Primary Care Practice Structural Capabilities and Emergency Department Utilization Among

High-Need High-Cost Patients

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Abstract

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Background

Primary care practices in the United States (US) are currently constrained in their ability to deliver high quality care due to population aging, insurance expansion, and an increasing prevalence of chronically ill patients. The nurse practitioner (NP) workforce plays a critical role in meeting the growing demands for primary care, particularly in rural and underserved areas. NPs are also more likely to deliver care to clinically and socially complex populations such as high-need high-cost (HNHC) patients. HNHC patients are adults who suffer from multiple chronic conditions and experience additional functional, behavioral, or socioeconomic needs. Despite comprising only 5% of the US population, HNHC patients account for nearly half of total health care expenditures and over 90% of Medicare expenditures. HNHC patients with behavioral health diagnoses such as depression or substance abuse face heightened challenges managing their conditions and consequentially have higher preventable spending and emergency department (ED) utilization compared to the overall HNHC population.

Significant policy attention has been placed on enhancing primary care practices as a strategy to improve outcomes and reduce costs in HNHC patients. Structural capabilities are features of primary care practices (e.g., after-hours care or care coordination) which are needed to deliver high quality primary care and chronic disease management. Yet, to date little research has been done on structural capabilities in primary care practices where NPs deliver care to

HNHC patients. *The overall purpose of this dissertation is to understand how to enhance primary care delivery and structural capabilities to improve outcomes for HNHC patients.* We have achieved the following specific aims: (1) Establish a clear definition of HNHC patients, (2) Identify existing primary care and payment models used among HNHC patients and evaluate their impact on ED utilization and costs, (3) Evaluate structural capabilities in NP primary care practices located in Health Professional Shortage Areas (HPSAs), and (4) Analyze the association between NP practice structural capabilities and ED utilization among HNHC patients with behavioral health conditions.

Dissertation Chapters and Key Findings

Chapter One includes an introduction to the landscape of current primary care delivery, the role of the NP workforce in expanding access, and the unique challenges of delivering care to HNHC patients. This chapter also discusses the conceptual framework guiding the dissertation, the specific aims of each study, and how each study will fill a gap in the literature.

Chapter Two (Aim 1) consists of a concept analysis of HNHC patients using the Walker and Avant framework. Three subgroups of HNHC patients were identified: adults over the age of 65 who suffer from multiple chronic conditions with functional or behavioral health needs, the frail elderly, and patients under 65 years old with a serious mental health condition or disability. Antecedents that predispose an individual to becoming a HNHC patient include challenges accessing timely care, low socioeconomic status, or unmet needs. Persistent high spending occurs as a result of poorly managed chronic diseases leading to acute exacerbations, preventable health service utilization, and fragmented care between the acute and primary care settings.

Chapter Three (Aim 2) is a systematic review of studies conducted from 2000-2020 on primary care and payment models used with HNHC patients. About half of the primary care

models evaluated in the systematic review (11 out of 21 studies) showed no significant difference in ED utilization among HNHC patients. Care coordination and care management (15 out of 21 studies) demonstrated both positive and negative associations with ED utilization and costs. Primary care models that demonstrated significant reductions in ED utilization had shared features, including frequent follow-up, multidisciplinary team-based care, enhanced access, and care coordination.

Chapter Four (Aim 3) includes a cross-sectional study of NP survey data from 2018-2019 on practice structural capabilities linked with data on primary care shortages (i.e., HPSA designation). Bivariate analyses and multivariable regression models were used to compare NP characteristics and structural capabilities in HSPA practices compared to non-HPSA practices. The majority of NPs in our sample (61%) delivered care in HPSA practices. NP practices located in HPSAs were significantly more likely to deliver care coordination compared to non-HPSA practices. We found no significant difference in prevalence of registries, after-hours care, or shared communication systems.

Chapter Five (Aim 4) is a study of cross-sectional NP survey data from 2018-2019 on practice structural capabilities linked with Medicare Part A and Part B claims to identify HNHC patients and ED utilization. Multivariable Poisson models were used to estimate the association between ED utilization and structural capabilities in practices serving HNHC patients with behavioral health conditions including depression, alcohol use, and substance use disorder. Care coordination was associated with decreased rates of ED utilization among the overall HNHC population and those with alcohol use, but not among HNHC patients with depression or substance use disorders. Shared communication systems were associated with decreased rates of

all-cause and preventable ED utilization among HNHC patients with alcohol use and substance use disorders.

Chapter 6 is a summary of findings across studies in this dissertation and will present the strengths, limitations, and contributions to science. This chapter will also discuss implications for policy, practice, and directions for future research.

Conclusion

HNHC patients face complex and wide-ranging medical, social, and behavioral health needs resulting in poor clinical outcomes and high costs. Enhancing primary care is an urgent goal for policymakers to improve disease management while reducing overall costs of care. Findings from these studies demonstrate that NPs practice in underserved areas and are significantly more likely to deliver care coordination in HPSA practices and to HNHC patients with behavioral health conditions. Care coordination has the potential to increase effectiveness of primary care delivery by tailoring models to target specific HNHC patients. Shared communication systems also show promise for improving primary care delivery and reducing ED utilization among HNHC patients with alcohol use and substance use disorders. Future research should continue to explore how structural capabilities may enable NPs to deliver timely, high quality, cost-effective primary care for HNHC patients.

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List of Acronyms

ACRONYM	FULL NAME
ACOs	Accountable Care Organizations
AHRQ	Agency for Healthcare Research and Quality
aRR	Adjusted Rate Ratio
AZ	Arizona
CI	Confidence Interval
ED	Emergency Department
HPSA	Health Professional Shortage Area
HNHC	High-Need High-Cost
HRSA	Health Resources & Services Administration
PCMH	Patient-Centered Medical Home
PI	Primary Investigator
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
MeSH	Medical Subject Headings
NP	Nurse Practitioner
OR	Odds Ratio
PA	Physician Assistant
PCMH	Patient-Centered Medical Home
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SD	Standard Deviation
SCI	Structural Capability Index
US	United States
WA	Washington

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Dedication

To emergency department nurses,

It has been a joy to study the work you do and to do it alongside you.

Chapter 1: Introduction

1.1 Background

Focusing on High-Need High-Cost Patients

Rates of multimorbidity in the United States (US) have risen to epidemic proportions specifically among older adults, affecting 81% of Americans 65 years and older (Buttorff et al., 2017). Caring for patients with multimorbidity takes up the vast majority of health care expenditures in the US and is responsible for over 90% of Medicare spending (Centers for Medicare & Medicaid Services, 2018; Thorpe et al., 2015). Given soaring health care costs accounting for nearly one-fifth of the US economy (Martin et al., 2019), health systems and policymakers have been eager to identify strategies to improve patient outcomes while increasing savings. Particular policy attention has been placed on the small subset (5%) of the US population, known as high-need high-cost (HNHC) patients, who account for nearly half of all health care expenditures (Long et al., 2017; Zodet, 2016).

HNHC patients are adults suffering from multiple (at least two) chronic conditions with additional functional, behavioral health, or socioeconomic needs such as social isolation, housing instability, or food insecurity (Long et al., 2017; Ryan et al., 2016). Chronic and overlapping medical and behavioral health conditions in HNHC patients contribute to poor disease management, high health service utilization, and subsequent higher mortality – 7.1 times higher compared to other Medicare beneficiaries (Bélanger et al., 2019). Primary care is an ideal point of intervention for HNHC patients with a strong evidence base and the potential to scale interventions across practices. Indeed, redesigning traditional primary care delivery is

emphasized as a strategy to improve ongoing chronic disease management and increase savings in HNHC patients (Blumenthal, Chernof, et al., 2016; Hochman & Asch, 2017).

The primary care setting enables patient-centered chronic disease education, continuous assessment, and multidisciplinary care teams which can address the wide-ranging behavioral health and socioeconomic needs of HNHC patients (Long et al., 2017). However, HNHC patients often experience barriers to high quality primary care which drive frequent and primary care treatable emergency department (ED) utilization due to challenges obtaining timely appointments, inadequate care coordination between providers, and lack of support with activities of daily living (Hayes, Salzberg, et al., 2016; Ryan et al., 2016). HNHC patients are three times more likely to use the ED compared to the general adult population (Hayes, Salzberg, et al., 2016). With an additional behavioral health diagnosis, HNHC patients experience even greater challenges obtaining timely appointments and high quality primary care and as a result make 27% more ED visits per year compared to HNHC patients without a behavioral health condition (Hayes, Mccarthy, et al., 2016).

Frequent ED utilization is harmful in older adults – the majority of HNHC patients – resulting in higher risks of readmission, inappropriate medication prescriptions, and 30-day mortality (Hastings et al., 2007; McCusker et al., 2009; Pines et al., 2013). However, recent interventions aimed to reduce costs and utilization in HNHC patients have yet to achieve sustainable differences. For example, over the past decade Medicare invested in six major disease management programs aimed at HNHC patients, demonstrating no effect on average on hospital admissions or expenditures (Nelson, 2012). In a recent national study of HNHC patients attributed to Accountable Care Organizations, care management and care coordination services did not make any statistically significant differences on quality, utilization, or spending

(Ouayogodé et al., 2019). Additionally, intensive primary care programs implemented with HNHC patients in Veterans Affairs medical homes and in HNHC patients with diabetes have not shown any significant reductions in acute care utilization or costs (Bui et al., 2019; Zulman et al., 2017). The results of these studies demonstrate the formidable challenge of sustainably reducing costs and utilization in HNHC patients and point to the urgent need for solutions to improve primary care delivery.

Optimizing the Nurse Practitioner Workforce

Challenges to providing high quality primary care for HNHC patients are further exacerbated by rapid growth in the demand for primary care services due to workforce shortages, population aging, and insurance expansion (Duchovny et al., 2017; IHS Markit, 2017; Raghupathi & Raghupathi, 2018). However, the nurse practitioner (NP) workforce has more than doubled from 2010-2017 (from 91,000 to 190,000) and is actively being deployed to meet the growing demands in primary care (Auerbach et al., 2020). Approximately 87% of NPs are certified to deliver primary care which has significant implications for expanding primary care access as well as improving care for HNHC patients (American Association of Nurse Practitioners [AANP], 2020). NPs are ideally suited to care for HNHC patients with complex and overlapping medical, behavioral, and social needs given their training in comprehensive and holistic care which emphasizes managing a patient's broad health needs as well as their social and emotional well-being (Grant et al., 2017). NPs are also more likely to care for Medicare beneficiaries with multiple chronic conditions – many of whom are HNHC (Fraze et al., 2020). In addition to supporting HNHC patients, the NP workforce is being increasingly used as a cost-effective strategy to expand high quality primary care access in rural areas experiencing primary care workforce shortages, known as Health Professional Shortage Areas (HPSAs).

Currently, 80 million Americans live in HPSAs and experience increased challenges accessing adequate primary care (*Designated HPSA Statistics*, 2020). Patients residing in HPSAs have a higher prevalence of chronic illness including diabetes, hypertension, obesity, and smoking compared to patients not living in these areas (Allen et al., 2011). NPs are poised to improve primary care delivery in HPSAs for patients whose chronic medical needs are exacerbated by limited primary care access and socioeconomic barriers to obtaining care such as education, housing, or transportation needs (Streeter et al., 2020). Indeed, compared to physicians, NPs are more likely to reside and practice in HPSAs in states with full scope of practice regulation where NPs can independently evaluate, diagnose, interpret tests, and treat patients (AANP, 2021; DePriest et al., 2020; Xue et al., 2018).

The Role of Primary Care Practice Structural Capabilities

The primary care setting enables opportunities for focused interactions with patients and families, time with care coordinators, and ongoing interactions which can support better care for complex HNHC patients and patients residing in HPSAs (G. F. Anderson et al., 2015). Considerable evidence exists describing the role of NPs in the primary care setting (Grant et al., 2017). Yet, little is known about the practice features or infrastructure (i.e., structural capabilities) used by NPs to enhance primary care delivery such as extended practice hours, reminders for provider workflows, or care coordination (Burton et al., 2020; Friedberg et al., 2010; Martsolf, Ashwood, et al., 2018). Chronically ill patients residing in HPSAs and complex HNHC patients may specifically benefit from the use of structural capabilities used to expand access to timely care and support providers deliver chronic care.

Structural capabilities are associated with improved patient and provider outcomes including improved patient appointment and medical compliance (Schwebel & Larimer, 2018),

outcomes for diabetes (Orzano et al., 2007; K. A. Peterson et al., 2020), workplace climate (Martsolf, Ashwood, et al., 2018), job satisfaction (Lewis et al., 2012), enhanced care in vulnerable neighborhoods (Friedberg et al., 2010), and reduced spending and hospital admissions (Burton et al., 2020). For example, chronic disease registries which are used to remind patients who are due for appointments or disease management have been shown to improve chronic disease outcomes and help practices achieve optimal standards of care (Burton et al., 2020; Hoque et al., 2017). After-hours care which extends practice hours into late evening and on the weekend enables patients to obtain timely primary care is associated with reduced ED utilization, lower expenditures, and lower rates of unmet medical needs (Jerant et al., 2012; O'Malley, 2013). Additionally, care coordination is a widely implemented model used to integrate patient care and resources across the health care spectrum. Care coordination is associated with lower medical expenditures and inpatient hospitalizations (Powers et al., 2020) and lower ED visits and 30-day readmission rates (Berkowitz et al., 2018).

Furthermore, many of the structural capabilities that demonstrate positive patient outcomes are also interventions or infrastructure that HNHC patients themselves report would be useful. Recent qualitative research asking HNHC patients to identify solutions to prevent overuse or nonurgent ED visits include the use of after-hours care, care management, and reminders for appointments and disease management activities (Ryan et al., 2016; Tanmoy Das et al., 2021). These findings indicate that HNHC patients have specific preferences for care which they believe can impact the quality of disease self-management and decision to make an ED visit. Yet, it is unclear if primary care practices have been restructured to implement structural capabilities which can better support the complex needs and preferences of HNHC patients.

This dissertation produces much needed evidence on the structural capabilities of primary care practices where NPs deliver care to underserved and HNHC populations. Findings from these studies can contribute to a growing body of knowledge on how NPs and their teams and practices may enhance primary care delivery for their most clinically and socially complex patients. Included in this dissertation is a concept analysis defining HNHC patients, a systematic review evaluating existing primary care models used to serve HNHC patients, an exploration of the structural capabilities implemented in underserved (i.e., HPSA) areas, and an analysis of the relationship between structural capabilities and ED utilization among HNHC patients with behavioral health conditions. These studies investigate four specific structural capabilities: care coordination, after-hours care, chronic disease registries, and shared communication systems. Table 1.2 outlines the corresponding survey items for each structural capability.

1.2 Overall Aim

The overall purpose of this dissertation is to understand how to enhance primary care delivery and structural capabilities to improve outcomes for HNHC patients. This dissertation follows the published papers format option. Chapter 2-5 were developed as independent manuscripts prepared for journal publication. Chapter 2 entitled "High-Need High-Cost Patients: A Concept Analysis" was published in *Nursing Forum* (2020). Chapter 3 entitled "A Systematic Review of Primary Care and Payment Models on Emergency Department Use in Patients Classified as High Need, High Cost" was published in the *Journal of Emergency Nursing* (2021). Chapter 4 entitled "Primary Care Practice Structural Capabilities in Health Professional Shortage Areas" is accepted for publication in the *American Journal for Managed Care.* Chapter 5 entitled "Analyzing Structural Capabilities and Emergency Department Utilization Among High-Need

High-Cost Patients with Behavioral Health Conditions" will be submitted in *Health Affairs.* The

Institutional Review Board of Columbia University approved this dissertation work.

1.3 Specific Aims and Study Designs

This dissertation includes six chapters with four distinct aims outlined in Table 1.

Aim 1 (Chapter 2): Establish a clear definition of HNHC patients.

>*Study Design:* Concept Analysis using Walker and Avant's (2019) framework.

Aim 2 (Chapter 3): Identify existing primary care and payment models used among HNHC

patients and evaluate their impact on ED utilization and costs.

>*Study Design:* Systematic review of literature from 2000-2020 using the Preferred

Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Aim 3 (Chapter 4): Evaluate structural capabilities in NP primary care practices in HPSAs.

>*Study Design:* Secondary analysis of cross-sectional NP survey and health care

workforce data from 2018-2019 using bivariate analyses and multivariable regression models.

Aim 4 (Chapter 5): Analyze the association between structural capabilities and ED utilization

among HNHC patients with behavioral health conditions.

>*Study Design:* Secondary analysis of cross-sectional NP survey and Medicare claims data

from 2018-2019 using bivariate analyses and multivariable Poisson models.

1.4. Conceptual Framework

The Andersen Model of Health Service Utilization provides the conceptual underpinning

for this dissertation (Andersen, 1995). The Andersen Model identifies *predisposing*, *enabling*,

and *need* factors that may influence a person's health service utilization and has been adapted for

the purposes of this dissertation (Figure 1.1). *Predisposing factors* refer to the biologic or social

characteristics which may predispose someone to use health services such as education,

ethnicity, or social relationships (i.e., age, sex, race, HPSA Designation, or rural/urban setting). *Enabling factors* consist of organizational, financial, or structural attributes that may enable or impede an individual from health service use including insurance, having a usual source of care, or the availability of resources. In these studies, enabling factors are primary care practice structural capabilities which may enable or impede ED utilization (i.e., after-hours care, care coordination, shared communication systems, and chronic disease registries). *Need* is defined as how an individual perceives their own health and the actual health status and need for medical care of an individual. This dissertation uses medical and behavioral health conditions as an indicator of health status (i.e., number and type of medical and behavioral health conditions). The Andersen Model of Health Service Utilization was adapted for the purposes of this dissertation to focus on the relationship between predisposing, enabling, and need factors and the health behavior of ED utilization. Models adjusted for a patient's age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and whether the practice is in a rural, urban, or underserved location.

1.5 Gaps and Potential Contributions

Chapter Two: Considerable variation exists across the demographics, comorbidities, disease severity, spending, and utilization patterns of HNHC patients (Clough et al., 2016; Joynt et al., 2017). Lack of consensus on the definition of HNHC patients challenges the ability to effectively identify HNHC patients and synthesize findings across studies. This concept analysis fills the literature gap by providing a comprehensive definition of HNHC patients and describing their attributes and defining features.

Chapter Three: Improving chronic care and decreasing persistent high costs in HNHC patients is an urgent priority for policymakers and health system administrators (Blumenthal,

Chernof, et al., 2016). Prior to this dissertation no review existed evaluating primary care-based interventions applied to the HNHC population. This study is a systematic review to identify current primary care and payment models serving HNHC patients and evaluate their impact on ED utilization. These findings can inform development and implementation of future interventions by identifying the most effective models for HNHC patients.

Chapter Four: The NP workforce is increasingly being deployed to support primary care delivery in underserved areas. While NPs are more likely to deliver care in HPSA designated practices, little is known about how NP practices have been restructured to serve HPSA populations who experience heightened socioeconomic challenges and high rates of morbidity. Exploring NP practices located in HPSAs can shed light on the capacity of NPs to expand high quality primary care in underserved areas.

Chapter Five: This study produces new knowledge on how primary care practices may be restructured to enhance primary care delivery for HNHC patients with behavioral health conditions. Focusing on HNHC patients with behavioral health conditions may help substantially reduce spending as they have higher-than-average rates of preventable spending, higher rates of ED visits, and are more likely to remain in the top 10% of spending over two year compared to the overall HNHC population (Hayes, Mccarthy, et al., 2016; Powers et al., 2019). Additionally, exploring structural capabilities is beneficial as they are modifiable features of a primary care practice and, if found to be successful, have the potential to scale adoption.

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1.6 Addressing Nursing Priorities

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This timely dissertation directly addresses multiple recommendations in the recently released National Academy of Medicine report, *The Future of Nursing 2020-2030: Charting a Path to Achieve Healthy Equity* (2021). The main focus of the report addresses the critical role of

the nursing workforce in achieving health equity at both the individual level (e.g., patient education and disease management) and the structural level (e.g., implementing care coordination). Specifically, the report recommends deploying the growing NP workforce to expand primary care in HPSAs, enhance care for patients with behavioral health conditions, and improve care coordination models. The studies in this dissertation directly align with these recommendations and provide evidence to support the expansion of the NP workforce and inform how the infrastructure of primary care practices may be modified to improve care for complex and costly populations.

1.7 IRB Approval

This dissertation work includes one concept analysis, one systematic review, and two studies using secondary data obtained from a larger study (L. Poghosyan, R01MD011514). Researchers from the parent study obtained approval from the Institutional Review Board at Columbia University. De-identified data was subsampled and maintained on secure networks within Columbia University School of Nursing. These studies pose minimal human subjects risk given the use of de-identified data without any required contact with human subjects (i.e., NPs or Medicare beneficiaries). The content is solely the responsibility of the author.

1.8 Conclusion

Enhancing primary care is an urgent goal for policymakers to improve outcomes while reducing costs in HNHC patients. This timely study is directly related to national priorities to leverage the NP workforce in expanding access and quality of primary care delivery (National Academy of Medicine, 2021). Findings from this dissertation fill a critical gap in the evidence on NP primary care practices and can provide evidence needed to make actionable policy recommendations to guide primary care practice redesign.

Table 1.1

Dissertation Chapters, Titles, Aims, and Study Designs

Chapter	Title	Aims	Study Design
2	High-Need High-Cost Patients: A Concept Analysis	Establish a clear definition of HNHC patients	Concept Analysis
3	A Systematic Review of Primary Care and Payment Models on Emergency Department Use in Patients Classified as High Need, High Cost	Identify existing primary care and payment models used among HNHC patients and evaluate their impact on ED utilization and costs.	Systematic Review
4	Primary Care Practice Structural Capabilities in Health Professional Shortage Areas	Evaluate structural capabilities in NP primary care practices in HPSAs	Bivariate Descriptive and Multivariable Logistic Regression Models
5	Primary Care Practice Structural Capabilities and Emergency Department Utilization Among High-Need High-Cost Patients with Behavioral Health Conditions	Analyze the association between structural capabilities and ED utilization among HNHC patients with behavioral health conditions	Bivariate Descriptive and Multivariable Poisson models

Note. HNHC: high-need high-cost, ED: emergency department, NP: nurse practitioner, HPSA: Health

Professional Shortage Areas

Table 1.2

Structural Capabilities and Corresponding Survey Items

After-Hours Care

How many nights per week is your practice open for patient visits during extended evening hours?

Is your practice setting regularly open to provide care on Saturdays or Sundays?

Care Coordination

Does your practice have designated staff for care management services and/or care coordination? If yes, which of the following are provided:

    Creating and managing patient problem lists

    Providing resources to assist self-management of symptoms, conditions, and medications

    Medication management and reconciliation

    Helping patients access community and social services

    Helping patients schedule appointments

    Coordinating care between clinicians, hospitals, pharmacists, labs, insurance companies, and imaging services

Shared Communication Systems

Do clinicians at your practice use a shared communication system to contact patients:

    Who are due for guidelines recommended for chronic conditions?

    After a hospitalization?

    Who have not had an appointment for an extended period?

Chronic Disease Registry

Does your practice have a registry that creates a list of patients who are overdue for their chronic disease services (e.g., hemoglobin A1c in diabetes; cholesterol in coronary artery disease)?

Figure 1.1

Adapted Andersen Model of Health Service Utilization (Andersen, 1995)
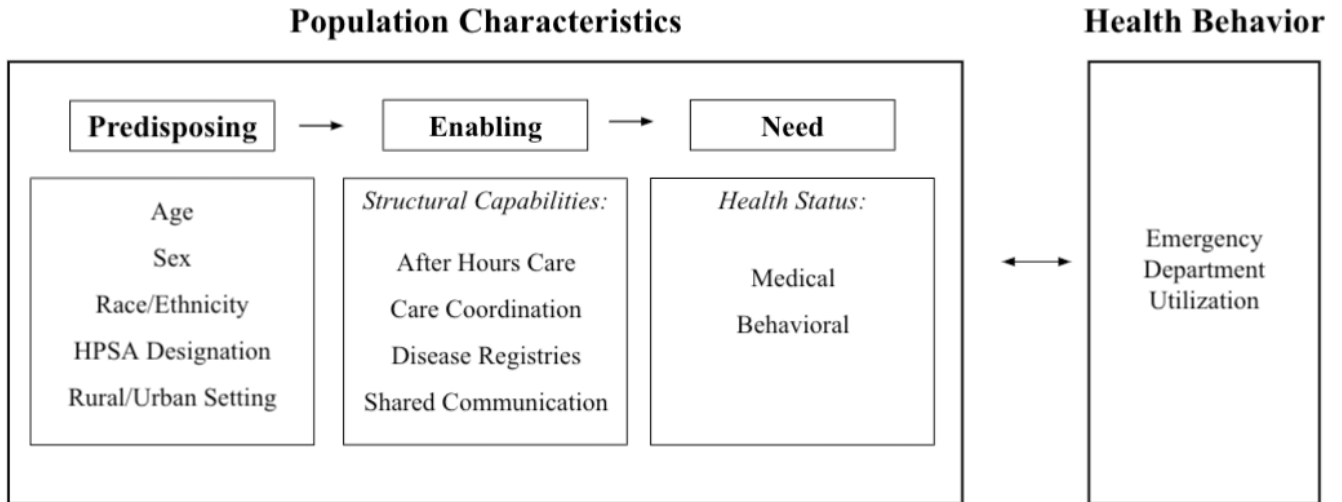
Chapter 2: High-Need High-Cost Patients: A Concept Analysis

Note. Chapter 2 is a manuscript accepted for publication as is in Nursing Forum. The published version is included in Appendix G. It is now published as:

2.1 Abstract

Aim: To develop a conceptual understanding of high-need high-cost (HNHC) patients.

Background: HNHC patients are variously defined in the literature as the small subset of patients accounting for the majority of US health care costs. Interventions aimed to reduce costs and improve disease management have been challenged by lack of consensus on the definition and attributes of HNHC patients.

Design: Concept Analysis

Data Sources: Literature review of 2 databases (PubMed and CINAHL) and hand-searching through websites and relevant health services journals to identify uses of the concept.

Review Methods: The Walker and Avant method of concept analysis

Results: HNHC patients are categorized by a feedback loop of acute health conditions, preventable health service utilization, and fragmented care. Antecedents that predispose becoming a HNHC patient include challenges accessing timely care, low socioeconomic status, unmet support, and social factors such as isolation and inadequate access to housing. Consequences of being a HNHC patient include poor clinical outcomes, increased risk of mortality, and persistent high spending.

Conclusions: Reducing preventable health service utilization in HNHC patients is a point of focus for health systems and policymakers as a means of reducing overall costs. This concept analysis can inform future research and interventions aimed to improve care delivery for this costly and chronically ill population.

