuting Area Codes. *National Agricultural Library.* [Online] n.d. [Cited: 03 20, 2019.] https://data.nal.usda.gov/dataset/rural-urban-commuting-area-codes.

Uppal, S., Rice, L. W., Beniwal, A., & Spencer, R. J. (2016). Trends in hospice discharge, documented inpatient palliative care services and inpatient mortality in ovarian carcinoma. *Gynecologic Oncology*, *143*(2), 371–378. https://doi.org/10.1016/j.ygyno.2016.08.238

van Loenen, T., van den Berg, M. J., Westert, G. P., & Faber, M. J. (2014). Organizational aspects of primary care related to avoidable hospitalization: A systematic review. *Family Practice*, *31*(5), 502–516. https://doi.org/10.1093/fampra/cmu053

Van Walraven, C., Bennett, C., Jennings, A., Austin, P. C., & Forster, A. J. (2011). Proportion of hospital readmissions deemed avoidable: A systematic review. *CMAJ*, *183*(7), E391–E402. https://doi.org/10.1503/cmaj.101860

Van Walraven, C., Mamdani, M., Fang, J., & Austin, P. C. (2004). Continuity of care and patient outcomes after hospital discharge. *Journal of General Internal Medicine*, *19*(6), 624–631. https://doi.org/10.1111/j.1525-1497.2004.30082.x

Vest, J. R., Gamm, L. D., Oxford, B. A., Gonzalez, M. I., & Slawson, K. M. (2010). Determinants of preventable readmissions in the United States : a systematic review Determinants of preventable readmissions in the United States : a systematic review. *Implementation Science*, *5*(1), 88. https://doi.org/10.1186/1748-5908-5-88

Villani, J., & Mortensen, K. (2013). Patient-provider communication and timely receipt of preventive services. *Preventive Medicine*, *57*(5), 658–663. https://doi.org/10.1016/j.ypmed.2013.08.034

Wright, C. M., Youens, D., & Moorin, R. E. (2018). Earlier Initiation of Community-Based Palliative Care Is Associated With Fewer Unplanned Hospitalizations and Emergency Department Presentations in the Final Months of Life: A Population-Based Study Among Cancer Decedents. *Journal of Pain and Symptom Management*, *55*(3), 745-754.e8. https://doi.org/10.1016/j.jpainsymman.2017.11.021

Yang, F., Xiong, Z.-F., Yang, C., Li, L., Qiao, G., Wang, Y., … Hu, H. (2017). Continuity of Care to Prevent Readmissions for Patients with Chronic Obstructive Pulmonary Disease: A Systematic Review and Meta-Analysis. *Copd*, *14*(2), 251–261. https://doi.org/10.1080/15412555.2016.1256384

Yoon, J., Rose, D. E., Canelo, I., Upadhyay, A. S., Schectman, G., Stark, R., … Yano, E. M. (2013). Medical home features of VHA primary care clinics and avoidable hospitalizations. *Journal of General Internal Medicine*, *28*(9), 1188–1194. https://doi.org/10.1007/s11606-013-2405-5

Yu, Wei. n.d.. End of Life Care: Medical Treatments and Costs by Age, Race, and Region. *Health Services Research & Development Research Studies.* [Online] n.d. [Cited: 4 1, 2019.] https://www.hsrd.research.va.gov/research/abstracts/IIR_02-189.htm.

Zhang, B., Wright, A. A., Huskamp, H. A., Nilsson, M. E., Maciejewski, M. L., Earle, C. C., … Prigerson, H. G. (2009). Health Care Costs in the Last Week of Life. *Archives of Internal Medicine*, *169*(5), 480. https://doi.org/10.1001/archinternmed.2008.587

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