2.2 Background

Healthcare costs are rapidly increasing across the United States (US) and are particularly concentrated to a small subset of the population known as high-need high-cost (HNHC) patients (Long et al., 2017; Zodet, 2016). HNHC patients are referred to as adults suffering from costly and chronic medical and behavioral health conditions (Hayes, Salzberg, et al., 2016; Long et al., 2017). Compared to the average US adult, HNHC patients spend more than twice as much on out-of-pocket expenses and nearly four times as much on overall health care services and medication, exceeding $21,000 for average annual per-person spending (Hayes, Salzberg, et al., 2016; Long et al., 2017). Yet, interventions aimed to control costs and reduce unnecessary health care utilization in this population have proved largely ineffective (Bleich et al., 2015; Boult et al., 2011; Coleman et al., 2002; Powers et al., 2020; Weppner et al., 2018), likely due to lack of consensus on the definition and characteristics of HNHC patients (Bleich et al., 2015; Blumenthal, Chernof, et al., 2016).

While HNHC patients are often referred to as the 5% of the population who account for the majority of overall US health care costs, significant heterogeneity exists in the definition of HNHC patients with regard to age, comorbidities, disability, and social needs (Keeney et al., 2019; Long et al., 2017). Additionally, many common characteristics used to describe HNHC patients are implied rather than explicitly stated which can further exacerbate challenges in identifying this population and developing sustainable interventions (Long et al., 2017). Further, defining the specific attributes of HNHC patients is essential as this population will likely expand as the US increases in numbers of older and chronically ill adults (Chamberlain et al., 2019; Coughlin & Long, 2009; Stanton & Rutherford, 2006).

The purpose of this concept analysis is to establish a clear definition of HNHC patients using Walker and Avant's (2019) framework. This analysis will provide defining attributes and cases to provide a comprehensive definition of HNHC patients that can inform future research and intervention development.

2.3 Methods

The concept of HNHC patients was analyzed using Walker and Avant's framework which includes (a) determining the aim of analysis, (b) identifying all uses of the concept, (c) determining the defining attributes, (d) constructing a model and alternative cases, (e) identifying antecedents and consequences, and (f) defining empirical referents (Walker & Avant, 2019).

Data Sources

A review of the literature was conducted in October 2019 to identify current uses of the concept and determine defining attributes. Two databases were search (PubMed and CINAHL) with no date restrictions, as well as Google Scholar, Scopus, the Commonwealth Fund, and the Agency for Healthcare Research and Quality. Search terms included *high-need, high-cost, high-need high-cost, high-risk,* and *high utilizer*. The search strategy was not limited to nursing and medical literature as to not bias the true nature of the concept (Walker & Avant, 2019). Searches were limited to studies written in English and conducted within the United States. Additional hand searching was performed by reviewing relevant editorial articles, websites, and health services journals such as *Health Affairs*, *The American Journal of Managed Care*, and *Preventing Chronic Disease*. Broad searching strategies were utilized to evaluate all uses of the concept. To be eligible, articles must have included information relating to the defining attributes or antecedents of the concept such as demographic characteristics, medical diagnoses, or psychosocial needs. After searching the literature, 23 articles were included and critically

reviewed to inform an understanding of the uses of the concept, key attributes, and model and borderline cases of HNHC patients.

2.4 Results

Uses of HNHC Patients

Existing healthcare literature primarily uses HNHC patients as an overarching concept which includes a variety of patient ages, demographics, and medical and social needs. These patients fall into three subgroups: (a) patients with multiple chronic conditions and functional disability, (b) the frail elderly, and (c) patients under 65 years old with a disability or a behavioral health condition.

Multiple Chronic Conditions and Functional Limitations

Patients suffering from multiple (≥ 2) chronic conditions in addition to having a functional limitation make up the largest subgroup of HNHC patients. Functional limitations are defined as difficulty with at least one activity of daily living (ADL) such as eating, bathing, dressing, toileting, or climbing stairs (Hayes, Salzberg, et al., 2016). Patients with both multiple chronic conditions and functional limitations have higher health service utilization, higher spending, and poorer overall health compared to chronically-ill adults without any functional limitation (Hayes, Salzberg, et al., 2016; Ryan et al., 2016). This group is largely identified as adults over the age of 65 who are insured by Medicare or are dually-eligible for Medicaid (Blumenthal, Chernof, et al., 2016; Chamberlain et al., 2019; Hayes, Salzberg, et al., 2016). The most frequent chronic conditions stated explicitly in the literature for HNHC patients include hypertension, coronary artery disease, congestive heart failure, diabetes, asthma, and chronic obstructive pulmonary disease (Bailey et al., 2019; Figueroa et al., 2019; Long et al., 2017).

Frail Elderly

Patients who are identified as frail elderly often have multiple functional limitations, memory disorders (e.g. dementia), or require long-term support services to live independently (McCarthy et al., 2015). Frailty indicators most often used to define the frail elderly subgroup of HNHC patients include gait abnormality, malnutrition, failure to thrive, cachexia, history of fall, and presence of a decubitus ulcer (Joynt et al., 2017; Kim & Schneeweiss, 2014; Long et al., 2017). The frail elderly account for the highest percentage of preventable spending and require interventions that are unique from other older adults addressing social needs, home support, and long term services (Figueroa et al., 2017; McCarthy et al., 2015).

Under 65 years old with Disability or Behavioral Health Conditions

This subgroup consist of younger adults with behavioral health conditions such as serious mental illness or disability who are often insured by Medicaid due to lower income or may be dually-eligible for Medicaid and Medicare due to disability (Long et al., 2017; Ryan et al., 2016). Younger adults have significant differences in quality of life, disability, and access to care compared to older adults (Adams, 2017; Okoro et al., 2018). Thus, segmenting younger adults allows for tailored interventions that may address the unique needs that come along with younger age such as resources needed in the school environment, social stressors, or lack of autonomy or health literacy.

Defining Attributes

Defining attributes are characteristics that are most frequently associated with the concept used to describe its true meaning and differentiate it from similar concepts (Walker & Avant, 2019). The concept of HNHC patients is new and without one standardized definition (Long et al., 2017). Further, characteristics of HNHC patients are often implied in the literature and not fully explicated, such as preventability of health service use. This concept analysis uncovered

both the implied and explicitly stated characteristics of HNHC patients: (a) acute-on-chronic health condition, (b) health service use, (c) fragmented care, and the existence of a (d) feedback loop. These characteristics apply to all subgroups.

Acute-on-Chronic Health Condition

An acute-on-chronic health condition differs from ongoing health needs as it is an acute onset of a chronic condition, also known as an acute exacerbation. Evidence surrounding HNHC patients demonstrates that acute-on-chronic health conditions are the major drivers of health services use, and thus, start the cause-and-effect system of the feedback loop (Schamess et al., 2017). HNHC patients often experience acute exacerbations as a result from inadequate disease management, social stressors (e.g., isolation or lack of housing), or poor care coordination (G. Anderson & Horvath, 2004; Long et al., 2017). An acute health condition can include exacerbations related to a chronic medical or behavioral health condition (Long et al., 2017).

Preventable Health Service Utilization

HNHC patients have the highest rates of health service utilization across the outpatient and inpatient settings often resulting from acute exacerbations (Figueroa et al., 2019; Hayes, Salzberg, et al., 2016; Ryan et al., 2016). HNHC are three times more likely to visit the emergency department (ED) and two times more likely to be hospitalized compared to the general adult population (Bélanger et al., 2019; Hayes, Salzberg, et al., 2016). Existing literature demonstrates varying rates (approximately 20-40%) of ED visits made by HNHC patients are preventable, often due to challenges with obtaining timely and routine primary care (Figueroa et al., 2017; Hayes, Salzberg, et al., 2016; Ryan et al., 2016). Studies also suggest that health service utilization in this population may be amenable to change with improvements in disease management or outpatient care coordination (Joynt et al., 2013; Long et al., 2017). Thus, a

defining attribute of HNHC patients is health service use that is either emergent but preventable or primary care treatable.

Fragmented Care

Fragmented care is defined as care that is poorly coordinated among multiple providers and organizations due to ineffective communication, incompatible electronic health records, or inadequate discharge education (G. Anderson & Horvath, 2004; Frandsen et al., 2015; K. Peterson et al., 2013). Fragmented care often occurs between primary and specialty providers or between the acute and primary care settings (Hayes, Salzberg, et al., 2016; Rust et al., 2008). HNHC patients across all subgroups can experience fragmented care across social, behavioral, and health care services (Long et al., 2017; Ryan et al., 2016). Finally, fragmented care can lead to inadequate disease management and subsequent adverse effects such as medication errors or redundant care (Frandsen et al., 2015)*.*

Feedback Loop

A feedback loop is a process where inputs lead to downstream reactions causing a nonlinear cause-and-effect relationship (Diaz et al., 2012). The feedback loop is a defining attribute as it represents the relationship between an acute health condition, preventable health service utilization, and care fragmentation. Existing research implies the existence of a feedback loop by demonstrating how reducing fragmentation can impact health service utilization in HNHC patients (Hardin et al., 2017). One quasi-experimental study found that enhanced care coordination (i.e., discharge planning, follow-up appointments, and education) led to a 39% reduction in ED visits, 25% reduction in hospitalizations, and a 79% reduction in 30-day readmissions in HNHC patients (Bailey et al., 2019).

Similar research exists demonstrating that interventions focused on integrating health and behavioral resources (reducing fragmentation) can improve medication and disease management, prevent acute exacerbations, and reduce preventable health service utilization (Bailey et al., 2019; Blumenthal, Chernof, et al., 2016; Coleman et al., 2006; Frandsen et al., 2015; Joynt et al., 2013). These findings validate the existence of a feedback loop by demonstrating the relationship between fragmented care, acute health conditions, and preventable health service utilization.

Antecedents

Antecedents are defined as events that occur or characteristics that exist prior to becoming a HNHC patient (Walker & Avant, 2019). Antecedents of HNHC patients include challenges accessing timely care, low socioeconomic status, unmet support, and social factors such as isolation and inadequate access to housing. While the vast majority (80%) of HNHC patients have insurance (Hayes, Salzberg, et al., 2016), many report challenges accessing care after-hours, receiving a same-day answer to medical concerns, or obtaining timely care and information (Long et al., 2017; Ryan et al., 2016). HNHC patients are more likely to be low income and subsequently cite cost-related barriers to accessing care or managing their chronic conditions, such as difficulty affording medication (Bailey et al., 2019; Long et al., 2017; Ryan et al., 2016).

HNHC patients also have unmet needs either with their medical care (i.e. difficulty obtaining medication), ADLs (i.e., lack of needed support with bathing or feeding), or other needs related to obtaining housing or nutritional food (Beach et al., 2018; Long et al., 2017; Ryan et al., 2016). Patients with unmet needs are more likely to have acute exacerbations of ongoing medical or behavioral conditions and frequent hospitalizations and ED use (Beach et al., 2018; Keeney et al., 2019; Ryan et al., 2016). HNHC patients also have high rates of

psychosocial factors such as isolation and mental illness which are found to worsen medical conditions and lead to higher health service use and mortality rates (DuGoff et al., 2019; Manemann et al., 2018; Ryan et al., 2016).

Consequences

Consequences are defined as outcomes that occur as a result of being a HNHC patient (Walker & Avant, 2019). Presence of a feedback loop allows for consequences occurring as a result of positive feedback (amplification of consequences) or negative feedback (reduction of consequences).

Positive Feedback Loop

In a state of positive feedback, HNHC patients have poor clinical outcomes, caregiver burnout, increased risk of mortality, and persistent high spending which drives up national healthcare expenditures (Chamberlain et al., 2019; Figueroa et al., 2019; Hayes, Salzberg, et al., 2016; Stanton & Rutherford, 2006). In positive feedback, fragmented care and high health service use can contribute to poor clinical outcomes including redundant health testing, polypharmacy, medication errors, and conflicting care plans (G. Anderson & Horvath, 2004; Bodenheimer, 2008; Dufour et al., 2019; Institute of Medicine, 2011). HNHC patients who suffer multiple acute health conditions and complex care needs are often burdensome for caregivers leading to high rates of stress, burnout, poor care, and neglect (Beach et al., 2018). Lastly, unlike acute and transient high costs due to short term conditions like a fracture or heart attack, HNHC patients remain high spenders over at least two years, leading to greater costs incurred by patients, health systems, and tax payers (Figueroa et al., 2019; Hayes, Salzberg, et al., 2016).

Negative Feedback Loop

In a negative feedback loop, patients have care that is well integrated between providers leading to decreased instances of acute exacerbations and preventable health service use (Bailey et al., 2019; Blumenthal et al., 2018; Harris et al., 2016). Effective care integration is also associated with improved clinical outcomes, management of ongoing conditions, and reduced caregiver burnout (Garnett et al., 2018; McCarthy et al., 2015). Recent studies demonstrate that health systems may increase overall savings with decreased preventable health service utilization (Berkowitz et al., 2018; Powers et al., 2020).

2.5 Empirical Referents

Empirical referents are categories that demonstrate the occurrence of the concept and are used to measure the defining attributes (Walker & Avant, 2019). When a concept is concrete (e.g., preventable health service use) the empirical referents may be identical to the defining attributes. There are no tools currently used to measure or identify HNHC patients overall, however, there are empirical referents for specific defining attributes. Empirical referents for fragmented care, for example, include adverse clinical outcomes such as patients receiving duplicate testing or conflicting information, ineffective communication across providers such as providers lacking medical history, diagnostic testing, or not being informed about specialist care (Sarnak & Ryan, 2016). Additionally, multiple tools exist to measure patient perception of care coordination and fragmentation (Agency for Healthcare Research and Quality, 2016).

2.6 Presentation of Model and Alternative Cases

Model Case

Sarah is a 76-year-old woman presenting to the ED for the fifth time so far this year after recently being discharged for a congestive heart failure exacerbation. She complains of worsening shortness of breath, swollen ankles, fatigue, and stated that she tried to hold off

coming to the ED but couldn't reach her primary care provide by phone. Sarah waited three days for an appointment at her primary care office and tried to relieve her shortness of breath using her asthma inhaler in the meantime. She can't drive herself to the ED and knows that an ambulance service is covered by both her Medicare and Medicaid insurance, so she decides to call for one.

This model case illustrates all defining attributes of a HNHC patient in the subgroup of adults with multiple chronic conditions and functional disability. Sarah suffers from multiple chronic illnesses, has a functional limitation, and is dually eligible for Medicare and Medicaid insurance. She demonstrates high health service utilization due to acute exacerbations of her chronic condition. Sarah's difficulty contacting her provider is an antecedent of HNHC patients and also suggests that her ED visit may have been prevented with timely primary care intervention.

Borderline case

Anthony is a 93-year-old veteran who makes consistent visits to check to both his primary and specialty care providers. He sits down every Sunday and carefully sorts out his daily pills for hypertension, high cholesterol, diabetes, and atrial fibrillation. Anthony is an active gardener and golfer and can tell when his sugar is low, so he always packs a snack. He had not been hospitalized in nearly a decade but required admission last year for an emergency cholecystectomy. He spent two weeks in an acute care center and one month in a subacute rehabilitation facility during this period. He has stayed out of the hospital since.

A borderline case is one that contains most, but not all of the defining attributes (Walker & Avant, 2019). Anthony has many shared features of HNHC patients as an older adult with multiple chronic conditions and a frequent health service user. However, while Anthony did have

an acute health condition, it was not an acute exacerbation of a chronic condition nor was his health service use preventable. He also lacked many of the antecedents and consequences common to HNHC patients; he has adequate access to primary and specialty care, he has no unmet needs in terms of obtaining medications or ADLs, he has stable housing and a vibrant social life.

2.7 Discussion

The goal of this concept analysis was to provide a clear definition of HNHC patients and to identify both the implied and explicit defining attributes. The feedback loop in HNHC patients is validated by evidence demonstrating how effective care coordination (decreased fragmentation) can reduce acute health conditions and preventable health service utilization. There currently exist multiple health systems that are unable to share information across providers further perpetuating care fragmentation and adverse clinical outcomes such as medical errors, unnecessary testing, or duplicated care. Understanding the role of the feedback loop might enable the development of targeted interventions aimed at coordinating care transitions and exchanging information across providers.

Additionally, alternative payment delivery models such as accountable care organizations can provide incentives for health systems and providers to invest in long-term interventions. Both Medicaid and Medicare programs have implemented payment reforms in conjunction with specific cost-reduction targets to incentivize behavior change, track ongoing programs, and reimburse providers for activities needed for chronic disease management. These payment models demonstrate that it is feasible to reduce both out-of-pocket and overall costs incurred by health systems. Yet, more research is needed to understand how alternative payment models may be used to enhance disease management and reduce high spending in HNHC patients.

2.8 Limitations

This concept analysis was restricted in scope of search strategy. Relevant articles may have been missed during literature review and articles were excluded that were not written in English or conducted outside the US. While this concept analysis includes the most frequently identified defining attributes, it is not an all-inclusive summary. Many studies describing HNHC patients use claims data which may not accurately reflect complexity of comorbid conditions, socioeconomic status, health literacy, or caregiver competency. Only one qualitative study was found that interviewed HNHC patients and their caregivers to better understand their characteristics, functional needs, and adverse consequences of unmet support (Beach et al., 2018).

2.9 Conclusion

HNHC patients account for a large portion of national health care costs. This concept analysis identified three subgroups of HNHC patients: adults with multiple chronic conditions and functional disability, the frail elderly, and patients under 65 years old with a disability or behavioral health condition. HNHC patients are categorized by a feedback loop of acute-on-chronic health conditions, preventable health service utilization, and fragmented care which contributes to poor clinical outcomes, high spending, and increased mortality. This concept analysis can be used to inform the development of interventions targeted to distinct subgroups within the HNHC population.

Figure 2.1

Defining Attributes of High-Need High-Cost Patients.
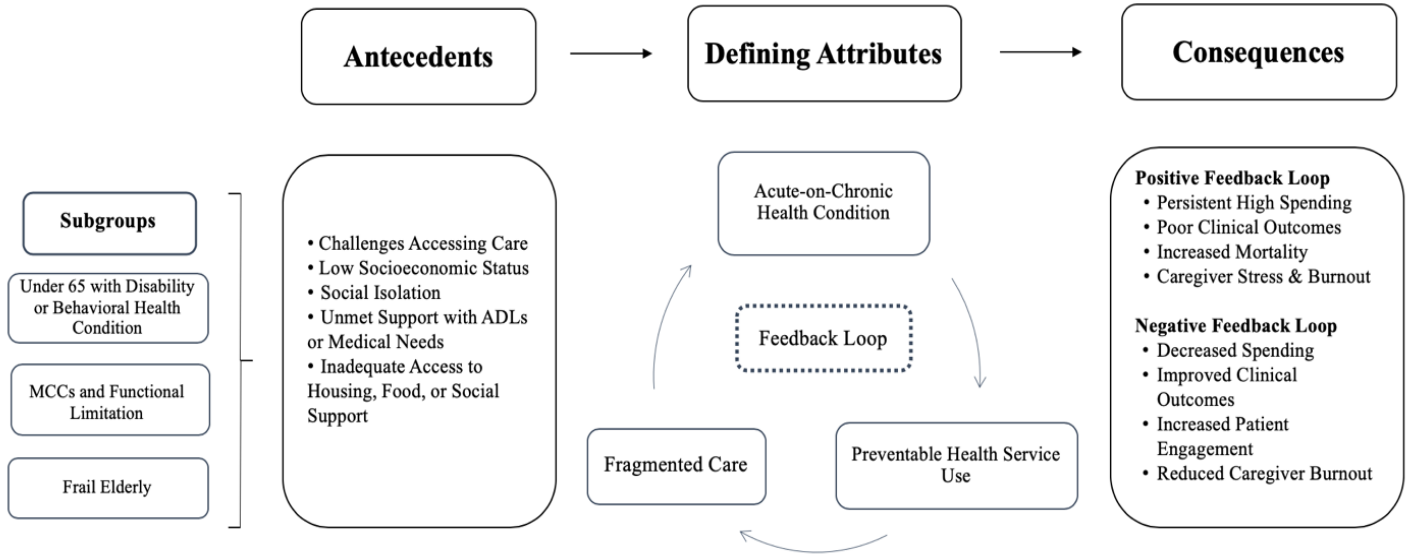
Note. This model demonstrates the defining attributes, antecedents, and consequences relating to

all subgroups of high-need high-cost patients. *MCC:* multiple chronic conditions, *ADLs:*

activities of daily living.

Chapter 3: A Systematic Review of Primary Care and Payment Models on Emergency Department Utilization in High-Need High-Cost Patients

3.1 Abstract

Purpose: Reducing costly and harmful emergency department (ED) utilization by high-need high-cost (HNHC) patients is a priority across health care systems. The purpose of this systematic review is to evaluate the impact of various primary care and payment models on ED utilization and overall costs in HNHC patients.

Methods: Using PRISMA guidelines, a search was performed from January 2000 to March 2020 in three databases. Two reviewers independently appraised articles for quality. Studies were eligible if they evaluated models implemented in the primary care setting and HNHC patients in the United States. Outcomes included all-cause and preventable ED utilization and overall health care costs.

Results: Of 21 articles included, four models were evaluated: care coordination (n = 8), care management (n = 7), intensive primary care (n = 4), and alternative payment models (n = 2). Statistically significant reductions in all-cause ED utilization were reported in 10 studies through care coordination, alternative payment models, and intensive primary care. Significant reductions in overall costs were reported in five studies and one reported a significant increase. Care management and care coordination models had mixed effects on ED utilization and overall costs.

Conclusions: Studies that significantly reduced ED utilization had shared features including frequent follow up, multidisciplinary team-based care, enhanced access, and care coordination. Identifying primary care models that effectively enhance access to care and improve ongoing chronic disease management is imperative to reduce costly and harmful ED utilization in HNHC patients.

3.2 Introduction

Emergency department (ED) utilization has been rising steadily across the United States (US) for the past thirty years (Sun et al., 2018; Tang et al., 2010). Recurrent ED use is responsible for high costs of care, ED crowding, adverse patient outcomes, and increased mortality (Kulstad et al., 2010; Morley et al., 2018; Van den Heede & Van de Voorde, 2016). Extensive evidence demonstrates the impact of crowding on ED nurses' ability to provide high quality care contributing to delays in antibiotic and analgesic administration, increased frequency of medication errors, and increased risk of stress and exposure to violence towards staff (Hunsaker et al., 2015; Morley et al., 2018). Frequent ED use is particularly harmful for high-need high-cost (HNHC) patients, the small subset (5%) of adults who account for the majority of US health care costs (Cohen et al., 2012; Long et al., 2017; Ryan et al., 2016).

HNHC patients are defined as adults suffering from multiple (at least 2) chronic conditions with additional functional limitation (e.g., difficulty bathing or feeding) or other complex psychosocial needs (e.g., frailty, mental illness, social isolation; Cohen et al., 2012; Long et al., 2017; Ryan et al., 2016). Due to high rates of multimorbidity, HNHC patients require ongoing and coordinated disease management between the primary and acute care settings (Hayes, Salzberg, et al., 2016; Long et al., 2017). Yet, many HNHC patients experience challenges accessing timely care or reaching their provider (Ryan et al., 2016). Consequentially HNHC patients are three times more likely to use the ED compared to the average US adult and more likely to have an ED visit categorized as preventable through timely and routine primary care (Hayes, Salzberg, et al., 2016; Long et al., 2017; Ryan et al., 2016). Thus, a HNHC patient, for example, might be a Medicare insured adult suffering from congestive heart failure, diabetes,

and obesity, who has visited the ED 3 times in the past month with worsening shortness of breath and lower extremity swelling after failing to reach her primary care provider for three days.

Frequent and discontinuous ED care threatens the effectiveness of ongoing outpatient disease management due to gaps in communication, inadequate discharge education, or poor care coordination between the acute and primary care settings (Clarke et al., 2017; Engel et al., 2012). Health systems are eager to identify strategies that effectively improve primary care delivery for HNHC patients in order to reduce subsequent ED utilization (Blumenthal, Anderson, et al., 2016). Specific primary care models that expand accessibility to care and improve care coordination have been shown to reduce ED utilization (Lowe et al., 2005; O'Malley, 2013; Rust et al., 2008). For example, after-hours care (e.g., access to evening and weekend hours) is associated with lower all-cause and non-urgent ED use (Jerant et al., 2012; O'Malley, 2013). Yet, the evidence is limited on how various primary care models impact ED utilization in the complex and chronically ill HNHC population.

Frequent ED utilization also contributes to disproportionately high spending in the HNHC population (Figueroa et al., 2019). HNHC patients spend more than twice as much on out-of-pocket expenses and nearly four times as much on medication and overall health care services compared to the average US adult (Figueroa et al., 2019; Hayes, Salzberg, et al., 2016). Alternative payment models such as Accountable Care Organizations have been identified as strategies to curb spending and incentivize providers for achieving high quality outcomes for HNHC patients (Brown et al., 2012; Mccarthy et al., 2014; O'Malley et al., 2019). Yet, little research has been done to understand how innovative payment models outside of typical fee-for-service models may impact downstream ED utilization and overall health care costs in the HNHC population. Thus, the purpose of this systematic review is to identify existing primary

care-based models and evaluate their impact on ED utilization and overall costs in HNHC patients.

3.3 Methods

Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used as a foundation for this review (Liberati et al., 2009). A comprehensive literature search was performed (by A.B.) in PubMed, Embase, and CINAHL for peer-reviewed studies published from January 2000 to March 2020. The search strategy utilized medical subject headings (MeSH) and field descriptions which were combined with general search terms. The MeSH terms *emergency medical services, emergency department, primary health care,* and *primary care* were used in conjunction with terms describing HNHC patients. We used terms to describe both HNHC patients as well as patients who are frequent ED utilizers (i.e., *high-need, high-cost, high-need high-cost, high-risk,* and *high utilizer*) to be as inclusive as possible. Medicare and Medicaid search terms were also included to ensure inclusivity of a broad spectrum of patients. Additional searches were performed by manually searching relevant journals and reference lists of included articles in the *Journal of Emergency Nursing*, *Academic Emergency Medicine*, the *Journal of Emergency Medicine*, *The American Journal of Managed Care*, and the *Annals of Family Medicine*. Table 3.1 provides the search terms used for all databases.

Eligibility Criteria

Studies were included if they *(a) evaluated primary care or payment models based in the primary care setting, (b) evaluated the outcomes ED utilization and costs, (c) were conducted in the United States,* and *(d) included HNHC adults over 18 years old*. Authors selected studies that

either explicitly included the term HNHC patients or sampled their populations using HNHC indicators (i.e., adults with at least two chronic conditions, high frequency of acute care utilization, or top 5% of total expenditures).

Studies were excluded if they *(a) did not fit inclusion criteria, (b) were considered grey literature (e.g., editorials, conference abstracts, or unpublished manuscripts), and (c) were not written in English.* Models that were implemented exclusively in the hospital setting or in specialty practices (e.g., radiology, ophthalmology, or post-operative surgery clinics) were excluded as these participants were not generalizable.

Data Extraction

Data was extracted from each article based on a priori defined categories established in previous research and systematic reviews of ED utilization (Bleich et al., 2015; Morgan et al., 2013). For each study, data were extracted referring to study design, sample, definition of HNHC population, model type and definition, and outcomes. Outcomes of interest included: all-cause ED utilization, preventable ED utilization, and overall costs. Table 3.2 presents the data extraction from each study.

<div align="center">

3.4 Results

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Literature Search

After removing duplicates, our initial search yielded 2,140 titles. Two authors independently screened the studies for eligibility leaving 51 full-text studies to be evaluated. Of these, 30 articles were excluded due to differing populations (n = 8), settings (n = 5), and outcomes (n = 6). Studies were also excluded if models were not based in the primary care setting (n = 7), or if they were not published in peer-reviewed journals (n = 4). Figure 1

demonstrates the search strategy and eligibility using the PRISMA flow diagram (Liberati et al., 2009).

Description of Included Studies

The final review included 21 studies that met eligibility criteria. Of these, four studies were randomized controlled trials (Boult et al., 2011; K. Brown et al., 2005; Powers et al., 2020; Zulman et al., 2017) and two were quasi-experimental studies (Bailey et al., 2019; Komaromy et al., 2019). Seven studies were cohort studies including two retrospective cohorts (Baker et al., 2013; Capp et al., 2017), four prospective cohorts with control groups (Newcomer et al., 2004; Peikes et al., 2018; Schraeder et al., 2008; Weppner et al., 2018), and one longitudinal cohort (Cross et al., 2017). Additionally, six pretest-posttest studies were included (Berkowitz et al., 2018; K. Brown et al., 2005; Bui et al., 2019; Hardin et al., 2017; Ritchie et al., 2016; Schuttner et al., 2018), one nested case control (Coleman et al., 2002), and one cross-sectional study (Ouayogodé et al., 2019).

Quality Appraisal

Two authors (A.B. and S.K.) independently reviewed and appraised each of the 21 studies using the Downs and Black tool (Downs & Black, 1998). The Downs and Black tool consists of 27 questions surrounding population characteristics, generalizability, assessment of confounders, and appropriateness of statistical analyses (Downs & Black, 1998). Individual subscales as well as overall total score on the Downs and Black tool have demonstrated high internal consistency, and test-retest and inter-rater reliability for both randomized and non-randomized studies (Downs & Black, 1998). The Downs and Black tool has been modified for items which do not apply to non-randomized studies or when adequate information is not

provided to calculate power (O'Connor et al., 2015; Soril et al., 2016) The modified Downs and Black tool has a maximum score of 28.

The Downs and Black tool consists of five subscales: (a) reporting, (b) external validity, (c) bias, (d) confounding, and (e) power. All items have *yes*, *no*, or *unable to determine* responses and are scored as 0 (no) or 1 (yes) except for the reporting subscale (0 to 2). The reporting subscale addresses whether the study provides sufficient information to develop an unbiased assessment of findings, such as a list of principal confounders. The external validity subscale evaluates whether findings are generalizable to the population from which the study subjects were drawn. Lastly, the power subscale addresses whether findings could be due to chance.

Studies ranged in score from moderate (score = 17; Capp et al., 2017) to high quality (score = 25; Boult et al., 2011a; Zulman et al., 2017) out of a total score of 28 on the Downs and Black tool (Table 3.3). Factors that led to lower quality scores across all studies included items related to randomization, blinding of treatment and outcome assessment, and allocation concealment. A large proportion of studies (16 out of 21) either did not report a power calculation or did not have sufficient power to detect treatment effect. Overall, all studies demonstrated high quality for the reporting and external validity subscales indicating low risk of bias.

Primary Care Models and Outcomes

This review identified four models currently used to support primary care for HNHC patients: *(a) Care Management, (b) Care Coordination, (c) Intensive Primary Care,* and *(d) Alternative Payment Models.* This review reports significant findings for outcomes including all-cause ED utilization, preventable ED utilization, and overall costs.

Care Coordination

Eight studies evaluated care coordination models, defined as models that focus on the organization and integration of patient care activities across all patients and providers involved to effectively share information and achieve safer care (Bailey et al., 2019; Berkowitz et al., 2018; Boult et al., 2011; Capp et al., 2017; Coleman et al., 2002; Powers et al., 2020; Schuttner et al., 2018; Weppner et al., 2018). There was wide variability in model components and activities across studies; yet, all care coordination models included multidisciplinary assessment, comprehensive discharge planning, disease education, medication management, and follow-up or remote monitoring with patients.

Of eight studies implementing care coordination, four demonstrated statistically significant reductions in all-cause ED utilization (Bailey et al., 2019; Berkowitz et al., 2018; Capp et al., 2017; Schuttner et al., 2018), one demonstrated reductions in preventable ED utilization (Schuttner et al., 2018), and four reported reductions in overall costs (Bailey et al., 2019; Berkowitz et al., 2018; Powers et al., 2020; Schuttner et al., 2018). One study evaluated 3,802 high ED utilizing HNHC patients pre- and post-implementation of a multidisciplinary, community-based care coordination model integrated in an urban, academic medical center in Colorado (Capp et al., 2017). This model integrated community medical, behavioral, and social services in conjunction with home visits and frequent follow up. The study showed 29.7% fewer ED visits ($P < .05$) after HNHC patients were enrolled (Capp et al., 2017).

Schuttner et al (2018) study enrolled 65 HNHC patients in an ambulatory clinic affiliated with a large academic care system within Southern California. The clinic offered interprofessional care coordination and behavioral health services alongside after-hours and same-day urgent care. HNHC patients reported a significant 12% monthly decrease in all-cause

ED visits ($P < .001$) and a 17% monthly decrease in preventable ED visits ($P < .05$) resulting in a $93,000 cost savings over 21 months.

The study with the largest sample size among care coordination models compared outcomes of 4,686 Medicare and Medicaid HNHC patients over four years in Maryland as part of the Johns Hopkins Community Health Partnership (Berkowitz et al., 2018). Berkowitz et al. (2018) found that of 1,000 Medicaid beneficiary-episodes, ED visits were reduced by 133 visits over the 90-day study period ($P < .01$) and costs per Medicaid beneficiary-episode were reduced by $4,295 ($P < .01$). There was no statistically significant reduction in ED visits or costs of care for Medicare patients. Similarly, Bailey and colleagues (2019) found significant changes in ED utilization were limited to Medicaid (rather than Medicare) patients enrolled in their program with a 39% decrease in ED utilization ($P < .05$). Exposure to the care coordination model was associated with an average decrease in medical expenditures of $8,690 over 6 months (95% CI: -14,441; Bailey et al., 2019). Additional subgroup analyses demonstrated again that the decrease in costs was limited to Medicaid patients with an adjusted average decrease of $15,998 (95% CI: -24, 427 to -7, 568; $P < .001$) in total Medicaid expenditures compared to patients in usual care.

Lastly, Powers et al (2020) conducted a randomized controlled trial among HNHC patients enrolled in a program offering multidisciplinary care coordination and care planning with a primary care provider, community health worker, and social worker. No significant reductions in ED utilization were found, yet patients randomized to the program had 27% lower total medical expenditures compared to patients in usual care (absolute reduction of $7732 per patient per year, $P < .05$).

Care Management

Care management is a primary care model referring to activities often led by nurses to support disease management, assess health needs, facilitate communication with providers, and navigate the health system (Long et al., 2017; Ouayogodé et al., 2019). Seven studies evaluated care management, and all incorporated interdisciplinary collaborative care, individualized assessment, risk identification, monitoring, and patient education (Baker et al., 2013; Bui et al., 2019; Hardin et al., 2017; Newcomer et al., 2004; Ouayogodé et al., 2019; Ritchie et al., 2016; Schraeder et al., 2008). Only two studies reported statistically significant differences in all-cause ED utilization (Hardin et al., 2017; Ritchie et al., 2016); no studies reported significant findings related to preventable ED utilization; and one reported significant reductions in cost (Hardin et al., 2017).

Hardin et al (2017) developed and tested a care management model at an inner-city tertiary care hospital serving a highly vulnerable and socioeconomically diverse population including many patients experiencing homelessness, unemployment, substance abuse and psychiatric illness. The was conducted with 339 HNHC patients and included root cause analysis of high health service utilization, interdisciplinary management, and frequent follow up, demonstrating a 43% reduction in mean ED visits ($P < .001$) and reductions for both total direct expenses (47%, $P < .001$) and ED expenditures (50%, $P < .001$). Ritchie et al (2016) evaluated the impact of a care management model consisting of individualized care planning managed by a large interdisciplinary team, home assessments, and primary care, mental health, and pharmacist consultation. Over 100 observation days, median ED visits significantly declined post-implementation (from 5.5 to 0; $P = .015$) for 152 HNHC adults.

Intensive Primary Care

The intensive primary care model is a team-based, multidisciplinary approach to increase the intensity, frequency, and accessibility to primary care services to support HNHC patients (Edwards et al., 2017; Long et al., 2017). Four studies evaluated the impact of intensive primary care on HNHC patients (K. Brown et al., 2005; Komaromy et al., 2019; Sledge et al., 2006; Zulman et al., 2017). Traditional primary care settings often lack the ability to effectively manage and support the complex care required for HNHC patients (Edwards et al., 2017). Of four studies, two demonstrated significant reductions in ED utilization (K. Brown et al., 2005; Komaromy et al., 2019) and one showed a significant difference in overall costs when patients were enrolled in intensive primary care models (Zulman et al., 2017).

Brown et al (2005) implemented an intensive primary care model consisting of longer appointment times for evaluation interviews, multidisciplinary assessment and follow-up, weekly visits, and 24-hour availability of a team member on call. Among HNHC patients enrolled, average ED visits were significantly decreased (6.9 pre- to 4.9 post-implementation, $P = .05$), but no significant difference was found in ED visits per month. Komaromy and colleagues (2019) conducted a quasi-experimental study of 6 outpatient intensivist teams across New Mexico to support HNHC Medicaid patients through motivational interviewing, care planning, walk-in appointments, and after-hours care using an on-call system. For patients enrolled in the intensive primary care model, odds of an ED visit 12 months post-enrollment were 53% lower for patients enrolled in the model (OR 0.47, CI 0.39, 0.58) compared to those receiving to usual care.

Zulman and colleagues (2017) conducted a randomized controlled trial of 583 HNHC patients receiving intensive outpatient care in the Veterans Affairs (VA) Health Care System. HNHC patients were enrolled with multidisciplinary teams and received comprehensive patient assessments, intensive care management and coordination, and social services. This model found

no significant differences in ED utilization, but was associated with a significant increase in monthly person-level primary care costs (D-in-D [SE] = $30 [$14]).

Alternative Payment Models

Two studies evaluated alternative payment models consisting of value-based payments to align incentives and improve care for HNHC patients (Cross et al., 2017; Peikes et al., 2018). Alternative payment models have been increasingly implemented across the US to improve access and quality of primary care while allocating limited resources more effectively (Mccarthy et al., 2014). In particular, these payment models incentivize quality over quantity of care by reimbursing providers for primary care activities that are often excluded from the fee-for-service payment structure such as care management, phone follow up, extended time (Berenson & Horvath, 2003; Clarke et al., 2017; Holtrop et al., 2015).

Cross et al (2017) evaluated the effects of a multi-year pay-for-value payment model on HNHC patient assigned to primary care providers participating in Blue Cross Blue Shield of Michigan's physician group incentive program. Patients enrolled in the program had lower odds of incurring an ED visit over the four-year period compared to the control group (OR, 0.88*; P =* .0002), despite not differing in the number of ED visits. Peikes and colleagues (2018) tested the impact of the Comprehensive Primary Care Initiative developed by the Centers for Medicare and Medicaid Services including multi-payer support for practices to enhance primary care delivery, patient engagement, and disease management activities. Patients enrolled in these practices reduced all-cause ED visits by 2% ($P < .05$) over the four-year initiative. There were no significant differences in preventable ED visits.

3.5 Discussion

This review synthesized 21 studies evaluating various primary care and payment models and their impact on ED utilization and overall costs in the HNHC population. Studies were of moderate to high quality. There were four major primary care models examined across studies including *(a) Care Management, (b) Care Coordination, (c) Intensive Primary care,* and *(d) Alternative Payment Models.* Overall, 10 studies reported significant differences in all-cause ED utilization (Berkowitz et al., 2018; K. Brown et al., 2005; Capp et al., 2017; Cross et al., 2017; Hardin et al., 2017; Komaromy et al., 2019; Peikes et al., 2018; Ritchie et al., 2016; Schuttner et al., 2018).

Studies included in this review were of acceptable quality, yet little over half of the studies (11 out of 21) showed no significant difference in ED utilization. These findings could be attributed to small sample sizes, insufficient power to detect a treatment effect, or due to variability in outcomes evaluated. For example, while some primary care models found no significant changes in utilization or spending, they might have demonstrated positive results for patient-reported outcomes or quality of care. Additionally, lack of significant difference in ED utilization may be partially explained by the fact that one-size-fits-all models of care have had mixed results in the HNHC population due to heterogeneity in diagnoses, symptom severity, medical literacy, and social needs (Keeney et al., 2019). HNHC patients have high rates of multimorbidity often with additional functional limitations, disability, and socioeconomic challenges such as social isolation or housing instability (Hayes, Salzberg, et al., 2016; Long et al., 2017). Individualizing models of care to the unique medical and social needs of HNHC patients is imperative to making sustainable improvements in quality of care and ED utilization (Joynt et al., 2017; Long et al., 2017; Schneider & Shah, 2020).

Both studies evaluating alternative payment models demonstrated significant reductions in ED utilization (Cross et al., 2017; Peikes et al., 2018). These findings are consistent with recent research which shows that the adoption of Patient Centered Medical Homes are associated with lower ED utilization, specifically among patients with chronic illness (David et al., 2015). In existing fee-for-service payment structures, health systems are reimbursed for the services they provide, and are disincentivized to invest in care models that might reduce outpatient or inpatient utilization (Blumenthal, Chernof, et al., 2016; Hochman & Asch, 2017; McCarthy et al., 2015). Additionally, research has found that aggregate savings in prevented acute care visits might not be substantial enough to have a large effect on overall spending within the HNHC population (Joynt et al., 2013). Thus, implementing alternative payment models may be an effective strategy to align incentivizes and reimburse providers and health systems for high quality care delivery for HNHC patients (Clarke et al., 2017; Mccarthy et al., 2014; O'Malley et al., 2019).

3.6 Implications for ED Nurses

While enhancing primary care delivery can improve access to care and ongoing disease management, no model will successfully reduce acute care utilization if the ED is, in fact, where patients prefer to be treated. ED nurses can play an integral role in assessing the preferences for care in HNHC patients. However, due to fragmentation in communication across the primary and acute care settings, ED nurses are often unaware of the upstream factors which may enable or impede ED use. This review can educate ED nurses on the effectiveness of a variety of primary care models and encourage nurses to engage in conversations with HNHC patients surrounding the availability and quality of primary care models at their practices. Further, the ED setting is an ideal point of intervention for nurses to conduct a comprehensive assessment of the unique

medical and psychosocial needs of a HNHC patient and advocate for specific resources (e.g., care coordination, case management) or consultation (e.g., psychiatry, social work, or podiatry) in real time (Bilazarian, 2020; Billings & Raven, 2012).

3.7 Limitations

This study had some limitations including the potential for missed studies during the selection process. Given the lack of standardization in the definition of HNHC patients, studies may have been missed that evaluated HNHC patients, but used a unique definition. As this systematic review includes cohort and cross-sectional studies, causation between primary care models and ED utilization cannot be established. Finally, the vast majority of the studies (16 out of 21) either did not report a power calculation or did not have sufficient power to detect treatment effect.

3.8 Conclusion

This review identified four models currently used to enhance primary care delivery to HNHC patients: care management, care coordination, intensive primary care, and alternative payment models. Consistent with recent research, care management and care coordination had both mixed effects on ED utilization and overall costs. Future research should explore why variability exists in effectiveness of primary care models within the HNHC population. Contextualizing these findings will enable a better understanding of how to enhance primary care delivery and ongoing disease management for this costly and complex population.

Table 3.1

Search Terms for PubMed, Embase, and CINAHL

Database	Search Terms
PubMed	(("Emergency Medical Services"[Mesh] OR emergency department*[tiab] OR emergency room*[tiab] OR health care util*[tiab]) AND ("Primary Health Care"[Mesh] OR primary care*[tiab] OR care coordin*[tiab] OR "Case Management"[Mesh] OR "Disease Management"[Mesh] OR "Case Managers"[Mesh] OR care manag*[tiab] OR disease manag*[tiab] OR "after-hours care") AND ("Dual MEDICAID MEDICARE Eligibility"[Mesh] OR "Medicare"[Mesh] OR "high-need high-cost" OR "high need high cost" OR "high cost" OR "high-cost" OR "high risk" OR "high utilizer")
Embase	('emergency department'/exp OR 'emergency department' OR 'emergency room' OR 'emergency visit') AND ('case manager'/exp OR 'care coordinator'/exp OR 'care coordinator' OR 'primary medical care'/exp OR 'primary medical care' OR 'out-of-hours care'/exp OR 'out-of-hours care' OR 'disease management') AND ('high-need' OR 'high-need high-cost' OR 'high-cost' OR 'high-utilizer' OR 'high-risk')
CINAHL	((MH "Emergency Service+") OR "emergency department" OR "emergency room" OR "health care utilization" OR "emergency visit") AND ((MM "Primary Health Care") OR "primary care" OR "primary practice" OR (MM "Case Management") OR (MM "Case Managers") OR (MM "Nursing Care Coordination (Saba CCC)") OR (MM "Multidisciplinary Care Team+") OR (MM "Disease Management+")) AND ((MM "Medicare") OR (MM "Medicaid") OR "high-need" OR "high-need high-cost" OR "high-cost" OR "high-risk" OR "high-utiliz*" OR "dual* eligibl*")

Table 3.2

Data Extraction Table

Author (Year)	Study design	Sample	Definition of HNHC	Primary Care Model	Model Definition	Result: All-Cause ED Utilization	Result: Preventable ED Utilization	Result: Costs
Bailey (2019)	Quasi Experimental	2,235 model: 285 control: 1950	> 18, Medicare, Medicaid, Dual eligible, > 2 hospitalizations or ED visits in last 6 months, >1 chronic condition	Care Coordination	Non-profit health system in a medically underserved area in Tennessee including: 1) Screening by nurses 2) Patient engagement 3) Medication and disease management 4) Discharge planning & care coordination 5) Community-based 45 day follow up	Medicaid enrollees experienced 1.96 times fewer ED visits ($p < 0.05$)	No significant difference	Decreased medical expenditures in model group ($-$ 8690 per 6-month period; 95% CI, $-$ 14,441 to $-$ 2939; $p < .005$) Medicaid subgroup experienced an adjusted average decrease of $-$ 15,998 (95% CI, $-$ 24,427 to $-$ 7568; $p < .001$)
Baker (2013)	Retrospective matched cohort study	1,767	>2 clinic visits, Medicare, at least 1 of 3 conditions	Care Management and Telehealth	Two multispecialty clinics in Oregon and Washington offering care management integrated with telehealth for patient education and daily review of clinical needs	No significant difference		
Berkowitz (2018)	Pretest/ Posttest	4,686	> 18, >1 chronic condition, visited PCP in last year, Medicare or Medicaid	Care Coordination	Comparison of Medicare and Medicaid participants from 2012-2016 in Maryland: 1) Discharge planning 2) Daily interdisciplinary rounds 3) Patient education 4) Medication management 5) Telephone follow-up after discharge 6) Skilled home care and remote patient monitoring	90-day ED visit rates were reduced for Medicaid insured patients by 133 per 1000 beneficiary-episodes ($p < 0.01$) No significant difference for Medicare insured patients		For Medicaid insured patients: aggregate cost of care was reduced by $59.8 million ($4295 per beneficiary-episode; $p < 0.01$) No significant difference for Medicare insured patients
Boult (2011)	Randomized Controlled Trial	850	> 65, high-risk defined using claims-based predictive model	Care Coordination	14 primary care teams in 8 community-based primary care practices across Baltimore, Maryland, and Washington, DC: 1) Comprehensive home assessment 2) Creation of evidence-based care guide with patient 3) Monthly patient monitoring 4) Transitional care support 5) Care coordination 6) Self-management and patient education	No significant difference		No significant difference
Brown (2005)	Pretest/ Posttest	17	> 1 chronic condition,	Intensive Primary Care	1) Longer appointment times for evaluation interviews	ED average visits were significantly		No significant difference

			> 1 inpatient admission in past year, life expectancy > 3 years		2) Multidisciplinary assessment and follow-up 3) Frequent visits (weekly initially) 4) 24-h availability of a team member on call	different with pre 6.9 and post 4.9 visits (p = .05) ED visits per month were not significantly different	
Bui (2019)	Pretest/ Posttest	1,342	> 18, >1 chronic condition, Medicare or Medicaid insured, identified as "high risk" by referral or risk prediction model	Care Management	Primary care-embedded case management with multidisciplinary teams including a case manager, community health worker, health behavior specialist, and clinicians to provide individualized care	No significant difference	
Capp (2017)	Retrospective Cohort	3,802 model: 406 control: 3396	> 18, > 2 ED visits/hospital admissions in last 180 days	Community-based Care Coordination	A multidisciplinary program part of a large urban academic medical center in Colorado: 1) Intensive medical, behavioral health, and social care coordination services 2) Home visits within sixty days of an ED visit or hospital discharge 3) Behavioral screening and education with a provider, care coordinator, health coach, behavioral health evaluator, and community health worker	27.9% fewer ED visits (p < .05)	
Coleman (2002)	Case Control (Nested)	297 cases (use the ED): 103 controls (did not use the ED): 194	> 65, multiple chronic conditions, history of high utilization or physician referral	Care Coordination	Large group-model health maintenance organization in Denver metropolitan area offering: 1) Timely follow-up after a change in treatment 2) Care planning with few decision-makers involved 3) Patient self-report of care coordination	No significant difference	No significant difference
Cross (2017)	Longitudinal Cohort	17,443	2 more conditions, enrollment in same primary practice with same provider for duration of study	Alternative Payment Models	Multi-year engagement by primary care practices in a pay-for-value program part of Blue Cross Blue Shield of Michigan	Lower odds of incurring any ED visit over time compared with control patients (OR, 0.88; p = .0002) No significant difference in number of ED visits overall (+3.2%, p = .132)	No significant difference over the four-year study period
Hardin (2016)	Pretest/ Posttest	339	> 18, > 3 hospital or ED visits in past 12 months	Care Management	Conducted from 2012-2015 at an inner-city tertiary care hospital with a socioeconomically diverse and highly vulnerable population: 1) Chart review with root cause analysis	ED visits reduced by 43% (p < .001)	Total direct expenses reduced by 46% (p < .001)

Author (Year)	Study Design	Sample Size	Inclusion Criteria	Intervention Type	Intervention Description			
					2) Interdisciplinary care management plan with weekly follow up 3) EMR integration			ED expenditures reduced by 50% (p < .001)
Komaromy (2019)	Quasi Experimental	770	> 18, enrolled in Medicaid managed care, > 2 chronic conditions, either 1 hospitalization or > 3 ED visits in past 6 months	Intensive Primary Care	6 outpatient intensivist teams across New Mexico offering: 1) Patient-centered interdisciplinary team care 2) Motivational interviewing 3) Care planning 4) Walk-in appointments and after-hours support using a 24-h on-call system	Odds of an ED visit 12 months post-enrollment were 53% lower (OR 0.47, CI 0.39, 0.58) in exposed group		No significant difference
Newcomer (2004)	Prospective Cohort with Control Group	3,079 Model: 1537 Control: 1542	> 65, > 1 chronic condition	Preventive Care Management	1) Health risk screening and planning 2) Ongoing monitoring 3) Caregiver and client support 4) Medication/treatment adherence 5) Transitional care	No significant difference		
Ouayogodé (2020)	Cross-sectional study	1,402,582	> 65, complex needs defined as frailty or > 2 conditions	Care Management	2017-2018 National Survey of ACOs evaluating: 1) Chronic care management 2) Predictive risk stratification 3) Transitional care	No significant difference		No significant difference
Peikes (2018)	Prospective Cohort with Control Group	1,730,958 Model: 565,674 Control: 1,165,284	Spending 30% above the average	Alternative Payment Models	Multi-payer support for 502 practices to implement: 1) Enhanced access to care 2) Preventive care 3) Risk-stratified care management and care coordination 4) Patient engagement	Slowed growth in emergency department visits by 2 percent (p < .008)	No significant difference	No significant difference in costs of care regardless of Medicare financial support
Powers (2020)	Randomized Controlled Trial	253 Model: 71 Control: 127	Adult Medicaid patients in the top 5% of total expenditures or Chronic Illness Intensity Index score with either > 3 ED visits or > 2 hospitalizations or > 2 conditions	Care Coordination	Multidisciplinary care team at CareMore Health in Memphis, Tennessee consisting of a community health worker, a social worker, and a provider: 1) Comprehensive medical, social, behavioral assessment 2) Individualized care plan 3) Frequent (at least weekly) follow up	No significant difference		Patients randomized to complex care management had 37% lower total medical expenditures (adjusted difference, -$7732 per member per year; 95% CI, -$14,914 to -$550; p = .036
Ritchie (2016)	Pretest/ Posttest	152	> 18, > 5 ED visits or > 2 hospitalizations in the past 12 months	Care Management	Geriatric Resources for the Assessment and Care of Elders program implemented in four primary care clinics at a large urban academic medical center: 1) Individualized care planning 2) Comprehensive in-home assessment by a nurse practitioner/social worker (NP/SW) team alongside a geriatrician, mental health liaison and pharmacist	Decline in the median number of ED visits (5.5 to 0, p = .015) after enrollment in program		

Author	Study Design	N	Inclusion Criteria	Model Type	Description	Outcome 1	Outcome 2	Outcome 3
Schraeder (2008)	Prospective Cohort with Control Group	670 Model: 400 Control: 277	> 65, determined to be high-risk for mortality, functional decline, or increased health service use from screening survey	Care Management	Collaborative care management in a multi-specialty physician group practice across rural and urban Illinois offering: 1) Risk identification 2) Comprehensive assessment 3) Collaborative planning 4) Health monitoring 5) Patient education 6) Transitional care	No significant difference		No significant difference
Schuttner (2018)	Pretest/ Posttest	65	> 18, > 1 chronic illness, > 2 ED visits within 12 months	Care Coordination and After-Hours Care	Interprofessional care program (nutrition, behavioral health, pharmacy, and care coordination) implemented in an ambulatory clinic affiliated with a large academic care system in California located in an ambulatory clinic with extended hours and same-day urgent care access	12% monthly decrease in ED visits after model (p < .001)	17% monthly decrease in preventable ED visits (p = .043)	40 prevented visits over 21 months resulting in $93,000 cost savings, no statistical significance reported.
Sledge (2006)	Randomized Controlled Trial	96 Model: 47 Control: 49	> 18, > 2 hospital admissions per year in the 12–18 months prior to recruitment	Intensive Primary Care	Urban academically affiliated clinic offering: 1) Comprehensive interdisciplinary medical and psychosocial assessment 2) Follow-up ambulatory case management for 1 year	No significant difference	No significant difference	No significant difference
Weppner (2018)	Prospective cohort with control group	208 Model: 104 Control: 104	Patients selected from VA's Need risk-prediction estimating the probability of hospitalization or death in the next 90 days.	Care Coordination	Patient-Aligned Care Teams within a VA primary care clinic consisting of an interprofessional hour long conference to develop and integrate care plan in medical record and coordinate follow up and outreach	No significant difference		
Zulman (2017)	Randomized Controlled Trial	583 Model: 150 Control: 433	Top 5% of overall facility costs or top 5% of VA's Need risk-prediction	Intensive Primary Care	Intensive multidisciplinary team-based program in the VA: 1) Comprehensive patient assessments 2) Intensive case management 3) Care coordination 4) Social and recreational services	No significant difference		Significant increase in monthly person-level primary care costs (D-in-D [SE] = $30[$14])

Note. ED: emergency department, EMR: electronic medical record, ACO: Accountable Care Organizations, VA: Veteran's Affairs, OR: odds ratio, CI: confidence interval, D-in-D:

differences-in-difference analysis, SE: standard error

Table 3.3

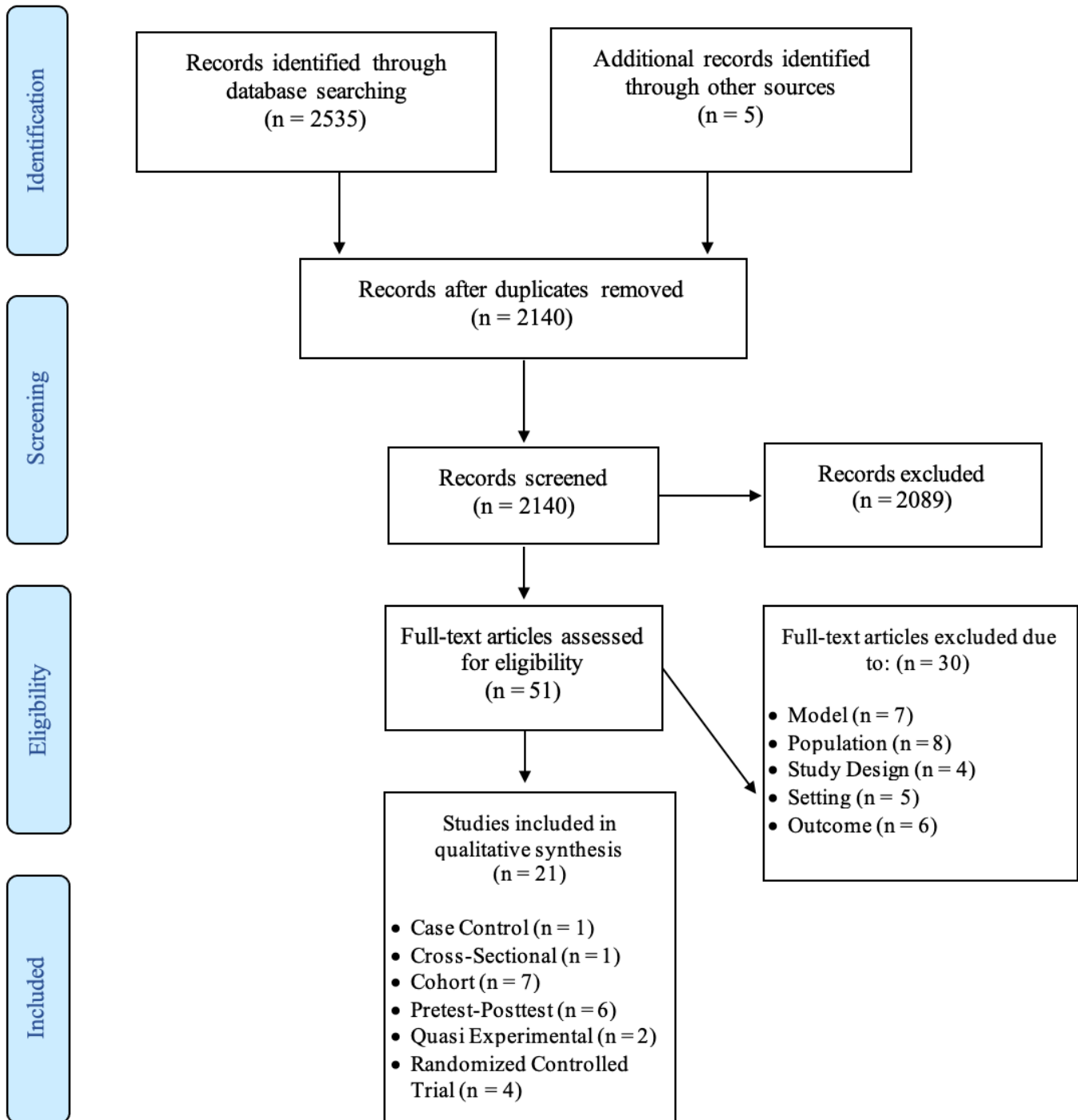*Quality Assessment Scores: Downs and Black Tool*

Author (Year)	Bailey (2019)	Baker (2013)	Berkowitz (2018)	Boult (2011)	Brown (2005)	Bui (2019)	Capp (2017)	Coleman (2002)	Cross (2017)	Hardin (2016)	Komaromy (2019)	Newcomer (2004)	Ouayogodé (2020)	Peikes (2018)	Powers (2020)	Ritchie (2016)	Schraeder (2008)	Schuttner (2018)	Sledge (2006)	Weppner (2018)	Zulman (2017)
Reporting																					
1. Hypothesis, aims, objective clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2. Main outcomes in Introduction or Methods	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3. Patient Characteristics clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4. Model clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5. Principal confounders described	2	1	2	2	0	2	2	2	0*	1	2	2	2	2	2	0*	2	2	0*	2	2
6. Main findings clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7. Random Variability estimates provided for outcomes	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1
8. Adverse events reported	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9. Characteristics of patients lost to follow-up described	1	0	0	1	1	1	0	1	0	0*	1	1	1	0*	1	1	1	1	1	1	1
External Validity																					
10. Probability values reported for main outcomes	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11. Subjects asked to participate were representative of population	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0*	1	1	1	1	1	1
12. Subjects were representative of population	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0*	1	1	1	1	1	1
Internal Validity																					
13. Staff, places, and facilities representative of population	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14. Participants blinded to treatment	0*	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0	0	0*	0	0*

15. Researchers blinded to outcome assessment	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0	0	0*	0	0*
16. Data dredging clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17. Analysis adjusted for length of follow-up	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18. Appropriate statistical tests performed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19. Compliance with model was reliable	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20. Outcome measures were reliable and valid	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21. Participants recruited from same source population	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
22. All participants recruited over same time period	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
23. Participants randomized to treatment	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1
24. Allocation of treatment concealed from investigators and participants	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	1	0	0*
25. Adequate adjustment for confounding	1	1	1	1	0*	1	1	1	0*	0*	1	1	1	1	1	0*	1	1	0*	1	1
26. Losses to follow up taken into account	1	1	0*	1	1	0*	0*	1	0*	0*	1	1	1	1	1	1	1	1	1	1	1
Power																					
27. Sufficient power to detect treatment effect	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1
Total /28	21	19	20	25	20	22	16	24	17	18	23	24	23	22	22	19	22	23	22	24	25

Note. 0*: Unable to determine. Total score for the modified Downs and Black scale = 28. Item 5: If a list of principal confounders is provided, studies receive a score of 2, 1 if the list is partially provided, and 0 if no confounders are described. Item 27: Studies received 1 if explicitly state sufficient power was reached, and 0 if power was not reached or no report of power calculation (Downs & Black, 1998; O'Connor et al., 2015).

Figure 3.1

PRISMA Flow Diagram (Liberati et al., 2009)

Chapter 4: Primary Care Practice Structural Capabilities in Health Professional Shortage Areas

4.1 Abstract

Objectives: To evaluate structural capabilities in primary care practices employing nurse practitioners (NPs) and test whether they differ across health professional shortage areas (HPSAs) and non-HPSAs.

Study Design: Secondary analysis of cross-sectional survey data and health care workforce data from 2018-2019.

Methods: We computed bivariate analyses and multivariable adjusted regression models to evaluate differences in NP and practice characteristics and to determine the odds of having a structural capability in a HPSA practice compared to a non-HPSA practice.

Results: Across all NPs in our sample, the majority (61%) delivered care in HPSA practices. We found statistically significant differences in NP educational degrees, practice certifications, and structural capabilities between HPSA and non-HPSAs. Care coordination was 77% more likely to be delivered in HPSA practices compared to non-HPSA practices (OR 1.77, $p < .05$).

Conclusions: Expanding care coordination may be beneficial for HPSA populations with high rates of morbidity and socioeconomic needs. Future research is needed to understand how the NP workforce may be optimized to meet the growing primary care demands in underserved areas.

4.2 Background

Providing high quality primary care has proved to be challenging as the United States (US) faces a national shortage of primary care physicians compounded by growing rates of an aging and chronically ill population (Duchovny et al., 2017; Raghupathi & Raghupathi, 2018). Currently, 80 million Americans reside in geographic areas, known as Health Professional Shortage Areas (HPSAs), which are disproportionately affected by a lack of supply of primary care physicians relative to the general population (*Designated HPSA statistics*, 2020). Improving primary care access in HPSAs is critical as maldistribution of the health care workforce is linked to poor health outcomes including disease severity, quality of life, and life expectancy (Allen et al., 2011; Basu et al., 2019). Indeed, patient populations residing in HPSAs have higher prevalence of diabetes, hypertension, obesity, and smoking compared to patients not living in these areas.

Deploying the nurse practitioner (NP) workforce has been identified as an optimal strategy by policymakers and administrators to meet the growing demands in primary care. NPs are the fastest growing primary care workforce in the US (Auerbach et al., 2018), and approximately 89% of NPs are equipped to deliver primary care (American Association of Nurse Practitioners, 2020). NPs demonstrate equivalent patient outcomes to physicians including disease-specific physiologic measures, symptom reduction, and acute care utilization (P. Buerhaus et al., 2018; Kuo et al., 2015; Kurtzman & Barnow, 2017; Yang et al., 2018). Additionally, NPs are equipped to expand primary care in HPSAs for patients with high rates of multimorbidity and complex social needs as NPs are trained in comprehensive and holistic care emphasizing a patient's broad health needs as well as their social and emotional well-being (Grant et al., 2017).

Indeed, NPs are significantly more likely to care for patients with three or more chronic conditions compared to physicians (25.9% vs 20.8%; Fraze et al., 2020), and deliver chronic disease services such as disease education and counseling (Lin et al., 2004; Ritsema et al., 2014). Further, in states with full scope of practice regulation where NPs can independently evaluate, diagnose, interpret tests, and treat patients, NPs are more likely to practice and reside in HPSAs compared to physicians (DePriest et al., 2020; Xue et al., 2018). Full scope of practice regulation for NPs is also associated with an approximate 30% increase in yearly checkups in HPSAs (Traczynski & Udalova, 2018).

Yet, little is known about the practice infrastructure or integrated features (i.e., structural capabilities) used by NPs to enhance primary care delivery in HPSAs. Previous research demonstrates that practice structural capabilities can improve primary care access through extended practice hours, and delivery of chronic care through reminders for provider workflows, or care coordination (Friedberg et al., 2009; Martsolf, Ashwood, et al., 2018). Care coordination, for example, consists of the integration of personnel or activities used to manage patient care across the health care spectrum and has been shown to be associated with lower medical expenditures, inpatient hospitalizations, emergency department visits, and 30-day readmission rates (Berkowitz et al., 2018; Powers et al., 2020). Availability of chronic disease registries - designed to support providers manage patients with chronic illness through tracking systems, clinician reminders, and checklists, have been shown to improve patient outcomes and support practices to achieve the standard of care for ongoing chronic care (Burton et al., 2020; K. A. Peterson et al., 2020).

Yet, it is unclear if HPSA practices employing the growing NP workforce implement specific structural capabilities to meet the needs of their complex and chronically ill patient

populations. Such evidence is needed to understand how the NP workforce may be optimized to expand access to primary care in underserved areas. To fill this gap, our study assessed primary care practice structural capabilities in practices employing NPs and tested whether they differ across HPSAs and non-HSPAs.

4.3 Methods

Data Sources and Collection

This study was a secondary analysis of cross-sectional data from two sources: (1) survey data collected from primary care NPs in 2018-2019 (PI: Poghosyan, R01MD011514) on NP characteristics, practice setting, and structural capabilities, and (2) publicly available data from the Health Resources & Services Administration (HRSA) from 2018-2019 on HPSA designation.

Survey data was collected from primary care NPs as part of a large study focused on racial and ethnic disparities in chronic disease outcomes and NP practice. Researchers sent surveys to 10, 237 NPs in primary care settings across six geographically diverse states. NPs were identified through the OneKey database from IQVIA, which includes the most complete information on office-based providers in the US (DesRoches et al., 2015). Using a modified Dillman method, three rounds of mail and online surveys were sent out to eligible NPs with reminder postcards and phone calls to non-responders (Hoddinott & Bass, 1986). Overall, 1,244 NPs in 1,109 practices completed and returned the surveys, with a response rate of 31.2%. A nonresponse analysis was conducted and determined to have low bias (Harrison et al., 2021).

Data on HPSA designation was collected by researchers for the large study. HPSA designation was obtained from the Primary Care Service Area files which contain data on primary care availability in communities and are maintained by the Dartmouth Institute. Data on HPSA designation is updated regularly and made publicly available by HRSA.

Data Merging

Survey data on NP practices was merged with data on HPSA designation using zip code information available both in the NP survey and in the Primary Care Service Area files. The NP survey provided either 5-digit or 4-digit zip codes on NP practice location and the Primary Care Service Area file provided 9-digit zip codes to identify HPSA geographic areas. Crosswalk files from the US Department of Housing and Urban Development were used to link differing zip code levels using an incident fraction for each 9-digit and 5-digit zip codes to account for differences in geographic scales (Din & Wilson, 2020).

Sample

We extracted data from the parent study from Arizona (AZ) and Washington (WA) as these states have full scope of practice regulation. NPs are more likely to practice and reside in HPSAs in states with full scope of practice regulation (DePriest et al., 2020; Xue et al., 2018). We sampled surveys from 366 NPs across 269 unique practices in AZ (46%) and WA (54%).

Measures

HPSA

Our independent variable of interest was HPSA designation calculated on a range from 0-25. Criteria for designation include the following a) the population to provider ratio (10 point max), b) percentage of the population below 100% of the federal poverty level (5 point max), travel time to the nearest source of care outside the HPSA (5 point max), and infant health index (5 point max; *Designated HPSA Statistics*, 2020). Practices without any HPSA score were coded as "non-HPSA", and practices with any score (HPSA score 1-25) were coded as "HPSA" indicating geographic areas or populations with inadequate access to primary care.

Structural Capabilities

Structural capabilities were obtained from the Structural Capability Index (SCI) contained within NP survey data. The SCI is a validated measure used to evaluate primary care practice attributes linked with high quality care delivery (Friedberg et al., 2008; Martsolf, Ashwood, et al., 2018). Previous research has used the SCI to explore structural capabilities in medical home, and the impact of various structural capabilities on patient outcomes, patient satisfaction, and quality of care (Friedberg et al., 2008, 2009; Martsolf, Ashwood, et al., 2018; Martsolf, Kandrack, et al., 2018).

We selected four subscales on the SCI which have been shown to expand access to care and improve ongoing disease management: (a) *shared systems for communication* [3 items] shown to improve patient satisfaction and enhance timely communication between patients and providers (Liederman & Morefield, 2003; Sada et al., 2011), (b) *care coordination* [7 items] associated with lower medical expenditures, hospitalizations, emergency department visits, and readmission rates (Berkowitz et al., 2018; Powers et al., 2020), (c) *chronic disease registries* [1 item] shown to improve patient outcomes and support practices to achieve the standard for chronic care in diabetes and hypertension (Burton et al., 2020; Hoque et al., 2017; K. A. Peterson et al., 2020), and (d) *after-hours care* [2 items] which is associated with reduced emergency department utilization, lower expenditures, and lower rates of unmet medical needs (Jerant et al., 2012; O'Malley, 2013).

The majority of structural capabilities were measured on subscales with binary (yes/no) responses where NPs reported on the presence or absence of each structural capability. We dichotomized subscales with multiple items by operationalizing the entire subscale as present if more than 50% of items were reported as present. This method of standardization is consistent

with prior research (Martsolf, Ashwood, et al., 2018). Table 4.1 provides the corresponding survey items for each capability evaluated.

Covariates

To isolate the relationship between HPSA and practice capabilities, we controlled for NP demographics and practice characteristics including age, gender, race, education (i.e., highest educational degree received), time employed (i.e., time working at current practice), and certification. Practice characteristics included practice type (e.g., physician practice, community health center, or hospital-based clinic) and practice size (e.g., number of NPs, physicians, or physician assistants).

Data Analysis

Descriptive statistics were computed to describe the characteristics of NP respondents and their practices. Bivariate chi-square analyses were computed to evaluate differences in NP and practice characteristics across HPSAs and non-HPSAs. We built multivariate logistic regression models to evaluate the odds of having a structural capability in a HPSA practice compared to a non-HPSA practice. Multicollinearity was assessed between covariates by calculating the variance inflation factor and were determined to be acceptable. Final models adjusted for NP demographics and practice characteristics. We also adjusted for the clustering of NPs within practices to ensure the sample variance was not underestimated and to decrease the potential for Type 1 error. Analyses were performed using R Studio version 1.3.

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4.4 Limitations

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We sampled NPs from two states limiting the extent to which these findings can be generalized to other states. Self-reported survey data is subject to self-report bias. To control biases, validated tools were used with rigorous methodology throughout survey development and

data collection. We were unable to assess if there were differences in the quality of structural capabilities which may exist between practices. For example, NPs reported only on the presence of structural capabilities within their practices, rather than their actual or perceived efficacy. We also did not include whether NPs were practicing in teams or independently, and how the presence of teams may impact the implementation of structural capabilities within a practice. Lastly, the use of cross-sectional data limits our ability to infer causation.

4.5 Results

Sample Characteristics

Table 4.2 presents the characteristics of NPs and primary care practices in our sample in HPSAs and non-HPSAs. Overall, 366 NPs responded in 269 distinct practices. The majority of NPs (61%) practiced in HPSA designated areas. Demographic characteristics of NPs in HPSA practices were generally similar to those in non-HPSAs. The average age of NPs in our sample was 50. In both HPSA and non-HPSA practices, the majority of NPs were female (85-87%), between the ages of 31-44, and had worked at their current primary care practice for under five years. NPs in HPSA areas had similar racial composition as non-HPSAs as both reported the highest percentage of NPs as White or Caucasian (87% HPSA vs. 84% non-HPSA), and the second highest as Asian (6.8% HPSA vs. 10% non-HPSA).

There were statistically significant differences in educational degrees and practice certifications between NPs in HPSAs and non-HPSAs. NPs in HPSAs were significantly more likely to have a greater distribution of specialties such as hospice, midwifery, wound care, or HIV medicine (6.7% vs. 2.8%, $p < .05$) compared to NPs in non-HPSAs. In non-HPSAs NPs were more likely to have only an adult certification (11% vs. 18%, $p < .05$). NPs were significantly more likely to report bachelor's or associates as their highest degree in HPSAs

compared to non-HPSAs (34% vs. 0%, p < .05). In non-HPSA practices, a higher percentage of

NPs had a doctorate degree (22% non-HPSA vs. 18% HPSA, p < .05). All NPs in non-HPSAs

had graduate degrees at either the master's or doctoral level. Practice size was similar in HPSAs

and non-HPSAs. The majority of practices in both HPSAs and non-HPSAs (37%) were run by

over seven primary providers including NPs, physicians, and physician assistants.

Structural Capabilities

The prevalence of structural capabilities across all primary care practices in our sample is

demonstrated in Table 4.3 and calculated based on the percentage of nurse practitioner

respondents. The most prevalent structural capability across practices was chronic disease

registries (65%). The least prevalent practice capability was access to after-hours care during the

week (24%) and on the weekends (30%). Only 43% of practices offered care coordination.

Results from our regression models show significant differences in structural capabilities

across HPSAs and non-HPSAs (Table 4.4). NPs who practiced in HPSAs were 68% more likely

to have care coordination (OR 1.68, p < .05), even after controlling for differences in individual

NP and practice characteristics (OR 1.77, p < .05). While not significant, NPs who practiced in

HPSAs were also more likely to reporting implementing chronic disease registries. Both

unadjusted and adjusted regressions demonstrated that NPs in HPSA practices were 26% more

likely to implement chronic disease registries (OR 1.26, p = .33).

There was no significant difference in shared communication systems or after-hours care

across HPSA and non-HPSA practices, but NPs who practiced in HPSAs were slightly less likely

to have shared communication compared to NPs in non-HPSAs (unadjusted OR 0.99, p = .95).

On the other hand, NPs in HPSA practices were slightly more likely to offer after-hours care

even after accounting for differences in practice size and NP demographics (OR 1.07, p = .81). However, neither of these relationships were statistically significant.

4.6 Discussion

Using cross-sectional survey data from two states, this study explored the association between primary care practice structural capabilities and HPSA designation. We found that NPs were significantly more likely to deliver care coordination in practices located in HPSAs compared to non-HPSAs. Delivering care coordination has been shown to improve disease management and reduce emergency department utilization specifically for patients with complex needs and multimorbidity (Berkowitz et al., 2018; Capp et al., 2017), and may be used more frequently in HPSA practices to support their complex and chronically ill populations. Further, care coordination is also more likely to be primary delivered by NPs, underscoring the key role of NPs enhancing primary care delivery.

Though not statistically significant, our study also demonstrated that NPs in HPSA practices are more likely to implement disease registries. Disease registries and reminders for chronic care are associated with improved patient outcomes including reaching target adherence measures for diabetes and achieving clinical practice guidelines for care (Hoque et al., 2017; K. A. Peterson et al., 2020), and lower per beneficiary spending (Burton et al., 2020). Additionally, disease registries may be used on paper rather than implementing new software or electronic health records (Orzano et al., 2007). Thus, disease registries show promise in improving chronic care at low cost to practices.

We evaluated states with full scope of practice laws to assess how to optimize NPs in underserved areas when they are able to practice as independent providers. Consistent with research that NPs are more likely to practice in HPSAs in states with full scope of practice

regulations (DePriest et al., 2020; Xue et al., 2018), we found that the majority of NPs in our sample (61%) were working in HPSA practices. However, the formula used to designate primary care HPSAs does not take into account the availability of additional primary care providers such as NPs or physicians which may complicate the accuracy of evaluating differences across HPSA designations (*Designated HPSA*, 2020).

Consequentially, in this study the extent of differences across HPSA designation in NP characteristics and structural capabilities was largely insignificant. Existing research similarly demonstrates small and insignificant differences in patient health status and access to care across HPSAs and non-HPSAs (Liu, 2007). We recommend future research to continue to evaluate patient and provider outcomes across HPSA designation to test the sensitivity of HPSA criteria and designation status. Further, refining the HPSA criteria to include availability of the NP workforce would be an important contribution to inform policy and demonstrate more accurately how NPs are meeting the primary care needs of underserved areas.

4.7 Implications for Practice and Policy

Substantial evidence exists demonstrating the positive impact of care coordination on a variety of indicators including improved quality of life and decreased medical expenditures and lower rates of inpatient hospitalizations (Marek et al., 2013; Powers et al., 2020). Yet only 43% of NPs in our sample reported delivering care coordination at their practices. Two strategies may be used to support care coordination implementation: First, enhancing practice infrastructure through dedicated personnel, electronic medical records, or psychosocial resources, can be useful to facilitate effective care coordination delivery (Friedman et al., 2016). Secondly, emphasizing the use of chronic care management codes from the Centers for Medicare and Medicaid Services

can incentive practices by reimbursing for care management or coordination for Medicare beneficiaries (Agarwal et al., 2020).

This study was conducted in states with full scope of practice regulations for NPs and many of the structural capabilities we studied (i.e., care coordination and disease management) are primarily delivered by NPs (Lin et al., 2004; Ritsema et al., 2014). We chose full scope of practice states to control for regulatory differences. Consequentially, we were unable to assess whether variation in scope of practice regulation (i.e., full vs. reduced vs. restricted practice laws) modifies the relationship between HPSA designation and the presence of structural capabilities. Thus, it is unclear whether the extent of regulation impacts the presence or delivery of structural capabilities. Future research should consider how restrictive scope of practice regulation may impact implementation of structural capabilities in order to make actionable policy recommendations for optimizing NP care delivery and improving primary care access in underserved areas.

4.8 Conclusion

We found statistically significant differences in NP educational degrees, practice certifications, and structural capabilities between HPSA and non-HPSAs. NPs in HPSA designated primary care practices were significantly more likely to have care coordination compared to practices that are located in areas with adequate access to primary care. Expanding care coordination may be beneficial for complex and chronically ill patients residing in HPSAs. Future research is needed to understand how to optimize the NP workforce and implementation of structural capabilities to meet the growing demands for primary care in underserved areas.

Table 4.1

Structural Capability Index and Corresponding Survey Items

Weekend After-Hours Care

Is your practice setting regularly open to provide care on Saturdays or Sundays?

Weekday After-Hours Care

How many nights per week is your practice open for patient visits during extended evening hours?

Care Coordination

Does your practice have designated staff for care management services and/or care coordination? If yes, which of the following are provided:

Creating and managing patient problem lists

Providing resources to assist self-management of symptoms, conditions, and medications

Medication management and reconciliation

Helping patients access community and social services

Helping patients schedule appointments

Coordinating care between clinicians, hospitals, pharmacists, labs, insurance companies, and imaging services

Shared Communication Systems

Do clinicians at your practice use a shared communication system to contact patients:

Who are due for guidelines recommended for chronic conditions?

After a hospitalization?

Who have not had an appointment for an extended period?

Chronic Disease Registry

Does your practice have a registry that creates a list of patients who are overdue for their chronic disease services (e.g., hemoglobin A1c in diabetes; cholesterol in coronary artery disease)?

Table 4.2

Characteristics of NPs and Primary Care Practices in HPSAs compared to Non-HPSAs

	Overall (n = 366)	HPSA (n = 224)	Non-HPSA (n = 142)	p
NP Characteristics				
Age Group				.88
≤30	10 (2%)	6 (2%)	4 (3%)	
31-44	129 (36%)	79 (36%)	50 (36%)	
45-54	79 (22%)	50 (23%)	29 (21%)	
55-64	96 (27%)	55 (25%)	41 (29%)	
65+	47 (13%)	31 (14%)	16 (11%)	
Gender				.56
Female	315 (86%)	195 (87%)	120 (85%)	
Male	51 (14%)	29 (13%)	22 (15%)	
Education				< .05
Bachelors, Associates, Other	8 (2%)	8 (34%)	0 (0%)	
Masters	280 (78%)	172 (78%)	108 (78%)	
Doctorate (DNP or PhD)	71 (20%)	40 (18%)	31 (22%)	
Race				.22
White or Caucasian	312 (86%)	194 (87%)	118 (84%)	
Black or African American	7 (1.9%)	4 (1.8%)	3 (2.1%)	
Asian	29 (8.0%)	15 (6.8%)	14 (10%)	
Other	7 (1.9%)	4 (1.8%)	3 (2.1%)	
Certification				< .05
Adult	50 (14%)	24 (11%)	26 (18%)	
Gerontology	32 (8.7%)	17 (7.6%)	15 (11%)	
Family	282 (77%)	176 (79%)	106 (75%)	
Psych/Mental Health	11 (3.0%)	7 (3.1%)	4 (2.8%)	
Other (e.g., Hospice, Midwifery, HIV Medicine)	19 (5.2%)	15 (6.7%)	4 (2.8%)	
Time Employed				.64
< 1 year	73 (21%)	45 (21%)	28 (21%)	
1-5 years	140 (40%)	91 (43%)	49 (37%)	
6-10 years	67 (19%)	39 (18%)	28 (21%)	
11-20 years	48 (14%)	27 (13%)	21 (16%)	
> 20 years	18 (5.2%)	10 (4.7%)	8 (6.0%)	
Practice Characteristics				
State				.43
Arizona	168 (46%)	97 (43%)	71 (50%)	
Washington	198 (54%)	127 (57%)	71 (50%)	
Practice Size				.53
Solo NP provider	30 (8%)	16 (7%)	14 9%)	
2-3 Providers	106 (29%)	64 (29%)	42 (30%)	
4-6 Providers	96 (26%)	62 (28%)	34 (24%)	
7+ Providers	134 (37%)	82 (37%)	52 (37%)	

Note. NP: nurse practitioner, HPSA: Health Professional Shortage Area, DNP: Doctor of Nursing Practice,

Percentage's account for missing responses and NPs may have reported more than 1 Certification.

Table 4.3

Prevalence of Structural Capabilities in Primary Care Practices

Structural Capability	Prevalence (%)
Shared Communication	58
Care Coordination	43
Weekend After-Hours	30
Weekday After-Hours	24
Chronic Disease Registry	65

Note. Structural capability prevalence was calculated based on percentage of nurse practitioner respondents. A structural capability was determined as present if a nurse practitioner reported more than 50% of items as present.

Table 4.4

Relationship between HPSA Designation and Practice Structural Capabilities

Structural Capability	Unadjusted			Adjusted		
	OR	95% CI	p	OR	95% CI	p
Care Coordination	1.68	1.05, 2.69	.03*	1.77	1.03, 3.02	.04*
Shared Communication Systems	.99	.63, 1.56	.97	.91	.53, 1.52	.71
Chronic Disease Registry	1.26	.79, 2.01	.33	1.23	.73, 2.1	.43
After-Hours Care (weekend)	.94	.54, 1.63	.83	1.07	.59, 1.96	.81
After-Hours Care (week)	.80	.46, 1.39	.44	.87	.49, 1.59	.67

Note. OR: odds ratio, CI: confidence interval. Odds ratios represent the estimated odds for presence of a practice capability in HPSA versus non-HPSA. Reference group: non-HPSA. The multivariable analyses were adjusted for practice size as well as nurse practitioner demographics including age, gender, race, time employed, education level, and certification, and weighted by a HPSA incident ratio.

*$p < .05$.

Chapter 5: Analyzing Structural Capabilities and Emergency Department Utilization Among High-Need High-Cost Patients with Behavioral Health Conditions

Note. The target journal for Chapter 5 is Health Affairs.

5.1 Abstract

Nurse practitioners (NPs) play a critical role in meeting the growing demands for primary care, particularly for clinically and socially complex populations such as high-need high-cost (HNHC) patients. HNHC patients are adults who suffer from multiple chronic conditions, many of whom have an additional behavioral health diagnosis such as depression or substance abuse. HNHC patients with behavioral health conditions face heightened challenges accessing timely care and managing their conditions reflected by high rates of emergency department (ED) utilization and preventable spending. Structural capabilities (i.e., care coordination, after-hours care, chronic disease registries, and shared communication systems) are key attributes of primary care practices and can enable NPs to deliver effective chronic disease management to HNHC patients with co-occurring medical and behavioral conditions.

The purpose of this study was to analyze the association between structural capabilities and ED utilization among HNHC patients with behavioral health conditions. We completed a secondary analysis of cross-sectional NP survey data from 2018-2019 on structural capabilities linked with Medicare claims data on HNHC patients and ED utilization. Using multivariable Poisson models, we found shared communication systems were associated with decreased rates of all-cause and preventable ED utilization among HNHC patients with alcohol use (aRR 0.5, 95% CI: -0.92, -0.45) and HNHC patients with substance use disorders (aRR 0.61, 95% CI: -0.66, -0.34). Care coordination was also associated with decreased rates of ED utilization among the overall HNHC population and those with alcohol use, but not among HNHC patients with depression or substance use disorders. Care coordination has the potential to increase effectiveness of primary and chronic care delivery by tailoring traditional models to target specific HNHC patients.

5.2 Background

Medicare costs grew to $800 billion in 2019, nearly 21% of total national health expenditures (Centers for Medicare & Medicaid Services, 2020). Significant policy attention has been placed on developing solutions to improve care for high-need high-cost (HNHC) patients as a strategy to increase savings. HNHC patients are adults suffering from multiple chronic medical conditions with varying social, functional, and behavioral health needs who comprise only 5% of the United States (US) population yet account for half of all health care expenditures (Hayes, Salzberg, et al., 2016; Long et al., 2017). Compared to the general population, HNHC patients are more likely to be older, African American, insured by Medicare or dually eligible for Medicaid, and have lower levels of education and income (Long et al., 2017; Ryan et al., 2016).

HNHC patients with an additional behavioral health condition face particular challenges accessing timely care and managing their diseases reflected by high rates of unmet behavioral health needs and emergency department (ED) utilization (Ryan et al., 2016). Indeed, with a behavioral health diagnosis such as depression or substance abuse, HNHC patients have higher-than-average rates of preventable spending, higher rates of ED utilization, and are more likely to remain in the top 10% of spending over two years compared to the overall HNHC population (Hayes, Mccarthy, et al., 2016; Powers et al., 2019). Co-occurring medical and behavioral health conditions are optimally treated in the primary care setting which enables patient-centered chronic disease education, ongoing monitoring, and multidisciplinary care teams involving nurses, social workers, psychiatrists, and care coordinators (Long et al., 2017).

However, providing high quality primary care to HNHC patients has proved to be challenging as the US faces a national shortage of primary care physicians compounded by growing rates of an aging and chronically ill population (IHS Markit, 2017; Raghupathi &

Raghupathi, 2018). In addition, considerable variability exists across HNHC patients in demographics, comorbidities, disease severity, and spending patterns (Clough et al., 2016; Joynt et al., 2017). Interventions which are broadly applied to the HNHC population fail to take into account these differences and consequentially have been unable to make sustainable improvements in outcomes or spending (Nelson, 2012; Ouayogodé et al., 2019). Thus, significant policy attention has been placed on enhancing primary care models to target specific needs of HNHC patients as a strategy to improve chronic disease management and reduce costs (Blumenthal et al., 2018; Joynt et al., 2017; O'Malley et al., 2019).

Over the past several decades, the nurse practitioner (NP) workforce has been increasingly leveraged to improve primary care access and quality amid workforce shortages and growing demands in care (Auerbach et al., 2020). NPs are ideally suited to support primary care for HNHC patients with co-occurring medical and behavioral health conditions given their holistic training to manage an individual's medical needs in conjunction with their social and emotional well-being (Grant et al., 2017). Indeed, compared to physicians, NPs are more likely to care for patients with multiple chronic conditions and complex social needs (i.e., HNHC patients) and provide care in a wider range of community settings with vulnerable populations (P. I. Buerhaus et al., 2015; Fraze et al., 2020).

Evidence exists describing the role of NPs in caring for HNHC patients as members of multidisciplinary care teams and in delivery of care coordination and disease education (Bleich et al., 2015; Long et al., 2017). However, little is known about how NPs use primary care practice structural capabilities such as reminders or disease registries to improve chronic disease management for HNHC patients (Friedberg et al., 2009, 2010; Martsolf, Ashwood, et al., 2018). Care coordination, for example, consists of the integration of personnel or activities used to

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manage patient care across the health care spectrum. Among HNHC patients, care coordination has been shown to be associated with fewer hospitalizations and ED visits (Duru et al., 2020) and to lower per beneficiary episode costs by $4,295 (Berkowitz et al., 2018). Effective care coordination is critical for HNHC patients as fragmented care across settings and between specialists is associated with increased rates of preventable hospitalizations and costs of care (Frandsen et al., 2015).

Other structural capabilities such as after-hours care which extends practice hours during the evening and on weekends is associated with 10.4% lower total expenditures (Jerant et al., 2012), fewer ED visits (30.4% versus 37.7%), and lower rates of unmet medical need among US adults (O'Malley, 2013). In addition, availability of shared communication systems allow practices to contact and remind patients who are due for primary care services. Patient reminders are a successful strategy to improve patient appointment and medical compliance (Schwebel & Larimer, 2018), cancer screenings (Nease et al., 2008), and chronic disease outcomes (K. A. Peterson et al., 2020). Thus, the purpose of this study is to analyze the association between ED utilization and structural capabilities (i.e., care coordination, after-hours care, chronic disease registries, and shared communication systems) at primary care practices where NPs deliver care to HNHC patients with behavioral health conditions.

<p align="center">**5.3 Methods**</p>

Data Sources and Attribution Process

We completed a secondary analysis of cross-sectional data produced for a large study focused on eliminating racial and ethnic health disparities in chronic disease outcomes in NP practices (PI: Poghosyan, R01MD011514). The parent study collected survey data from primary

care NPs in 2018-2019 providing data on structural capabilities. Survey data was merged with Medicare Part A and Part B billing claims on HNHC patients and ED utilization.

Data Sources

Survey Data

As part of the parent study, researchers sent surveys to 5,689 NPs in six states: Arizona, Washington, New Jersey, Pennsylvania, California, and Texas. These states were selected as they have varying scope of practice laws governing the ability for NPs to practice as primary care providers and independently evaluate, diagnose, interpret tests, and treat patients (AANP, 2021). NPs were identified through the OneKey database from IQVIA, which includes the most complete information on office-based providers in the US including contact information, practice location, network affiliation, and national provider identifier (DesRoches et al., 2015). Using a modified Dillman method (Dillman et al., 2014), three rounds of mail and online surveys were sent out with reminder postcards to eligible respondents. After the third survey prompt, phone call reminders were made to NPs who did not complete the survey. Overall, 1,244 NPs completed and returned the surveys, with a response rate of 21.9%. A non-response analysis was undertaken to assess for non-response bias and determined to have low bias (Harrison et al., 2021). After the completion of the survey, researchers for the parent study requested Medicare Claims to gather patient level data.

Medicare Claims

Demographic, clinical, and utilization data was obtained from 2019 for beneficiaries attributed to primary care practices in our survey. The parent study obtained Medicare Part A and Part B billing claims which includes all claims submitted by inpatient and outpatient institutional

providers and individual clinicians. The Medicare Beneficiary Summary File was used to obtain patient level information including demographic information (e.g., age, sex, and race).

Attribution Process

Beneficiaries were attributed to primary care practices by first determining whether the primary care practices of clinicians (physician or NP) were the beneficiaries' dominant primary care practices. Researchers for the parent study collected National Provider Identifiers for all physicians and NPs practices included in the survey data from the IQVIA OneKey healthcare database. Beneficiaries were linked to primary care providers who delivered the highest proportion of primary care evaluation and management paid amounts to a given beneficiary in the target year as long. To ensure that providers and beneficiaries had an established and reasonably strong existing relationship, providers were required to deliver a minimum threshold of 30% of evaluation and management paid amounts (Mehrotra et al., 2010). In the rare case of ties (< 1%), one primary care clinician was randomly selected. Practices were randomly selected for clinicians working in multiple practices (< 3% of survey sample). Beneficiaries without a single, main provider (either physician or NP) were excluded from the analysis.

Patient Sample

Our total sample prior to identifying HNHC patients included 151,587 Medicare, fee-for-service beneficiaries attributed to 240 practices in Arizona and Washington. We extracted data on beneficiaries attributed to practices in Arizona and Washington as these states offer full scope of practice regulation allowing NPs treat patients independently as primary providers (AANP, 2021). Our total sample of Medicare beneficiaries (N = 151,587) excluded individuals less than 65 years old or those without continuous enrollment in Parts A or B during the study period.

To identify HNHC patients, we sampled high-need patients with a predisposition for being in the top percentage of high-cost patients by their number and type of comorbidities identified by recent studies (Figueroa et al., 2017; Joynt et al., 2013; Keeney et al., 2019). HNHC patients were sampled if they were 65 years or older with at least two chronic conditions (n = 70, 182). Chronic conditions included: congestive heart failure, cardiovascular disease, diabetes, hypertension, cerebrovascular disease, and chronic pulmonary disease which includes chronic obstructive pulmonary disease and asthma. Consistent with research on HNHC patients, we excluded beneficiaries with dementia and metastatic cancer as these conditions are predisposed to high costs and typically not amenable to change (Bailey et al., 2019; Bélanger et al., 2019). Chronic conditions were identified in the CMS Chronic Condition Warehouse. Primary and secondary International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis from both outpatient and inpatient claims files were used to define the chronic conditions.

We further subsampled HNHC patients with behavioral health conditions by selecting individuals with at least two chronic conditions plus an additional diagnosis of depression (n = 12,745), alcohol use (n = 1,377), or substance use disorder (n = 1,783). Using both inpatient and outpatients ICD-10-CM, alcohol use was defined based on Quan (2015)'s ICD-10-CM as consuming more than 2 alcoholic drinks per day or self-report of alcohol abuse or dependence; and substance use disorder was defined as any illicit drug use including cocaine, opioids, hallucinogens, or psychoactive substances (Quan et al., 2005).

Independent Variable

Our independent variable was the presence of structural capabilities within primary care practices measured by the Structural Capability Index (SCI) contained within the NP survey. The

SCI is a validated tool intended to measure structural capabilities that are used to deliver high quality primary care (Friedberg et al., 2008; Martsolf, Ashwood, et al., 2018). Previous research has applied the SCI to explore medical home capabilities and the impact of structural capabilities on patient outcomes, patient satisfaction, and quality of care (Friedberg et al., 2008, 2009; Martsolf, Ashwood, et al., 2018; Martsolf, Kandrack, et al., 2018).

We selected four structural capability subscales from the SCI: (1) *after-hours care* [2 items] is a measure of whether a practice has extended evening or weekend practice hours; (2) *care coordination* [7 items] indicates if a practice has staff designated to support patients access community and social services, assist with disease and medication management, schedule appointments, and integrate care across the health care spectrum; (3) *shared communication systems* [3 items] is the extent to which a practice uses systems to contact and remind patients who are due for primary care services, following a hospitalization, or who have not had an appointment for an extended period; and (4) *chronic disease registries* [1 item] asks if practices have the ability to make lists or monitor patients who are overdue for chronic disease services.

The majority of structural capabilities were measured on subscales with binary (yes/no) responses where NPs reported on the presence or absence of each structural capability. We dichotomized all other subscales to a binary scale by operationalizing the structural capability as present if more than 50% of items were reported as present which is consistent with prior research (Martsolf, Ashwood, et al., 2018). Structural capability scores were aggregated to the practice level for analysis as the SCI is conceptualized as shared perceptions of all NPs about the characteristics of primary care practices where they work. Table 5.1 presents the structural capabilities and corresponding survey items.

Outcome Variables

All-cause ED utilization and preventable ED utilization were the outcome variables. We used Part B "carrier" claims to identify ED utilization – number of ED visits per year. Provider-defined ED visits are those with Part B claims for Healthcare Common Procedure Coding System codes 99281, 99282, 99283, 99284, and 99285 (Venkatesh et al., 2017). We categorized preventable ED utilization as an ED visit for an ambulatory care sensitive condition that has any evidence of being avoidable or primary care treatable according to the widely used "NYU ED Algorithm" developed by Billings and colleagues (NYU Wagner, 2017). For each ED visit for an ambulatory care sensitive condition visit, the algorithm assigns a probability based on the primary ICD-10-CM diagnosis that the visit is in one of the five categories: (1) Non-Emergent; (2) Emergent, Primary Care Treatable; (3) Emergent, ED Care Needed, Preventable/Avoidable; (4) Emergent, ED Care Needed, Not Preventable/Avoidable; (5) All other. In this study, if an ED visit had any positive probability of belonging in the first three categories, it was operationalized as preventable ED utilization, all other ED visits were categorized as all-caused ED utilization.

Covariates

To assess the relationship between structural capabilities and ED utilization, in our models we controlled for patient age, sex, race, and ethnicity from the Medicare Beneficiary Summary File. We also controlled for practice characteristics including practice size (i.e., total number of NPs, physicians, and physician assistants within the practice), practice type (e.g., physician practice, hospital-based clinic, community health center, etc.), and practice location (i.e., urban or rural location). Practice location was determined using the ZIP code Version 3.1 of the Rural–Urban Commuting Area codes which classify rural-urban designations based on population density and work commuting patterns (U.S. Department of Agriculture Economic Research Service, 2020). Practices were defined as urban if they had 30% or more of their

workers going to a region indicated as an urbanized area and rural if they had less than 30% (Germack et al., 2020).

Statistical Analysis

We used bivariate analyses to compare demographics, comorbidities, and ED utilization of HNHC patients to non-HNHC patients. We also examined differences in comorbidities, ED utilization, and presence of structural capabilities across overall HNHC patients compared to HNHC patients with behavioral health conditions. Chi-squared tests of significance were used for categorical variables and t-tests were used for continuous variables.

We built zero-inflated, adjusted Poisson models to analyze the association between structural capabilities and the dependent variables of interest (i.e., all-cause and preventable ED utilization) among: (1) HNHC patients; (2) HNHC patients with depression; (3) HNHC patients with alcohol use; and (4) HNHC patients with substance use disorder. Zero-inflated Poisson models effectively estimate count data with excessive zeros (Mouatassim & Ezzahid, 2012). We present the exponentiated Poisson regression coefficients, which are the log of the rate ratio. Rate ratios are interpreted as the incidence rate at which events occur. The intraclass correlation was low for both outcomes (2.9% for all-cause ED visits and 2.6% for preventable ED visits), demonstrating sufficient variability in clusters of patients within practices (S. Park & Lake, 2005). We also determined that the risk of multicollinearity was within an acceptable range by calculating the variance inflation factor which was less than five for all covariates (See Appendix E for a detailed description). All statistical analyses were completed in R Studio Version 1.3 with the significance level set at $p < .05$.

<div align="center">

5.4 Results

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Characteristics of HNHC Patients

We identified 70,182 HNHC patients attributed to 240 primary care practices in Arizona and Washington. There were significant differences in patient and practice characteristics across HNHC and non-HNHC patients (Table 5.2). HNHC patients were more likely to be older with a mean age of 76 years and male compared to non-HNHC patients ($p < .001$). The majority of HNHC patients (88%) were non-Hispanic White, but HNHC patients were more likely to be Black and Hispanic. HNHC patients had on average, significantly higher rates of both all-cause (0.59 versus 0.27, $p < .001$) and preventable ED utilization (0.34 versus 0.14, $p < .001$). Practices caring for HNHC patients were predominantly physician-run practices (55%) and based in urban settings (92%).

Characteristics of HNHC Patients with Behavioral Health Conditions

HNHC patients with behavioral health conditions were more likely to be younger compared to the overall HNHC population (Table 5.3). HNHC patients with alcohol use were more likely to be male while HNHC patients with depression and substance abuse were more likely to be female ($p < .001$). HNHC patients with depression and alcohol use were more likely to be non-Hispanic White compared to the overall HNHC population while HNHC patients with substance abuse were less likely to be non-Hispanic White ($p < .001$).

HNHC patients with behavioral health conditions had significantly higher averages of all-cause and preventable ED utilization per year compared to the overall HNHC population ($p < .001$). Specifically, HNHC patients with substance use disorders had the highest average rate of ED utilization for both all-cause ED visits (1.45 versus 0.6, $p < .001$) and preventable ED visits (0.84 versus 0.34, $p < .001$) compared to the overall HNHC population, but also compared to HNHC patients with depression or alcohol use disorder.

Distribution of Structural Capabilities

There were significant differences in the prevalence of structural capabilities across practices caring for HNHC patients with behavioral health conditions compared to practices caring for the overall HNHC population (Table 5.3). Care coordination was significantly more likely to be delivered in practices serving HNHC patients with depression, alcohol use, and substance use disorder compared to the overall HNHC population ($p < .05$). Patients with substance use disorders were significantly more likely to receive care in practices with shared communication systems, chronic disease registries, and after-hours care capabilities.

Relationship between Structural Capabilities and ED Utilization

Table 5.4 presents the results of the exponentiated, zero-inflated Poisson models. There were significant negative associations between shared communication systems and care coordination and rates of ED utilization. Among HNHC patients with alcohol use, shared communication systems were associated with a 28% lower rate of all-cause ED utilization (aRR 0.72, 95% CI: -0.48, -0.18, $p < .001$) and a 50% lower rate of preventable ED utilization (aRR 0.5, 95% CI: -0.92, -0.45, $p < .001$). For HNHC patients with substance use disorders, shared communication systems were associated with a 24% lower rate of all-cause ED utilization (aRR 0.76, 95% CI: -0.38, -0.16, $p < .001$) and a 39% lower rate of preventable ED utilization (aRR 0.61, 95% CI: -0.66, -0.34, $p < .001$). Care coordination was associated with a 24% lower rate of ED utilization among HNHC patients with alcohol use (aRR 0.76; 95% CI: -0.44, -0.11, $p < .01$) and a 4% lower rate of ED utilization among the overall HNHC population (aRR 0.96; 95% CI: -0.07, -0.01; $p < .01$). Care coordination was not significantly associated with differences in ED utilization among HNHC patients with depression or substance use disorder.

Two structural capabilities (chronic disease registries and after-hours care) were positively associated with ED utilization. Chronic disease registries were associated with higher

rates of preventable ED utilization among HNHC patients with behavioral health conditions, but not among the overall HNHC population. After-hours care was also associated with higher rates of ED utilization among HNHC patients with depression (aRR: 1.09, 95% CI: 0, 0.17, p < .01) and among the overall HNHC patients (aRR: 1.07, 95% CI: 0.03, 0.1, p < .001).

<div align="center">**5.5 Discussion**</div>

This is the first study to investigate structural capabilities in primary care practices serving HNHC patients with behavioral health conditions. Despite HNHC Medicare beneficiaries being more likely to have a behavioral health diagnosis (Joynt et al., 2017), the literature base is limited on best practices to treat HNHC patients with behavioral health conditions in primary care. Our results demonstrate significant differences demographically and in utilization patterns in HNHC patients with behavioral health conditions compared to the overall HNHC population. In addition, we found significant variability in the association between structural capabilities and ED utilization across the overall HNHC population and HNHC patients with depression, alcohol use, and substance use disorders even after adjusting for patient and practice characteristics. These findings suggest that targeting HNHC patients with specific needs can more effectively improve chronic disease management and increase savings.

Only two structural capabilities – shared communication systems and care coordination– were associated with decreased rates of ED utilization. Shared systems for communication can support a proactive approach to primary care delivery through reminders for patients who are due for preventive or chronic care. We found that among HNHC patients with alcohol use and substance use disorders, shared systems for communication were associated with decreased rates of both all-cause and preventable ED utilization. Indeed, use of reminders is a successful strategy to improve patient appointment and medical compliance (Schwebel & Larimer, 2018), increase

cancer screenings (Nease et al., 2008), and improve diabetic management such as completing recommended laboratory testing and exams (Han et al., 2016; K. A. Peterson et al., 2020).

Reminders are particularly helpful for providers caring for patients with alcohol and substance use disorders as they can support screening, identification of unhealthy behaviors, and early intervention (Tai et al., 2014). Use of alcohol counseling reminders among adults is associated with a decrease in unhealthy alcohol use at follow-up screenings (Williams et al., 2009) and a decrease in non-attendance for mental health care appointments for patients with substance use disorders (Blaauw et al., 2019). Care reminders can also support compliance with behavioral health and mental health treatments by anticipating and preventing potential relapses between appointments. Our findings suggest that the use of reminders has potential for providers to improve care for HNHC patients with alcohol and substance abuse at low cost to practices.

There is longstanding interest in implementing care coordination models in practices caring for HNHC patients (Hochman & Asch, 2017; Long et al., 2017). HNHC patients have chronic medical, behavioral health, and social needs requiring integration of resources and services which care coordination can support. However, recent studies indicate that the impact of care coordination differs across the HNHC population when measuring hospitalization rate, ED utilization, and total costs of care (Berkowitz et al., 2018; R. S. Brown et al., 2012; Duru et al., 2020). For example, Brown et al. found care coordination reduced hospitalizations only when directed at HNHC patients with a higher-risk of being hospitalized. Duru et al. demonstrated that care coordination decreased ED utilization only among HNHC patients with diabetes plus additional behavioral health and social needs. Similarly, in our study we found that care coordination made significant differences in the overall HNHC population and those with alcohol use, but not among HNHC patients with depression and substance use disorder.

Barriers to effective care coordination are heightened among patients with mental health issues or substance abuse. Inadequate care coordination often occurs due to poor screening and identification of mental or behavioral health conditions in the primary care setting or due to poor integration of care between primary care and treatment or rehabilitation facilities (Knickman et al., 2016; US Department of Health and Human Services, 2016). In a recent survey of insured, nonelderly adults with a mental health issue, more than half reported experiencing adverse consequences of ineffective care coordination including duplicated tests, having test results not ready at the time of appointment, or receiving conflicting information from providers (Kleiman et al., 2016). In addition to poor patient outcomes, ineffective care coordination is estimated to be responsible for anywhere from $27.2 billion to $78.2 billion in annual health care waste (Shrank et al., 2019). Future research should focus on investigating how to optimize care coordination models for patients with behavioral health conditions given its potential to improve patient outcomes, reduce wasteful spending, and produce substantive savings.

Analyzing administrative claims limits our ability to explore events which may immediately precede an ED visit. In our study, after-hours care and chronic disease registries were associated with increased rates of ED utilization among HNHC patients with behavioral health conditions. However, we were unable to decipher whether a patient visited their primary care practice after-hours and was explicitly referred to the ED by their primary provider. We were also unable to assess if the association between disease registries and ED utilization was in response to a sicker patient population. Sicker patients are more likely to be over represented in disease registries are they are used to track the longitudinal impact of therapies used for patients with more severe illness (Jackson & Goss, 2018) and they pull data from electronic medical records which collect more data on sicker patients (Institue of Medicine, 2011). Preventable ED

visits, specifically, can be attributed to a multitude of factors including convenience, patient preference, or referral by a primary care provider (Uscher-Pines et al., 2014). Future research should incorporate qualitative investigation to better understand the patient decision making process and to capture real time physical, emotional, and socioeconomic factors which immediately precede an ED visit.

Expansion of the NP workforce has significant implications as a cost-effective strategy to improve coordinated primary care delivery for HNHC patients (Auerbach et al., 2020; Fraze et al., 2020). Nearly all interventions implemented with HNHC patients include nurses or nurse practitioners either as members of interdisciplinary care teams or leading delivery of patient-focused chronic disease management, education, or counseling (Bleich et al., 2015; Hochman & Asch, 2017; Long et al., 2017). Yet, this is the first study to evaluate primary care practices where NPs deliver care to HNHC patients. We recommend future research to continue exploring the primary care practices where NPs deliver care to HNHC patients in order to optimize the NP workforce and use of structural capabilities in improving primary care delivery.

5.6 Limitations

We sampled NPs from two states with full scope of practice regulation, limiting the extent to which these findings can be generalized to other states with reduced or restricted scope of practice regulation. Our sample included Medicare fee-for-service beneficiaries who are 65 years or older, limiting our ability to generalize findings to patients younger than 65 or to patients with other insurance plans (e.g., Medicare Advantage, Medicaid, or private insurance). Medicare Advantage penetration is 42% in AZ and 36% in WA which is comparable to the national average of 39% (Freed et al., 2021). There are inherent limitations in analyzing administrative claims data including the potential to miss patients who are undiagnosed or underreported. In

addition, administrative claims do not include information on social determinants of health such as education level, income, housing, or social isolation which particularly impact utilization and health status in HNHC patients (DuGoff et al., 2019; Ryan et al., 2016). Finally, cross-sectional data limits our ability to infer causal relationships or assess long-term patient outcomes, utilization, or medical expenditures.

5.7 Conclusion

Targeting interventions to the specific medical or behavioral health needs of HNHC patients may be a useful strategy to increase effectiveness. We found significant differences in the association between structural capabilities and ED utilization across HNHC patients with behavioral health conditions. Among HNHC patients with alcohol use and substance use disorders, shared communication systems were associated with decreased rates of ED utilization and show promise for improving primary care delivery and chronic disease management. Care coordination was associated with decreased rates of ED utilization across some, but not all HNHC patients. Future research should explore how traditional care coordination models may be tailored to better address the wide-ranging medical and behavioral health needs.

Table 5.1

Structural Capability Subscales and Corresponding Survey Items

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After Hours Care

How many nights per week is your practice open for patient visits during extended evening hours?

Is your practice setting regularly open to provide care on Saturdays or Sundays?

Care Coordination

Does your practice have designated staff for care management services and/or care coordination? If yes, which of the following are provided:

    Creating and managing patient problem lists

    Providing resources to assist self-management of symptoms, conditions, and medications

    Medication management and reconciliation

    Helping patients access community and social services

    Helping patients schedule appointments

    Coordinating care between clinicians, hospitals, pharmacists, labs, insurance companies, and imaging services

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Shared Communication Systems

Do clinicians at your practice use a shared communication system to contact patients:

    Who are due for guidelines recommended for chronic conditions?

    After a hospitalization?

    Who have not had an appointment for an extended period?

Chronic Disease Registry

Does your practice have a registry that creates a list of patients who are overdue for their chronic disease services (e.g., hemoglobin A1c in diabetes; cholesterol in coronary artery disease)?

Table 5.2

Descriptive Statistics of HNHC Patients Compared to Non-HNHC Patients, 2019

	Total Sample N = 151,587	Non-HNHC n = 81,405	HNHC n = 70,182	p[1]
Demographic Characteristics, n (%)				
Mean Age (years)	75	74	76	< .001
Female	88,536 (58%)	51,618 (63%)	36,918 (53%)	< .001
Race and Ethnicity				< .001
Non-Hispanic White	132,810 (89%)	72,183 (91%)	60,627 (88%)	
Black	2,672 (1.8%)	1,097 (1.4%)	1,575 (2.3%)	
Asian	4,054 (2.7%)	2,127 (2.7%)	1,927 (2.8%)	
Hispanic	5,896 (4.0%)	2,638 (3.3%)	3,258 (4.7%)	
Other[2]	3,268 (2.2%)	1,438 (1.8%)	1,830 (2.6%)	
Comorbidities, n (%)				
Mean number of conditions (SD)	1.58 (1.24)	0.62 (0.48)	2.68 (0.90)	< .001
CHF	16,836 (11%)	538 (0.7%)	16,298 (23%)	< .001
Chronic Pulmonary Disease	32,292 (21%)	5,572 (6.8%)	26,720 (38%)	< .001
Diabetes	36,158 (24%)	3,025 (3.7%)	33,133 (47%)	< .001
Cerebrovascular Disease	17,837 (12%)	1,379 (1.7%)	16,458 (23%)	< .001
HTN	105,103 (69%)	38,642 (47%)	66,461 (95%)	< .001
Alcohol Use	2,431 (1.6%)	1,054 (1.3%)	1,377 (2.0%)	< .001
Substance Use	3,006 (2.0%)	1,223 (1.5%)	1,783 (2.5%)	< .001
Depression	24,408 (16%)	11,663 (14%)	12,745 (18%)	< .001
Mean Utilization per year				
All-Cause ED visits (SD)	0.41 (1.03)	0.25 (0.69)	0.6 (1.30)	< .001
Preventable ED visits (SD)	0.23 (0.70)	0.14 (0.47)	0.34 (0.89)	< .001
Practice Characteristics, n (%)				
State				< .001
Arizona	62,880 (41%)	32,945 (39%)	29,935 (44%)	
Washington	88,707 (59%)	50,658 (61%)	38,049 (56%)	
Practice Type				< .001
Physician Practice	81,127 (54%)	43,928 (53%)	37,199 (55%)	
Hospital-based Clinic	36,061 (24%)	20,553 (25%)	15,508 (23%)	
Community Health Center	5,595 (3.7%)	3,033 (3.7%)	2,562 (3.8%)	
All Other	27,397 (18%)	15,237 (18%)	12,160 (18%)	
Practice Size				< .001
Solo provider	373 (0.3%)	227 (0.3%)	146 (0.2%)	
2-20 Providers	102,406 (74%)	53,833 (72%)	48,573 (76%)	
> 20 Providers	36,315 (26%)	20,988 (28%)	15,327 (24%)	
Practice Location				0.2
Rural	11,545 (7.6%)	6,263 (7.7%)	5,282 (7.5%)	
Urban	140,042 (92%)	75,142 (92%)	64,900 (92%)	

Note. HNHC: high-need high-cost, CHF: congestive heart failure, CVD: cardiovascular disease, HTN: hypertension. Chronic pulmonary disease includes chronic obstructive pulmonary disease and asthma.

[1]Two sample t-test and Pearson's Chi-squared tests performed. [2]Other includes American Indian Alaskan Native.

Table 5.3

Demographics, ED Utilization, and Structural Capabilities of HNHC Patients, 2019

	HNHC: ref (n = 70,182)	HNHC and depression (n = 12,745)	HNHC and alcohol use (n = 1,377)	HNHC and substance use (n = 1,783)
Demographic Characteristics				
Mean Age (years)	76	75***	74***	74***
Female (%)	53	67***	33***	61***
Non-Hispanic White (%)	88	91***	90***	87***
Comorbidities (%)				
CHF	23	25**	31***	31***
Chronic Pulmonary Disease	38	46***	46***	51***
Diabetes	47	47	37***	43***
Cerebrovascular Disease	23	28***	31***	29***
CVD	41	40*	42	43
HTN	95	95	93**	95
Alcohol use disorder	2.0	3.5***	--	7.8***
Substance use disorder	2.5	6.1***	10***	--
Depression	18	--	32***	44***
Utilization per year, mean (range)				
ED Visits	0.6 (0, 108)	0.86*** (0, 35)	1.01*** (0, 108)	1.45*** (0, 108)
Preventable ED Visits	0.34 (0, 72)	0.49*** (0, 25)	0.49* (0, 72)	0.84*** (0, 72)
Structural Capabilities (%)				
Care Coordination	32	34*	36*	35*
Chronic Disease Registries	54	55	54	57*
Shared Communication Systems	52	48	51	49*
After-Hours Care	26	26	26	28**

Note. HNHC: high-need high-cost, CHF: congestive heart failure, CVD: cardiovascular disease, ED: emergency department. Chronic pulmonary disease includes chronic obstructive pulmonary disease and asthma. Chi-squared tests were used to analyze the relationship between HNHC patient subgroups and the overall HNHC patient population. Structural capabilities were determined as present if nurse practitioners reported more than 50% of items on a subscale as present. Significance is compared to the reference group: HNHC patients.

*p < .05, ** p < .01, ***p < .001.

Table 5.4

Association Between Structural Capabilities and ED Utilization among HNHC Patients with Behavioral Health Conditions, 2019

	Care Coordination	Chronic Disease Registries	Shared Communication Systems	After-Hours Care
	aRR (95% CI)			
HNHC (n = 68,648)				
All-cause ED utilization	0.96** (-0.07, -0.01)	1 (-0.03, 0.03)	1.01 (-0.03, 0.04)	1.07*** (0.03, 0.1)
Preventable ED utilization	0.96 (-0.09, 0.01)	1.04 (-0.01, 0.09)	1 (-0.05, 0.05)	1.05 (0, 0.09)
HNHC & Depression (n = 12,500)				
All-cause ED utilization	0.95 (-0.1, 0.01)	1.02 (-0.04, 0.08)	1 (-0.06, 0.06)	1.09** (0.03, 0.14)
Preventable ED utilization	0.97 (-0.12, 0.05)	1.09* (0, 0.17)	0.96 (-0.13, 0.04)	1.06 (-0.03, 0.14)
HNHC & Alcohol Use (n = 1,344)				
All-cause ED utilization	0.76** (-0.44, -0.11)	1.59*** (0.32, 0.61)	0.72*** (-0.48, -0.18)	1.04 (-0.12, 0.19)
Preventable ED utilization	0.78 (-0.54, 0.04)	1.96*** (0.44, 0.91)	0.5*** (-0.92, -0.45)	0.89 (-0.36, 0.14)
HNHC & Substance Use Disorder (n = 1,751)				
All-cause ED utilization	0.95 (-0.16, 0.05)	1.38*** (0.21, 0.43)	0.76*** (-0.38, -0.16)	1.1 (-0.01, 0.19)
Preventable ED utilization	0.96 (-0.2, 0.11)	1.63*** (0.33, 0.64)	0.61*** (-0.66, -0.34)	1.03 (-0.12, 0.18)

Note. ED: emergency department, HNHC: high-need high-cost, aRR: adjusted rate ratio. Exponentiated aRR estimates are from zero-inflated adjusted Poisson models, one for each dependent variable (i.e., ED use and preventable ED use) and for each HNHC subgroup. Models adjusted for age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and practice setting (rural or urban).

For the full output from each of the regression models, see Appendix F.

*p < .05, ** p < .01, *** p < .001.

Conclusion

This chapter summarizes the results of studies presented in this dissertation. Strengths and limitations of the overall dissertation will be discussed as well as the contributions to science, and implications for policy, practice, and future research.

The overall purpose of this dissertation was to identify and evaluate the structural capabilities used in primary care practices where nurse practitioners (NPs) deliver care to underserved and high-need high-cost (HNHC) populations. Studies included in this dissertation use cross-sectional survey data collected in 2018-2019 from primary care NPs as part of a large study focused on racial and ethnic disparities in chronic disease outcomes in NP practices. Survey data provided information on practice characteristics and structural capabilities and was linked to Medicare Part A and Part B billing claims to identify HNHC patients and emergency department (ED) utilization. Publicly available data on Health Professional Shortage Areas (HPSAs) was also linked to provide data on underserved areas. The studies included in this dissertation sought to (1) define the HNHC population, (2) identify existing primary care and payment models used with HNHC patients, (3) evaluate structural capabilities in HPSA practices compared to non-HPSA practices, and (4) analyze the relationship between structural capabilities and ED utilization among HNHC patients with behavioral health conditions. The results for each individual study are summarized below.

Discussion of Principal Findings

Chapter Two: The concept analysis was conducted to provide a comprehensive definition of HNHC patients (Bilazarian, 2020). The Walker and Avant Framework (2019) consists of a review of the literature to identify all uses of the concept, determine defining attributes and antecedents and consequences, and construct model and alternative cases of the concept. Three subgroups of HNHC patients were identified: adults over the age of 65 with multiple chronic conditions with functional or behavioral health needs, the frail elderly, and patients under 65 years old with a serious mental health condition or disability. Antecedents that predispose an individual to becoming a HNHC patient include challenges accessing timely care, low

socioeconomic status, or unmet needs. HNHC patients can be categorized by a feedback loop of acute-on-chronic health conditions (i.e., acute exacerbations), preventable health service utilization, and fragmented care. Persistent high spending in HNHC patients occurs as a result of poorly managed chronic diseases leading to acute exacerbations, preventable health service utilization, and fragmented care between the acute and primary care settings.

Chapter Three: To understand how primary care practices are enhancing access and quality of chronic care for HNHC patients, we conducted a systematic review identifying existing primary care and payment models used with HNHC patients (Bilazarian et al., 2021). We also evaluated the association between primary care models, ED utilization, and health care costs. About half of the primary care models evaluated in the systematic review (11 out of 21 studies) showed no significant difference in ED utilization among HNHC patients. Care coordination and care management models (15 out of 21) had both positive and negative effects on ED utilization and overall costs. Primary care models that demonstrated significant reductions in ED utilization had shared features, including frequent follow-up, multidisciplinary team-based care, enhanced access, and care coordination.

Chapter Four: The growing NP workforce plays an important role in expanding primary care for rural and underserved populations (Barnes et al., 2018). We sought to explore if NP practices were more likely to have made structural changes – such as implementing after-hours care – to expand access to timely and high quality primary care in HPSAs compared to non-HPSAs. We evaluated NP practices in two states with full scope of practice laws (Arizona and Washington). Across all NPs in our sample, the majority (61%) delivered care in HPSA practices. These findings are consistent with research demonstrating that NPs are more likely to practice in HPSAs in states with full scope of practice laws (DePriest et al., 2020; Xue et al.,

2018). NP practices located in HPSAs were 77% more likely more likely to deliver care coordination compared to non-HPSA practices (OR 1.77, p < .05). We found no significant difference in prevalence of chronic disease registries, shared communication systems, or after-hours care in HPSA practices compared to non-HPSA practices.

Chapter Five: We analyzed the association between structural capabilities (i.e., care coordination, after-hours care, chronic disease registries, and shared communication systems) and ED utilization among HNHC patients with behavioral health conditions. HNHC patients with behavioral health conditions differed significantly from the overall HNHC population in demographics and rates of ED utilization. Shared communication systems were associated with a 50% decreased rate of preventable ED utilization among HNHC patients with alcohol use (aRR 0.5, p < .001) and a 39% decreased rate of preventable ED utilization among HNHC patients with substance use disorders (aRR 0.61, p < .001). Care coordination was associated with decreased rates of ED utilization among the overall HNHC population (aRR 0.96, p < .01) and those with alcohol use (aRR 0.76, p < .01), but not among HNHC patients with depression or substance use disorders. Chronic disease registries and after-hours care were associated with increased ED utilization among specific HNHC patients.

Table 6.1

Summary of Individual Study Findings

Chapter	Aim	Study Design	Results Summary	Journal (Status)
2	Establish a clear definition of HNHC patients	Concept Analysis	• Three HNHC subgroups were identified: adults over the age of 65 with multiple chronic conditions and functional or behavioral health needs, frail elderly, and patients under 65 years old with a serious mental health or disability • Antecedents that predispose becoming a HNHC patient include challenges accessing timely care, low socioeconomic status, or unmet needs • High spending occurs as a result of poorly managed chronic diseases leading to acute exacerbations, preventable health service utilization, and fragmented care	*Nursing Forum* (Published)
3	Identify existing primary care and payment models used among HNHC patients and evaluate their impact on ED utilization and costs	Systematic Review	• Of 21 care models, 11 showed no significant difference in ED use • Care coordination and case management models represented the majority of studies (15 out of 21) and had mixed effects on both ED use and overall costs • Studies that significantly reduced ED use had shared features, including frequent follow-up, multidisciplinary team-based care, enhanced access, and care coordination	*Journal of Emergency Nursing* (Published)
4	Evaluate structural capabilities in NP primary care practices in HPSAs	Bivariate Descriptive and Multivariable Logistic Regression Models	• The majority of NPs in our sample (61%) were working in HPSA practices • Care coordination was more likely to be delivered in HPSA practices • No significant difference in prevalence of registries, after-hours care, or shared communication systems	*American Journal of Managed Care* (Published)
5	Analyze the association between structural capabilities and ED utilization among HNHC patients with behavioral health conditions	Bivariate Descriptive and Multivariable Poisson models	• Shared communication systems were associated with decreased rates of ED utilization among HNHC patients with alcohol use and substance use disorders • Care coordination was associated with decreased rates of ED utilization among HNHC patients and those with alcohol use • Care coordination was not associated with ED utilization among HNHC patients with depression or substance use disorders	*Health Affairs* (Pending Submission)

Note. HNHC: high-need high-cost, ED: emergency department, NP: nurse practitioner, HPSA: Health Professional

Shortage Areas

Contributions to Science

Substantial literature exists demonstrating the ability of NPs to meet the growing demands in primary care to improve chronic disease management for HNHC patients and expand access to primary care for individuals residing underserved areas (Auerbach et al., 2018; P. Buerhaus et al., 2018; Fraze et al., 2020). However, little is known about the features or infrastructure of NP primary care practices which are needed to deliver high quality care. This dissertation produced some of the first evidence on primary care practices where NPs deliver care to HNHC patients and the relationship between structural capabilities and quality measures such as ED utilization.

Investigating structural capabilities in NP practices is useful amid recommendations to expand patient-centered medical homes (PCMHs). PCMHs are models of primary care that emphasize coordination and transitional care and often include many of the structural capabilities explored in this dissertation including disease registries, after-hours care, care coordination, or scheduling systems (Burton et al., 2020; Carlin et al., 2016; Friedberg et al., 2008). Additionally, NPs play a significant role in the PCMH model given their emphasis on chronic care and disease education. The rate of NPs in PCMHs is nearly twice as high as physicians (J. Park, 2015) and NP-led PCMHs are more likely to be located in HPSAs serving vulnerable and underserved populations compared to physician-led PCMHs (J. Park & Dowling, 2020). As primary care practices undergo structural transformations to adopt the PCMH model, our findings can contribute knowledge on the use and adoption of structural capabilities.

In addition, our results can shed light on how heterogeneity in the HNHC population can impact intervention effectiveness. We found significant variability in the relationship between structural capabilities and ED utilization across HNHC patients with behavioral health

conditions. For example, care coordination was associated with decreased rates of ED use among the overall HNHC population and those with alcohol use, but not among HNHC patients with depression or substance use disorders. These findings point to the potential for interventions to increase effectiveness by targeting the specific medical, social, or behavioral health needs of HNHC patients.

This dissertation is timely and related to recommendations from the recent National Academy of Medicine report (2021) to deploy the NP workforce as a cost-effective strategy to expand primary care. Studies in this dissertation contribute to the report's request for research to (1) explore the nurses' role in improving access to behavioral health care, (2) evaluate the effectiveness of interventions aimed to improve primary care access and delivery systems, and (3) improve the care of aging and frail older adults to control health care spending and reduce costs. Specifically, these findings directly address gaps in the literature on how NPs may improve care for patients with behavioral health needs and for aging and chronically ill (i.e., HNHC) populations.

Strengths

Studies included in this dissertation are strengthened by rigorous methodology to limit the potential for bias and confounding. Several quality assurance checks were conducted to assess the robustness of our findings including tests for multicollinearity, outliers, dispersion, and intraclass correlation (see Appendix E). Power analyses determined that our study samples were sufficient to determine a significant difference. In addition, survey data used to identify primary care practices is the only dataset containing a validated measure of the NP practice environment and structural capabilities in primary care practices (Harrison et al., 2021; Poghosyan et al., 2013). Linking survey data with administrative claims enabled us to evaluate

HNHC patients in the context of the overall population of Medicare beneficiaries and analyze patient level outcomes such as ED utilization.

Limitations

To evaluate practices where NPs deliver primary care, we sampled states with full scope of practice regulation governing NP practice (Arizona and Washington) limiting the generalizability of our findings to states with reduced or restricted scope of practice regulation. Given the use of cross-sectional data over a 12-month period, we were unable to infer causal relationships or assess long-term outcomes including utilization, medical expenditures, or clinical progress. The use of administrative data is also inherently limited in the ability to evaluate social determinants of health such as education level, income, housing, or social isolation which particularly impact health status and health service utilization in HNHC patients (Ryan et al., 2016). Additionally, there is potential for administrative claims data to miss patients who are undiagnosed or underreported. Self-reported survey data is subject to self-report bias, yet validated tools were used to control biases throughout survey development and data collection. Furthermore, researchers for the parent study conducted a nonresponse analysis after data collection demonstrating sufficient variation to characterize NP practice characteristics across different settings (Harrison et al., 2021).

Implications for Practice

Findings from this dissertation have implications for primary care practices caring for HNHC patients. The main primary care practice structural capabilities which were significantly associated with ED utilization were care coordination and patient reminders through shared communication systems. Reminders have the potential to support providers care for patients with alcohol and substance abuse disorders as they can support screening, identification of unhealthy

behaviors, and early intervention (Tai et al., 2014). Care coordination was significantly more likely to be delivered in HPSA practices and to HNHC patients with behavioral health conditions. Strategies may be utilized to improve effectiveness of care coordination in primary care through interoperability with specialists, integration with substance use treatment centers, or developing a resource directory for social or community services (Friedman et al., 2016; US Department of Health and Human Services, 2016). In addition, the Centers for Medicare & Medicaid Services have developed specific reimbursement codes to incentivize delivery of chronic care management and care coordination, however, these codes are not widely adopted by practices (Agarwal et al., 2020; Basu et al., 2015; National Academy of Medicine, 2021, p. 158). Emphasizing the use of reimbursement codes can support practices to invest in infrastructure and personnel which are needed to deliver effective care coordination and manage chronic diseases (Agarwal et al., 2020). Further research is needed to understand the barriers and facilitators to adoption of structural capabilities in primary care practices.

Implications for Policy

This dissertation produces timely, policy relevant findings that address national priorities identified by the Medicare Payment Advisory Commission (2019) and the National Academy of Medicine (2021) on primary care delivery and expanding NP workforce. In Chapter Four, the majority of NPs in our sample (61%) delivered care in HPSA practices, and NP practices located in HPSAs were significantly more likely to deliver care coordination compared to non-HPSA practices. Recent research also points to the direct relationships between state scope of practice regulation and ability of NPs to expand primary care access in HPSAs (DePriest et al., 2020; Kandrack et al., 2019; Xue et al., 2018). These findings can contribute to a growing body of

literature providing supportive evidence for continued expansion of full scope of practice regulation for NPs.

Alternative payment models such as Accountable Care Organizations (ACOs) can improve outcomes for HNHC patients whose complex needs require extensive attention, resources, and specialized staff (Hochman & Asch, 2017; O'Malley et al., 2019). ACOs align incentives for primary care providers by reimbursing for value rather than for individual services (Mccarthy et al., 2014). Additionally, many ACOs utilize predictive modeling and risk stratification to segment patients into subgroups and target similar needs (O'Malley et al., 2019; Ouayogodé et al., 2019). Findings from this dissertation demonstrate the need for interventions which target specific HNHC patients. Thus, continued evaluation of ACOs can determine whether value-based care models may or may not be achieving policy goals for HNHC patients and can inform the continued development of innovative primary care and payment models.

Implications for Future Research

This dissertation has identified areas where new evidence is needed to understand how to improve primary care delivery for HNHC patients. Specifically, future research is needed to produce evidence on best approaches to segmenting HNHC patients and determine the most effective features of shared communication systems.

(1) Identify best approaches to segmenting HNHC patients: Findings from this dissertation indicate that targeted interventions are needed to make sustainable changes to chronic disease management and overall costs in HNHC patients. However, in order to develop targeted interventions, research is first needed to identify best approaches to segmenting HNHC patients with wide-ranging needs. Future research should specifically evaluate existing strategies such as subgrouping HNHC patients by specific comorbidities and spending patterns,

socioeconomic needs, or risk for hospitalization (R. S. Brown et al., 2012; Duru et al., 2020; O'Malley et al., 2019).

(2) Analyze patient and provider outcomes across HPSA designation to evaluate the sensitivity of HPSA criteria: It is well documented that NPs are more likely to practice in HPSAs in states with full scope of practice regulation (DePriest et al., 2020; Kandrack et al., 2019; Xue et al., 2018). Yet, the formula used to designate primary care HPSAs does not take into account the availability of additional providers such as NPs or physician assistants which may reduce the accuracy of analyzing patient and provider outcomes across HPSA designations (*Designated HPSA*, 2020). Future research should evaluate the sensitivity of HPSA criteria in order to provide rigorous and reliable evidence on the quality of care provided by NPs in underserved areas.

(3) Determine the most effective features of shared communication systems for HNHC patients with substance use disorders: Shared communication systems were significantly associated with decreased all-cause and preventable ED utilization in HNHC patients with substance use disorder. However, survey data only provides information on the presence or absence of shared communication systems rather than describing their specific components such as how practices screen patients who are overdue, how frequently patients receive reminders, and if providers follow-up with patients who are not seen. Future research is needed to determine the essential components of shared communication systems and care coordination which are most effective at managing HNHC patients with substance use disorder.

(4) Incorporate the patient perspective using qualitative methods: Research on HNHC patients largely utilizes administrative claims to identify and investigate HNHC patients. Administrative claims data are limited in their ability to identify factors which precede or influence preventable ED utilization such as patient preferences for care, referral by primary care

provider, or difficulty obtaining timely appointments (Ryan et al., 2016; Uscher-Pines et al., 2014). Future research should incorporate qualitative investigation to better understand the patient decision making process and to capture real time physical, emotional, and socioeconomic factors which contribute to ED utilization.

Conclusion

Improving primary care is an urgent goal for policymakers to improve care and reduce soaring health care costs in HNHC patients. This dissertation provides timely evidence on structural capabilities in practices where NPs care for underserved and HNHC populations. NPs are more likely to deliver care coordination in practices located in underserved areas. Care coordination can be more effective at improving patient outcomes by targeting specific medical or behavioral health needs of HNHC patients. Through proactive reminders, shared communication systems show promise at improving primary care delivery and reducing ED utilization among HNHC patients with alcohol use and substance use disorders. Future research should continue to explore how structural capabilities may enable NPs to expand access to timely, high quality, cost-effective primary care.

References

Adams, M. L. (2017). Difference between younger and older us adults with multiple chronic conditions. *Preventing Chronic Disease*, *14*(76), 1–14. https://doi.org/10.5888/pcd14.160613

Agarwal, S. D., Barnett, M. L., Souza, J., & Landon, B. E. (2020). Medicare's care management codes might not support primary care as expected. *Health Affairs*, *39*(5), 828–837. https://doi.org/10.1377/hlthaff.2019.00329

Agency for Healthcare Research and Quality. (2016). *Care coordination measure for primary care survey*. https://www.ahrq.gov/ncepcr/care/coordination/quality/index.html

Allen, N. B., Diez-Roux, A., Liu, K., Bertoni, A. G., Szklo, M., & Daviglus, M. (2011). Association of health professional shortage areas and cardiovascular risk factor prevalence, awareness, and control in the multi-ethnic study of atherosclerosis (mesa). *Circulation: Cardiovascular Quality and Outcomes*, *4*, 565–572. https://doi.org/10.1161/CIRCOUTCOMES.111.960922

American Association of Nurse Practitioners. (2020). *Nurse Practitioners in Primary Care*. https://www.aanp.org/advocacy/advocacy-resource/position-statements/nurse-practitioners-in-primary-care

American Association of Nurse Practitioners. (2021). *State Practice Environment*. https://www.aanp.org/advocacy/state/state-practice-environment

Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: does it matter? *Journal of Health and Social Behavior*, *36*(1), 1–10. https://doi.org/10.1007/s

Anderson, G. F., Ballreich, J., Bleich, S., Boyd, C., DuGoff, E., Leff, B., Salzburg, C., & Wolff, J. (2015). Attributes common to programs that successfully treat high-need, high-cost

individuals. *American Journal of Managed Care*, *21*(11), e597–e600.

Anderson, G., & Horvath, J. (2004). The growing burden of chronic disease in america. *Public Health Reports*, *119*(3), 263–270. https://doi.org/10.1016/j.phr.2004.04.005

Auerbach, D. I., Buerhaus, P. I., & Staiger, D. O. (2020). Implications of the rapid growth of the nurse practitioner workforce in the us. *Health Affairs*, *39*(2), 273–279. https://doi.org/10.1377/hlthaff.2019.00686

Auerbach, D. I., Staiger, D. O., & Buerhaus, P. I. (2018). Growing ranks of advanced practice clinicians — implications for the physician workforce. *New England Journal of Medicine*, *378*(25), 2358–2360. https://doi.org/10.1056/nejmp1801869

Bailey, J. E., Surbhi, S., Wan, J. Y., Munshi, K. D., Waters, T. M., Binkley, B. L., Ugwueke, M. O., & Graetz, I. (2019). Effect of intensive interdisciplinary transitional care for high-need, high-cost patients on quality, outcomes, and costs: a quasi-experimental study. *Journal of General Internal Medicine*, *34*(9), 1815–1824. https://doi.org/10.1007/s11606-019-05082-8

Baker, L. C., MacAulay, D. S., Sorg, R. A., Diener, M. D., Johnson, S. J., & Birnbaum, H. G. (2013). Effects of care management and telehealth: a longitudinal analysis using medicare data. *Journal of the American Geriatrics Society*, *61*(9), 1560–1567. https://doi.org/10.1111/jgs.12407

Barnes, H., Richards, M. R., McHugh, M. D., & Martsolf, G. (2018). Rural and nonrural primary care physician practices increasingly rely on nurse practitioners. *Health Affairs*, *37*(6), 908–914. https://doi.org/10.1377/hlthaff.2017.1158

Basu, S., Berkowitz, S. A., Phillips, R. L., Bitton, A., Landon, B. E., & Phillips, R. S. (2019). Association of primary care physician supply with population mortality in the united states, 2005-2015. *JAMA Internal Medicine*, *179*(4), 506–514.

https://doi.org/10.1001/jamainternmed.2018.7624

Basu, S., Phillips, R. S., Bitton, A., Song, Z., & Landon, B. E. (2015). Medicare chronic care management payments and financial returns to primary care practices: a modeling study. *Annals of Internal Medicine*, *163*(8), 580–588. https://doi.org/10.7326/M14-2677

Beach, S. R., Schulz, R., Friedman, E. M., Rodakowski, J., Martsolf, R. G., & James, A. E. (2018). Adverse consequences of unmet needs for care in high-need/high-cost older adults. *Journals of Gerontology: Social Sciences*, *00*(00), 1–12. https://doi.org/10.1093/geronb/gby021

Bélanger, E., Silver, B., Meyers, D. J., Rahman, M., Kumar, A., Kosar, C., & Mor, V. (2019). A retrospective study of administrative data to identify high-need medicare beneficiaries at risk of dying and being hospitalized. *Journal of General Internal Medicine*, *34*(3), 405–411. https://doi.org/10.1007/s11606-018-4781-3

Berenson, R. A., & Horvath, J. (2003). Confronting the barriers to chronic care management in medicare. *Health Affairs*, *Suppl*, 37–53. https://doi.org/10.1377/hlthaff.w3.37

Berkowitz, S. A., Parashuram, S., Rowan, K., Andon, L., Bass, E. B., Bellantoni, M., Brotman, D. J., Deutschendorf, A., Dunbar, L., Durso, S. C., Everett, A., Giuriceo, K. D., Hebert, L., Hickman, D., Hough, D. E., Howell, E. E., Huang, X., Lepley, D., Leung, C., … Brown, P. M. C. (2018). Association of a care coordination model with health care costs and utilization: the johns hopkins community health partnership (j-chip). *JAMA Network Open*, *1*(7), 1–14. https://doi.org/10.1001/jamanetworkopen.2018.4273

Bilazarian, A. (2020). High-need high-cost patients: a concept analysis. *Nursing Forum*, *August*, 1–7. https://doi.org/10.1111/nuf.12500

Bilazarian, A., Hovsepian, V., Kueakomoldej, S., & Poghosyan, L. (2021). A systematic review

of primary care and payment models on emergency department use in patients classified as high need, high cost. *Journal of Emergency Nursing*, 1–17. https://doi.org/10.1016/j.jen.2021.01.012

Billings, J., & Raven, M. C. (2012). Dispelling an urban legend: frequent emergency department users have substantial burden of disease. *Health Affairs*, *32*(12), 2099–2108. https://doi.org/10.1377/hlthaff.2012.1276

Blaauw, E., Riemersma, Y., Hartsuiker, C., Hoiting, J., & Venema, S. (2019). The influence of a short message service reminder on non-attendance in addiction care. *Substance Use and Misuse*, *54*(14), 2420–2424. https://doi.org/10.1080/10826084.2019.1650774

Bleich, S. N., Sherrod, C., Chiang, A., Boyd, C., Wolff, J., DuGoff, E., Salzberg, C., Anderson, K., Leff, B., & Anderson, G. (2015). Systematic review of programs treating high-need and high-cost people with multiple chronic diseases or disabilities in the united states, 2008–2014. *Preventing Chronic Disease*, *12*(197), 1–16. https://doi.org/http:// dx.doi.org/10.5888/pcd12.150275. PEER

Blumenthal, D., Anderson, G., Burke, S., Fulmer, T., Jha, A. K., & Long, P. (2016). Tailoring complex-care management, coordination, and integration for high-need, high-cost patients. In *National Academy of Medicine*.

Blumenthal, D., Chernof, B., Fulmer, T., Lumpkin, J., & Selberg, J. (2016). Caring for high-need, high-cost patients — an urgent priority. *New England Journal of Medicine*, *375*(10), 909–911. https://doi.org/10.1056/nejmp1608511

Blumenthal, D., McCarthy, D., & Shah, T. B. (2018). Academic medical centers and high-need, high-cost patients: a call to action. *Academic Medicine*, *93*(11), 1617–1619. https://doi.org/10.1097/ACM.0000000000002334

Bodenheimer, T. (2008). Coordinating care — a perilous journey through the health care system. In *New England Journal of Medicine* (Vol. 358, Issue 10). https://doi.org/10.1056/nejmhpr0706165

Boult, C., Reider, L., Leff, B., Frick, K. D., Boyd, C. M., Wolff, J. L., Frey, K., Karm, L., Wegener, S. T., Mroz, T., & Scharfstein, D. O. (2011). The effect of guided care teams on the use of health services: results from a cluster-randomized controlled trial chad. *Archives of Internal Medicine*, *171*(5), 460–466. https://doi.org/10.1001/archinternmed.2010.540

Brown, K., Levine, J. M., Fiellin, D. A., O'Connor, P., & Sledge, W. H. (2005). Primary intensive care: pilot study of a primary care–based intervention for high-utilizing patients. *Disease Management*, *8*, 169–177.

Brown, R. S., Peikes, D., Peterson, G., Schore, J., & Razafindrakoto, C. M. (2012). Six features of medicare coordinated care demonstration programs that cut hospital admissions of high-risk patients. *Health Affairs*, *31*(6), 1156–1166. https://doi.org/10.1377/hlthaff.2012.0393

Buerhaus, P. I., DesRoches, C. M., Dittus, R., & Donelan, K. (2015). Practice characteristics of primary care nurse practitioners and physicians. *Nursing Outlook*, *63*(2), 144–153. https://doi.org/10.1016/j.outlook.2014.08.008

Buerhaus, P., Perloff, J., Clarke, S., O'Reilly-Jacob, M., Zolotusky, G., & DesRoches, C. M. (2018). Quality of primary care provided to medicare beneficiaries by nurse practitioners and physicians. *Medical Care*, *56*(6), 484–490. https://doi.org/10.1097/MLR.0000000000000908

Bui, L. P., Hill-Briggs, F., Durkin, N., Apfel, A., Ephraim, P. L., Andon, L., Lalani, H. S., Dunbar, L., Appel, L. J., & Yeh, H. C. (2019). Does an all-condition case management program for high-risk patients reduce health care utilization in medicaid and medicare

beneficiaries with diabetes? *Journal of Diabetes and Its Complications*, *33*(6), 445–450. https://doi.org/10.1016/j.jdiacomp.2018.12.011

Burton, R. A., Zuckerman, S., Haber, S. G., & Keyes, V. (2020). Patient-centered medical home activities associated with low medicare spending and utilization. *Annals of Family Medicine*, *18*(6), 503–510. https://doi.org/10.1370/afm.2589

Buttorff, C., Ruder, T., & Bauman, M. (2017). Multiple chronic conditions in the united states. In *Multiple Chronic Conditions in the United States*. https://doi.org/10.7249/tl221

Capp, R., Misky, G. J., Lindrooth, R. C., Honigman, B., Logan, H., Hardy, R., Nguyen, D. Q., & Wiler, J. L. (2017). Coordination program reduced acute care use and increased primary care visits among frequent emergency care users. *Health Affairs*, *36*(10), 1705–1711. https://doi.org/10.1377/hlthaff.2017.0612

Carlin, C. S., Flottemesch, T. J., Solberg, L. I., & Werner, A. M. (2016). System transformation in patient-centered medical home (pcmh): variable impact on chronically ill patients' utilization. *Journal of the American Board of Family Medicine*, *29*(4), 482–495. https://doi.org/10.3122/jabfm.2016.04.150360

Centers for Medicare & Medicaid Services. (2018). *Medicare Spending by Number of Chronic Conditions, 2018*. https://portal.cms.gov/wps/portal/unauthportal/unauthmicrostrategyreportslink?evt=204800 1&src=mstrWeb.2048001&documentID=FE7B7B934CB8184F214E39982EB1F435&visM ode=0&currentViewMedia=1&Server=E48V126P&Project=OIPDA-BI_Prod&Port=0&connmode=8&ru=1&share=1&hid

Centers for Medicare & Medicaid Services. (2020). *National Health Expenditure Fact Sheet*. https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-

reports/nationalhealthexpenddata/nhe-fact-sheet.html

Chamberlain, A. M., Finney Rutten, L. J., Jacobson, D. J., Fan, C., Wilson, P. M., Rocca, W. A.,

    Roger, eronique L., & St Sauver, J. L. (2019). Multimorbidity, functional limitations, and

    outcomes: interactions in a population-based cohort of older adults. *Journal of Comorbidity*,

    9, 1–9. https://doi.org/10.1177/2235042X19873486

Clarke, J. L., Bourn, S., Skoufalos, A., Beck, E. H., & Castillo, D. J. (2017). An innovative

    approach to health care delivery for patients with chronic conditions. *Population Health*

    Management, *20*(1), 23–30. https://doi.org/10.1089/pop.2016.0076

Clough, J. D., Riley, G. F., Cohen, M., Hanley, S. M., Sanghavi, D., DeWalt, D. A., Rajkumar,

    R., & Conway, P. H. (2016). Patterns of care for clinically distinct segments of high cost

    medicare beneficiaries. *Healthcare*, *4*(3), 160–165.

    https://doi.org/10.1016/j.hjdsi.2015.09.005

Cohen, S., Yu, W., Machlin, S., & Chevan, J. (2012). The concentration and persistence in the

    level of health expenditures over time: estimates for the u.s. population, 2008-2009. *Agency*

    for Healthcare Research and Quality, *January*, 1–9.

    https://meps.ahrq.gov/data_files/publications/st354/stat354.pdf

Coleman, E. A., Eilertsen, T. B., Magid, D. J., Conner, D. A., Beck, A., & Kramer, A. M.

    (2002). The association between care coordination and emergency department use in older

    managed care enrollees. *International Journal of Integrated Care*, *2*(October), e03.

    http://www.ijic.org/

Coleman, E. A., Parry, C., Chalmers, S., & Min, S. (2006). The care transitions intervention.

    Arch Intern Med, *166*, 1822–1828. https://doi.org/10.1002/9781118785775.ch13

Columbia Public Health. (n.d.). *Population Health methods*. Retrieved May 19, 2021, from

https://www.publichealth.columbia.edu/research/population-health-methods/ridge-regression

Coughlin, T. A., & Long, S. K. (2009). Health care spending and service use among high-cost medicaid beneficiaries, 2002-2004. *Inquiry*, *46*(4), 405–417. https://doi.org/10.5034/inquiryjrnl_46.4.405

Cross, D. A., Cohen, G. R., Lemak, C. H., & Adler-Milstein, J. (2017). Sustained participation in a pay-for-value program: impact on high-need patients. *American Journal of Managed Care*, *23*(2), e33–e40.

David, G., Gunnarsson, C., Saynisch, P. A., Chawla, R., & Nigam, S. (2015). Do patient-centered medical homes reduce emergency department visits? *Health Services Research*, *50*(2), 418–439. https://doi.org/10.1111/1475-6773.12218

DePriest, K., D'Aoust, R., Samuel, L., Commodore-Mensah, Y., Hanson, G., & Slade, E. P. (2020). Nurse practitioners' workforce outcomes under implementation of full practice authority. *Nursing Outlook*, *68*(4), 459–467. https://doi.org/10.1016/j.outlook.2020.05.008

Designated health professional shortage areas statistics. (2020). Health Resources & Services Administration. https://data.hrsa.gov/tools/shortage-area/hpsa-find

DesRoches, C. M., Barrett, K. A., Harvey, B. E., Kogan, R., Reschovsky, J. D., Landon, B. E., Casalino, L. P., Shortell, S. M., & Rich, E. C. (2015). The results are only as good as the sample: assessing three national physician sampling frames. *Journal of General Internal Medicine*, *30*(3), 595–601. https://doi.org/10.1007/s11606-015-3380-9

Diaz, R., Behr, J. G., & Tulpule, M. (2012). A system dynamics model for simulating ambulatory health care demands. *Simulation in Healthcare*, *7*(4), 243–250. https://doi.org/10.1097/SIH.0b013e318259d134

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method (Vol. 4)*. John Wiley & Sons, Inc.

Din, A., & Wilson, R. (2020). Crosswalking zip codes to census geographies: geoprocessing the u.s. department of housing & urban development's zip code crosswalk files. *Cityscape*, *22*(1), 293–314. https://data.cityofnewyork.us/Social-Services/Rat-Sightings/3q43-55fe

Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *Journal of Epidemiology and Community Health*, *52*, 377–384. https://doi.org/10.1136/jech.52.6.377

Duchovny, N., Trachtman, S., & Werble, E. (2017). *Projecting Demand for the Services of Primary Care Doctors*. https://www.cbo.gov/system/files/115th-congress-2017-2018/workingpaper/52748-workingpaper.pdf

Dufour, I., Chouinard, M. C., Dubuc, N., Beaudin, J., Lafontaine, S., & Hudon, C. (2019). Factors associated with frequent use of emergency-department services in a geriatric population: a systematic review. *BMC Geriatrics*, *19*(185), 1–9. https://doi.org/10.1186/s12877-019-1197-9

DuGoff, E. H., Buckingham, W., Kind, A. J., Chao, S., & Anderson, G. F. (2019). Targeting high-need beneficiaries in medicare advantage: opportunities to address medical and social needs. *The Commonwealth Fund*, 1–14. http://www.ncbi.nlm.nih.gov/pubmed/30938944

Duru, O. K., Harwood, J., Moin, T., Jackson, N. J., Ettner, S. L., Vasilyev, A., Mosley, D. G., O'Shea, D. L., Ho, S., & Mangione, C. M. (2020). Evaluation of a national care coordination program to reduce utilization among high-cost, high-need medicaid beneficiaries with diabetes. *Medical Care*, *58*(6 Suppl 1), S14–S21.

https://doi.org/10.1097/MLR.0000000000001315

Edwards, S. T., Peterson, K., Chan, B., Anderson, J., & Helfand, M. (2017). Effectiveness of intensive primary care interventions: a systematic review. *J Gen Intern Med*, *32*(12), 1377– 1386. https://doi.org/10.1007/s11606-017-4174-z

Engel, K. G., Buckley, B. A., Forth, V. E., McCarthy, D. M., Ellison, E. P., Schmidt, M. J., & Adams, J. G. (2012). Patient understanding of emergency department discharge instructions: where are knowledge deficits greatest? *Academic Emergency Medicine*, *19*(9), E1035–E1044. https://doi.org/10.1111/j.1553-2712.2012.01425.x

Federally Qualified Health Centers (FQHCs) and the Health Center Program. (2019). Rural Health Information Hub. https://doi.org/10.4135/9781452240121.n119

Figueroa, J. F., Maddox, K. E. J., Beaulieu, N., Wild, R. C., & Jha, A. K. (2017). Concentration of potentially preventable spending among high-cost medicare subpopulations. *Annals of Internal Medicine*, *167*(10), 706–713. https://doi.org/10.7326/M17-0767

Figueroa, J. F., Zhou, X., & Jha, A. K. (2019). Characteristics and spending patterns of persistently high-cost medicare patients. *Health Affairs*, *38*(1), 107–114. https://doi.org/10.1377/HLTHAFF.2018.05160

Frandsen, B. R., Joynt, K. E., Rebitzer, J. B., & Jha, A. K. (2015). Care fragmentation, quality, and costs among chronically ill patients. *The American Journal of Managed Care*, *21*(5), 355–362.

Fraze, T. K., Briggs, A. D., Whitcomb, E. K., Peck, K. A., & Meara, E. (2020). Role of nurse practitioners in caring for patients with complex health needs. *Medical Care*, *58*(10), 853– 860. https://doi.org/10.1097/MLR.0000000000001364

Freed, M., Damico, A., & Neuman, T. (2021). *A Dozen Facts About Medicare Advantage in*

2020. Kaiser Family Foundation. https://www.kff.org/medicare/issue-brief/a-dozen-facts-about-medicare-advantage-in-2020/

Friedberg, M. W., Coltin, K. L., Safran, D. G., Dresser, M., & Schneider, E. C. (2010). Medical home capabilities of primary care practices that serve sociodemographically vulnerable neighborhoods. *Archives of Internal Medicine*, *170*(11), 938–944. https://doi.org/10.1001/archinternmed.2010.110

Friedberg, M. W., Coltin, K. L., Safran, D. G., Dresser, M., Zaslavsky, A. M., & Schneider, E. C. (2009). Associations between structural capabilities of primary care practices and performance on selected quality measures. *Annals of Internal Medicine*, *151*(7), 456–463. https://doi.org/10.7326/0003-4819-151-7-200910060-00006

Friedberg, M. W., Safran, D. G., Coltin, K. L., Dresser, M., & Schneider, E. C. (2008). Readiness for the patient-centered medical home: structural capabilities of massachusetts primary care practices. *Journal of General Internal Medicine*, *24*(2), 162–169. https://doi.org/10.1007/s11606-008-0856-x

Friedman, A., Howard, J., Shaw, E. K., Cohen, D. J., Shahidi, L., & Ferrante, J. M. (2016). Facilitators and barriers to care coordination in patient-centered medical homes (pcmhs) from coordinators' perspectives. *Journal of the American Board of Family Medicine*, *29*(1), 90–101. https://doi.org/10.3122/jabfm.2016.01.150175

Garnett, A., Ploeg, J., Markle-Reid, M., & Strachan, P. H. (2018). Self-management of multiple chronic conditions by community-dwelling older adults: a concept analysis. *SAGE Open Nursing*, *4*, 1–16. https://doi.org/10.1177/2377960817752471

Germack, H. D., Harrison, J., Poghosyan, L., & Martsolf, G. R. (2020). Practice patterns, work environments, and job outcomes of rural and urban primary care nurse practitioners.

Medical Care Research and Review, 1–10. https://doi.org/10.1177/1077558720974537

Grant, J., Lines, L., Darbyshire, P., & Parry, Y. (2017). How do nurse practitioners work in

primary health care settings? a scoping review. *International Journal of Nursing Studies*,

75, 51–57. https://doi.org/10.1016/j.ijnurstu.2017.06.011

Han, W., Sharman, R., Heider, A., Maloney, N., Yang, M., & Singh, R. (2016). Impact of

electronic diabetes registry "meaningful use" on quality of care and hospital utilization.

Journal of the American Medical Informatics Association, *23*(2), 242–247.

https://doi.org/10.1093/jamia/ocv040

Hardin, L., Kilian, A., Muller, L., Callison, K., & Olgren, M. (2017). Cross-continuum tool is

associated with reduced utilization and cost for frequent high-need users. *Western Journal*

of Emergency Medicine, *18*(2), 189–200. https://doi.org/10.5811/westjem.2016.11.31916

Harris, L. J., Graetz, I., Podila, P. S. B., Wan, J., Waters, T., & Bailey, J. E. (2016).

Characteristics of hospital and emergency care super-utilizers with multiple chronic

conditions. *Journal of Emergency Medicine*, *50*(4), 203–214.

https://doi.org/10.1016/j.jemermed.2015.09.002

Harrison, J., Germack, H. D., Poghosyan, L., D'Aunno, T., & Martsolf, G. (2021). Methodology

for a six-state survey of primary care nurse practitioners. *Nursing Outlook*.

https://doi.org/https://doi.org/10.1016/j.outlook.2021.01.010

Hastings, S. N., Schmader, K. E., Sloane, R. J., Weinberger, M., Goldberg, K. C., & Oddone, E.

Z. (2007). Adverse health outcomes after discharge from the emergency department -

incidence and risk factors in a veteran population. *Journal of General Internal Medicine*,

22(11), 1527–1531. https://doi.org/10.1007/s11606-007-0343-9

Hayes, S. L., Mccarthy, D., & Radley, D. (2016). The impact of a behavioral health condition on

high-need adults. In *To the Point*.

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? In *The Commonwealth Fund* (Vol. 26).

Health Resources & Services Administration. (2020). *What is Shortage Designation?* https://bhw.hrsa.gov/workforce-shortage-areas/shortage-designation

Hochman, M., & Asch, S. M. (2017). Disruptive models in primary care: caring for high-needs, high-cost populations. *Journal of General Internal Medicine*, *32*(4), 392–397. https://doi.org/10.1007/s11606-016-3945-2

Hoddinott, S. N., & Bass, M. J. (1986). The dillman total design survey method. *Canadian Family Physician*, *32*, 2366–2368. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2328022/pdf/canfamphys00201-0076.pdf

Holtrop, J. S., Luo, Z., & Alexanders, L. (2015). Inadequate reimbursement for care management to primary care offices. *Journal of the American Board of Family Medicine*, *28*(2), 271–279. https://doi.org/10.3122/jabfm.2015.02.140207

Hoque, D. M. E., Kumari, V., Hoque, M., Ruseckaite, R., Romero, L., & Evans, S. M. (2017). Impact of clinical registries on quality of patient care and clinical outcomes: a systematic review. *PLoS ONE*, *12*(9), 1–20. https://doi.org/10.1371/journal.pone.0183667

Hunsaker, S., Chen, H. C., Maughan, D., & Heaston, S. (2015). Factors that influence the development of compassion fatigue, burnout, and compassion satisfaction in emergency department nurses. *Journal of Nursing Scholarship*, *47*(2), 186–194. https://doi.org/10.1111/jnu.12122

IHS Markit. (2017). *2017 Update: The Complexities of Physician Supply and Demand:*

Projections From 2015 to 2030: Final Report. https://aamc-

black.global.ssl.fastly.net/production/media/filer_public/a5/c3/a5c3d565-14ec-48fb-974b-

99fafaeecb00/aamc_projections_update_2017.pdf

Institue of Medicine. (2011). *A Nationwide Framework for Surveillance of Cardiovascular and

Chronic Lung Diseases*. National Academies Press.

Institute of Medicine. (2011). The future of nursing: leading change, advancing health. In

National Academies Press. EDTNA-ERCA. https://doi.org/10.1111/j.1755-

6686.1999.tb00003.x

Jackson, A. D., & Goss, C. H. (2018). Epidemiology of cf: how registries can be used to advance

our understanding of the cf population. *Journal of Cystic Fibrosis*, *17*(3), 297–305.

https://doi.org/10.1016/j.jcf.2017.11.013

Jerant, A., Bertakis, K. D., Fenton, J. J., & Franks, P. (2012). Extended office hours and health

care expenditures: a national study. *Annals of Family Medicine*, *10*(5), 388–395.

https://doi.org/10.1370/afm.1382

Joynt, K. E., Figueroa, J. F., Beaulieu, N., Wild, R. C., Orav, E. J., & Jha, A. K. (2017).

Segmenting high-cost medicare patients into potentially actionable cohorts. *Healthcare*,

5(1–2), 62–67. https://doi.org/10.1016/j.hjdsi.2016.11.002

Joynt, K. E., Gawande, A. A., Orav, E. J., & Jha, A. K. (2013). Contribution of preventable acute

care spending to total spending for high-cost medicare patients. *JAMA - Journal of the

American Medical Association*, *309*(24), 2572–2578.

https://doi.org/10.1001/jama.2013.7103

Kandrack, R., Barnes, H., & Martsolf, G. R. (2019). Nurse practitioner scope of practice

regulations and nurse practitioner supply. *Medical Care Research and Review*, *78*(3), 208–

217. https://doi.org/10.1177/1077558719888424

Keeney, T., Belanger, E., Jones, R. N., Joyce, N. R., Meyers, D. J., & Mor, V. (2019). High-need phenotypes in medicare beneficiaries: drivers of variation in utilization and outcomes. *Journal of the American Geriatrics Society*, *00*(00), 1–8. https://doi.org/10.1111/jgs.16146

Kim, D. H., & Schneeweiss, S. (2014). Measuring frailty using claims data for pharmacoepidemiologic studies of mortality in older adults: evidence and recommendations. *Pharmacoepidemiology and Drug Safety*, *23*(9), 891–901. https://doi.org/10.1002/pds.3674

Kleiman, R., Hayes, S. L., & Churchouse, C. (2016). *Medical Homes May Help Improve Care for People with Mental Health Issues*. The Commonwealth Fund Blog. https://www.commonwealthfund.org/blog/2016/medical-homes-may-help-improve-care-people-mental-health-issues

Knickman, J., Krishnan, K. R. R., Pincus, H. A., Blanco, C., Blazer, D. G., Coye, M. J., Krystal, J. H., Rauch, S. L., Simon, G. E., & Vitiello, B. (2016). Improving access to effective care for people who have mental health and substance use disorders. In *Vital Directions for Health and Health Care Series*. https://doi.org/10.31478/201609v

Komaromy, M., Bartlett, J., Gonzales-van Horn, S. R., Zurawski, A., Kalishman, S. G., Zhu, Y., Davis, H. T., Ceballos, V., Sun, X., Jurado, M., Page, K., Hamblin, A., & Arora, S. (2019). A novel intervention for high-need, high-cost medicaid patients: a study of echo care. *Journal of General Internal Medicine*, *35*(1), 21–27. https://doi.org/10.1007/s11606-019-05206-0

Kulstad, E. B., Sikka, R., Sweis, R. T., Kelley, K. M., & Rzechula, K. H. (2010). ED overcrowding is associated with an increased frequency of medication errors. *American*

Journal of Emergency Medicine, *28*(3), 304–309.

https://doi.org/10.1016/j.ajem.2008.12.014

Kuo, Y. F., Chen, N. W., Baillargeon, J., Raji, M. A., & Goodwin, J. S. (2015). Potentially

preventable hospitalizations in medicare patients with diabetes: a comparison of primary

care provided by nurse practitioners versus physicians. *Medical Care*, *53*(9), 776–783.

https://doi.org/10.1097/MLR.0000000000000406

Kurtzman, E. T., & Barnow, B. S. (2017). A comparison of nurse practitioners, physician

assistants, and primary care physicians' patterns of practice and quality of care in health

centers. *Medical Care*, *55*(6), 615–622. https://doi.org/10.1097/MLR.0000000000000689

Lewis, S. E., Nocon, R. S., Tang, H., Park, S. Y., Vable, A. M., Casalino, L. P., Huang, E. S.,

Quinn, M. T., Burnet, D. L., Summerfelt, W. T., Birnberg, J. M., & Chin, M. H. (2012).

Patient-centered medical home characteristics and staff morale in safety net clinics. *Arch

Intern Med*, *172*(1), 23–31. https://doi.org/10.1016/j.cortex.2009.08.003.Predictive

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke,

M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The prisma statement for reporting

systematic reviews and meta-analyses of studies that evaluate health care interventions:

explanation and elaboration. *PLoS Medicine*, *6*(7), 1–28.

https://doi.org/10.1371/journal.pmed.1000100

Liederman, E. M., & Morefield, C. S. (2003). Web messaging: a new tool for patient-physician

communication. *Journal of the American Medical Informatics Association*, *10*(3), 260–270.

https://doi.org/10.1197/jamia.M1259

Lin, S. X., Gebbie, K. M., Fullilove, R. E., & Arons, R. R. (2004). Do nurse practitioners make a

difference in provision of health counseling in hospital outpatient departments? *Journal of*

the *American Academy of Nurse Practitioners*, *16*(10), 462–466.

https://doi.org/10.1111/j.1745-7599.2004.tb00425.x

Liu, J. (2007). Health professional shortage and health status and health care access. *Journal of Health Care for the Poor and Underserved*, *18*(3), 590–598.

https://doi.org/10.1353/hpu.2007.0062

Long, P. M., Abrams, A., Milstein, G., Anderson, K., Lewis Apton, M., Dahlberg, M. L., & Whicher, D. (2017). *Effective care for high needs patients: opportunities for improving outcomes, value and health*. https://lccn.loc.gov/2017041343

Lowe, R. A., Localio, A. R., Schwarz, D. F., Williams, S., Tuton, L. W., Maroney, S., Nicklin, D., Goldfarb, N., Vojta, D. D., & Feldman, H. I. (2005). Association between primary care practice characteristics and emergency department use in a medicaid managed care organization. *Medical Care*, *43*(8), 792–800.

https://doi.org/10.1097/01.mlr.0000170413.60054.54

Manemann, S. M., Chamberlain, A. M., Roger, V., Griffin, J. M., Boyd, C. M., Cudjoe, T. K. M., Jensen, D., Weston, S. A., Fabbri, M., Jiang, R., & Finney Rutten, L. J. (2018). Perceived social isolation and outcomes in patients with heart failure. *Journal of the American Heart Association*, *7*, 1–7. https://doi.org/10.1161/JAHA.117

Marek, K. D., Stetzer, F., Ryan, P. A., Bub, L. D., Adams, S. J., Schlidt, A., Lancaster, R., & O'Brien, A. M. (2013). Nurse care coordination and technology effects on health status of frail older adults via enhanced self-management of medication: randomized clinical trial to test efficacy. *Nursing Research*, *62*(4), 269–278.

https://doi.org/10.1097/NNR.0b013e318298aa55

Martin, A. B., Hartman, M., Washington, B., & Catlin, A. (2019). National health care spending

in 2017: growth slows to post-great recession rates; share of gdp stabilizes. *Health Affairs*, *38*(1), 1–11. https://doi.org/10.1377/hlthaff.2018.05085

Martsolf, G. R., Ashwood, S., Friedberg, M. W., & Rodriguez, H. P. (2018). Linking structural capabilities and workplace climate in community health centers. *The Journal of Health Care Organization, Provision, and Financing*, *55*, 1–10. https://doi.org/10.1177/0046958018794542

Martsolf, G. R., Kandrack, R., Baird, M., & Friedberg, M. W. (2018). Estimating associations between medical home adoption, utilization, and quality: a comparison of evaluation approaches. *Medical Care*, *56*(1), 25–30. https://doi.org/10.1097/MLR.0000000000000842

Mccarthy, D., Klein, S., & Cohen, A. (2014). The road to accountable care: building systems for population health. *The Commonwealth Fund*, *21*(1768), 1–12.

McCarthy, D., Ryan, J., & Klein, S. (2015). *Models of care for high-need, high-cost patients: an evidence synthesis* (Vol. 31).

McCusker, J., Roberge, D., Vadeboncoeur, A., & Verdon, J. (2009). Safety of discharge of seniors from the emergency department to the community. *Healthcare Quarterly (Toronto, Ont.)*, *12 Spec No*, 24–32. https://doi.org/10.12927/hcq.2009.20963

Mehrotra, A., Adams, J. L., Thomas, J. W., & McGlynn, E. A. (2010). The impact of different attribution rules on individual physician cost profiles. *Annals of Internal Medicine*, *152*(10), 649–654. https://doi.org/10.7326/0003-4819-152-10-201005180-00005

Morgan, S. R., Chang, A. M., Alqatari, M., & Pines, J. M. (2013). Non-emergency department interventions to reduce ed utilization: a systematic review. *Academic Emergency Medicine*, *20*(10), 969–985. https://doi.org/10.1111/acem.12219

Morley, C., Unwin, M., Peterson, G. M., Stankovich, J., & Kinsman, L. (2018). Emergency

department crowding: a systematic review of causes, consequences and solutions. *PLoS ONE*, *13*(8), 1–42. https://doi.org/10.1371/journal.pone.0203316

Mouatassim, Y., & Ezzahid, E. H. (2012). Poisson regression and zero-inflated poisson regression: application to private health insurance data. *European Actuarial Journal*, *2*(2), 187–204. https://doi.org/10.1007/s13385-012-0056-2

National Academy of Medicine. (2021). The future of nursing 2020-2030: charting a path to achieve health equity. In *The National Academies Press*. https://doi.org/10.17226/25982

Nease, D. E., Ruffin, M. T. I., Klinkman, M. S., Jimbo, M., Braun, T. M., & Underwood, J. M. (2008). Impact of a generalizable reminder system on colorectal cancer screening in diverse primary care practices: a report from the prompting and remind at encounters for prevention project. *Medical Care*, *46*(901), S68–S73. https://doi.org/10.1097/MLR.0b013e31817c60d7.Impact

Nelson, L. (2012). Lessons from medicare's demonstration projects on disease management and care coordination. In *Working Paper Series Congressional Budget Office* (Vol. 01, Issue January). www.cbo.gov/publications

Newcomer, R., Maravilla, V., Faculjak, P., & Graves, M. T. (2004). Outcomes of preventive case management among high-risk elderly in three medical groups: a randomized clinical trial. *Evaluation and the Health Professions*, *27*(4), 323–348. https://doi.org/10.1177/0163278704270011

NYU Wagner. (2017). *FACULTY & RESEARCH*. https://wagner.nyu.edu/faculty/billings/nyued-background

O'Connor, S. R., Tully, M. A., Ryan, B., Bradley, J. M., Baxter, G. D., & McDonough, S. M. (2015). Failure of a numerical quality assessment scale to identify potential risk of bias in a

systematic review: a comparison study. *BMC Research Notes*, *8*(335), 1–7.

https://doi.org/10.1186/s13104-015-1181-1

O'Malley, A. S. (2013). After-hours access to primary care practice linked with lower

emergency department use and less unmet medical need. *Health Affairs*, *32*(1), 175–183.

https://doi.org/10.1377/hlthaff.2012.0494

O'Malley, A. S., Rich, E. C., Sarwar, R., Schultz, E., Warren, W. C., Shah, T., & Abrams, M. K.

(2019). How accountable care organizations use population segmentation to care for high-

need, high-cost patients. In *Issue brief (Commonwealth Fund)*.

http://www.ncbi.nlm.nih.gov/pubmed/30645057

Okoro, C. A., Hollis, N. T. D., Cyrus, A. C., & Griffin-Blake, S. (2018). Prevalence of

disabilities and health care access by disability status and type among adults — united

states, 2016. *Morbidity and Mortality Weekly Report*, *67*(32), 882–887.

https://doi.org/10.15585/mmwr.mm6732a3

Orzano, A. J., Strickland, P. O., Tallia, A. F., Hudson, S., Balasubramanian, B., Nutting, P. A., &

Crabtree, B. F. (2007). Improving outcomes for high-risk diabetics using information

systems. *Journal of the American Board of Family Medicine*, *20*(3), 245–251.

https://doi.org/10.3122/jabfm.2007.03.060185

Ouayogodé, M. H., Mainor, A. J., Meara, E., Bynum, J. P. W., & Colla, C. H. (2019).

Association between care management and outcomes among patients with complex needs in

medicare accountable care organizations. *JAMA Network Open*, *2*(7), 1–13.

https://doi.org/10.1001/jamanetworkopen.2019.6939

Park, J. (2015). Nurse practitioner and physician assistant staffing in the patient-centered medical

homes in new york state. *Nursing Outlook*, *63*(5), 593–600.

https://doi.org/10.1016/j.outlook.2015.04.006

Park, J., & Dowling, N. M. (2020). Do nurse practitioner-led medical homes differ from physician-led medical homes? *Nursing Outlook*, *68*(5), 601–610. https://doi.org/10.1016/j.outlook.2020.05.010

Park, S., & Lake, E. T. (2005). Multilevel modeling of a clustered continuous outcome. *Nursing Research*, *54*(6), 406–413. https://doi.org/10.1097/00006199-200511000-00007

Peikes, D., Dale, S., Ghosh, A., Taylor, E. F., Swankoski, K., O'Malley, A. S., Day, T. J., Duda, N., Singh, P., Anglin, G., Sessums, L. L., & Brown, R. S. (2018). The comprehensive primary care initiative: effects on spending, quality, patients, and physicians. *Health Affairs (Project Hope)*, *37*(6), 890–899. https://doi.org/10.1377/hlthaff.2017.1678

Peterson, K. A., Carlin, C., Solberg, L. I., Jacobsen, R., Kriel, T., & Eder, M. (2020). Redesigning primary care to improve diabetes outcomes (the united study). *Diabetes Care*, *43*(3), 549–555. https://doi.org/10.2337/dc19-1140

Peterson, K., Helfand, M., Humphrey, L., Christensen, V., & Carson, S. (2013). Evidence brief: effectiveness of intensive primary care programs. In *VA Evidence-based Synthesis Program Evidence Briefs*. https://www.ncbi.nlm.nih.gov/books/NBK384618/pdf/Bookshelf_NBK384618.pdf

Pines, J. M., Mullins, P. M., Cooper, J. K., Feng, L. B., & Roth, K. E. (2013). National trends in emergency department use, care patterns, and quality of care of older adults in the united states. *Journal of the American Geriatrics Society*, *61*(1), 12–17. https://doi.org/10.1111/jgs.12072

Poghosyan, L., Nannini, A., Finkelstein, S. R., Mason, E., & Shaffer, J. A. (2013). Development and psychometric testing of the nurse practitioner primary care organizational climate

questionnaire. *Nursing Research*, *62*(5), 325–334.

https://doi.org/10.1097/NNR.0b013e3182a131d2

Powers, B. W., Modarai, F., Palakodeti, S., Sharma, M., Mehta, N., Jain, S. H., & Garg, V.

(2020). Impact of complex care management on spending and utilization for high-need,

high-cost medicaid patients. *American Journal of Managed Care*, *26*(2), E57–E63.

https://doi.org/10.37765/ajmc.2020.42402

Powers, B. W., Yan, J., Zhu, J., Linn, K. A., Jain, S. H., Kowalski, J. L., & Navathe, A. S.

(2019). Subgroups of high-cost medicare advantage patients: an observational study.

Journal of General Internal Medicine, *34*(2), 218–225. https://doi.org/10.1007/s11606-018-

4759-1

Quan, H., Sundararajan, V., Halfon, P., Fong, A., Burnand, B., Luthi, J.-C., Saunders, L. D.,

Beck, C. A., Feasby, T. E., & Ghali, W. A. (2005). Coding algorithms for defining

comorbidities in icd-9-cm and icd-10 administrative data. *Medical Care*, *43*(11), 1130–

1139.

Raghupathi, W., & Raghupathi, V. (2018). An empirical study of chronic diseases in the united

states: a visual analytics approach to public health. *International Journal of Environmental

Research and Public Health*, *15*(3), 431. https://doi.org/10.3390/ijerph15030431

Ritchie, C., Andersen, R., Eng, J., Garrigues, S. K., Intinarelli, G., Kao, H., Kawahara, S., Patel,

K., Sapiro, L., Thibault, A., Tunick, E., & Barnes, D. E. (2016). Implementation of an

interdisciplinary, team-based complex care support health care model at an academic

medical center: impact on health care utilization and quality of life. *PLoS ONE*, *11*(2), 1–14.

https://doi.org/10.1371/journal.pone.0148096

Ritsema, T. S., Bingenheimer, J. B., Scholting, P., & Cawley, J. F. (2014). Differences in the

delivery of health education to patients with chronic disease by provider type, 2005-2009. *Preventing Chronic Disease*, *11*, 1–7. https://doi.org/10.5888/pcd11.130175

Rust, G., Ye, J., Baltrus, P., Daniels, E., Adesunloye, B., & Fryer, G. E. (2008). Practical barriers to timely primary care access: impact on adult use of emergency department services. *Archives of Internal Medicine*, *168*(15), 1705–1710. https://doi.org/10.1001/archinte.168.15.1705

Ryan, J., Abrams, M. K., Doty, M. M., Shah, T., & Schneider, E. C. (2016). *How high-need patients experience health care in the United States* (Vol. 43).

Sada, Y., Street, R. L. J., Singh, H., Shada, R., & Naik, A. D. (2011). Primary care and communication in shared cancer care: a qualitative study. *American Journal of Managed Care*, *17*(4), 259–265.

Sarnak, D. O., & Ryan, J. (2016). How high-need patients experiences the health care system in nine countries. *The Commonwealth Fund*, 1–14.

Schamess, A., Foraker, R., Kretovics, M., Barnes, K., Beatty, S., Bose-Brill, S., & Tayal, N. (2017). Reduced emergency room and hospital utilization in persons with multiple chronic conditions and disability receiving home-based primary care. *Disability and Health Journal*, *10*(2), 326–333. https://doi.org/10.1016/j.dhjo.2016.10.004

Schneider, E. C., & Shah, T. B. (2020). Cold water or rocket fuel? lessons from the camden "hot-spotting" randomized controlled trial". *Health Affairs Blog*. https://doi.org/10.1377/hblog20200210.86393

Schraeder, C., Fraser, C. W., Clark, I., Long, B., Shelton, P., Waldschmidt, V., Kucera, C. L., & Lanker, W. K. (2008). Evaluation of a primary care nurse case management intervention for chronically ill community dwelling older people. *Journal of Clinical Nursing*, *17*(11C),

407–417. https://doi.org/10.1111/j.1365-2702.2008.02578.x

Schuttner, L., Zhang, Z., & Kuo, A. (2018). Reducing er use through a trainee-designed,

interprofessional care group for high-utilizing chronically ill patients: a pilot program.

Journal of Interprofessional Education & Practice, *9*, 1–12.

https://doi.org/10.1016/j.physbeh.2017.03.040

Schwebel, F. J., & Larimer, M. E. (2018). Using text message reminders in health care services:

a narrative literature review. In *Internet Interventions* (Vol. 13, pp. 82–104).

https://doi.org/10.1016/j.invent.2018.06.002

Shrank, W. H., Rogstad, T. L., & Parekh, N. (2019). Waste in the us health care system:

estimated costs and potential for savings. *Journal of the American Medical Association*,

322(15), 1501–1509. https://doi.org/10.1001/jama.2019.13978

Sledge, W. H., Brown, K. E., Levine, J. M., Fiellin, D. A., Chawarski, M., White, W. D., &

O'Connor, P. G. (2006). A randomized trial of primary intensive care to reduce hospital

admissions in patients with high utilization of inpatient services. *Disease Management*,

9(6), 328–338.

http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed7&NEWS=N&AN=

2006609282

Soril, L. J. J., Leggett, L. E., Lorenzetti, D. L., Noseworthy, T. W., & Clement, F. M. (2016).

Characteristics of frequent users of the emergency department in the general adult

population: a systematic review of international healthcare systems. *Health Policy*, *120*(5),

452–461. https://doi.org/10.1016/j.healthpol.2016.02.006

Stanton, M., & Rutherford, M. (2006). The high concenration of u.s. health care expenditures. In

Agency for Healthcare Research and Quality (Issue 19).

http://www.meps.ahrq.gov/PrintProducts/PrintProdLookup.asp?ProductType=

Streeter, R. A., Snyder, J. E., Kepley, H., Stahl, A. L., Li, T., & Washko, M. M. (2020). The geographic alignment of primary care health professional shortage areas with markers for social determinants of health. *PLoS ONE*, *15*(4), 1–20. https://doi.org/10.1371/journal.pone.0231443

Sun, R., Karaca, Z., & Wong, H. S. (2018). Trends in hospital emergency department visits by age and payer, 2006–2015. In *Healthcare Cost and Utilization Project (HCUP)*. www.hcup-us.ahrq.gov/reports/statbriefs/sb238-Emergency- Department-Age-Payer-2006-2015.pdf

Tai, B., Hu, L., Ghitza, U. E., Sparenborg, S., VanVeldhuisen, P., & Lindblad, R. (2014). Patient registries for substance use disorders. *Substance Abuse and Rehabilitation*, *5*, 81–86. https://doi.org/10.2147/sar.s64977

Tang, N., Stein, J., Hsia, R. Y., Maselli, J. H., & Gonzales, R. (2010). Trends and characteristics of us emergency department visits, 1997-2007. *Journal of the American Medical Association*, *304*(6), 664–670. https://doi.org/10.1001/jama.2010.1112

Tanmoy Das, L., Abramson, E. L., Kaushal, R., Das, L. T., Abramson, E. L., & Kaushal, R. (2021). *High-need, high-cost patients offer solutions for improving their care and reducing costs*. New England Journal of Medicine Catalyst. https://www.gao.gov/assets/680/670112.pdf.

Thorpe, K. E., Allen, L., & Joski, P. (2015). The role of chronic disease, obesity, and improved treatment and detection in accounting for the rise in healthcare spending between 1987 and 2011. *Applied Health Economics and Health Policy*, *13*(4), 381–387. https://doi.org/10.1007/s40258-015-0164-7

Traczynski, J., & Udalova, V. (2018). Nurse practitioner independence, health care utilization, and health outcomes. *Journal of Health Economics*, *58*, 90–109. https://doi.org/10.1016/j.jhealeco.2018.01.001

U.S. Department of Agriculture Economic Research Service. (2020). *Rural-Urban Commuting Area Codes*. https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/

US Department of Health and Human Services. (2016). *Facing Addiction in America: The Surgeon General's Report on Alcohol, Drugs, and Health*.

Uscher-Pines, L., Pines, J., Kellermann, A., Gillen, E., & Mehrotra, A. (2014). Deciding to visit the emergency departement for non-urgent conditions: a systematic review of the literature. *American Journal of Managed Care*, *19*(1), 47–59. https://doi.org/10.1016/j.biotechadv.2011.08.021.Secreted

Van den Heede, K., & Van de Voorde, C. (2016). Interventions to reduce emergency department utilisation: a review of reviews. *Health Policy*, *120*(12), 1337–1349. https://doi.org/10.1016/j.healthpol.2016.10.002

Venkatesh, A. K., Mei, H., Kocher, K. E., Granovsky, M., Obermeyer, Z., Spatz, E. S., Rothenberg, C., Krumholz, H. M., & Lin, Z. (2017). Identification of emergency department visits in medicare administrative claims: approaches and implications. *Acad Emerg Med*, *24*(4), 422–431. https://doi.org/10.1111/acem.13140

Walker, L. O., & Avant, K. C. (2019). *Strategies for theory construction in nursing* (6th ed.). Pearson.

Weppner, W. G., Davis, K., Tivis, R., Willis, J., Fisher, A., King, I., & Smith, C. S. (2018). Impact of a complex chronic care patient case conference on quality and utilization. *Translational Behavioral Medicine*, *8*(3), 366–374. https://doi.org/10.1093/tbm/ibx082

Williams, E. C., Lapham, G., Achtmeyer, C. E., Volpp, B., Kivlahan, D. R., & Bradley, K. A. (2009). Use of an electronic clinical reminder for brief alcohol counseling is associated with resolution of unhealthy alcohol use at follow-up screening. *Journal of General Internal Medicine*, *25*(Suppl 1), 11–17. https://doi.org/10.1007/s11606-009-1100-z

Xue, Y., Kannan, V., Greener, E., Smith, J. A., Brasch, J., Johnson, B. A., & Spetz, J. (2018). Full scope-of-practice regulation is associated with higher supply of nurse practitioners in rural and primary care health professional shortage counties. *Journal of Nursing Regulation*, *8*(4), 5–13. https://doi.org/10.1016/S2155-8256(17)30176-X

Yang, Y., Long, Q., Jackson, S. L., Rhee, M. K., Tomolo, A., Olson, D., & Phillips, L. S. (2018). Nurse practitioners, physician assistants, and physicians are comparable in managing the first five years of diabetes. *American Journal of Medicine*, *131*(3), 276-283.e2. https://doi.org/10.1016/j.amjmed.2017.08.026

Zodet, M. (2016). Characteristics of persons with high health care expenditures in the u.s. civilian noninstitutionalized population. In *Agency for Healthcare Research and Quality*. http://www.meps.ahrq.gov/mepsweb/data_files/publications/mr23/mr23.pdf

Zulman, D. M., Chee, C. P., Ezeji-Okoye, S. C., Shaw, J. G., Holmes, T. H., Kahn, J. S., & Asch, S. M. (2017). Effect of an intensive outpatient program to augment primary care for high-need veterans affairs patients a randomized clinical trial. *JAMA Internal Medicine*, *177*(2), 166–175. https://doi.org/10.1001/jamainternmed.2016.8021
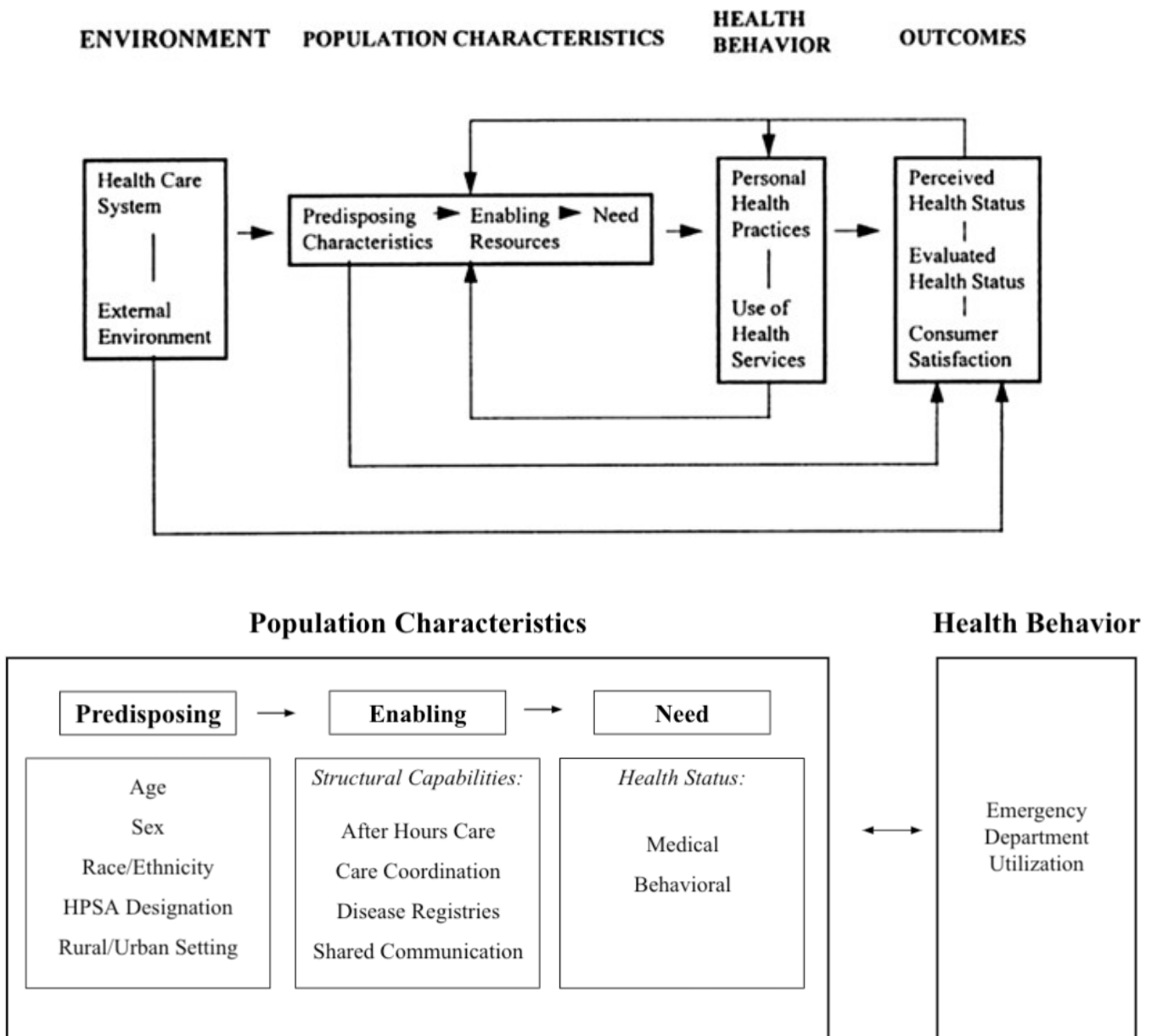
List of Appendices

Appendix A:

The Andersen Behavioral Model

The Andersen Behavioral Model provides the conceptual underpinning which frames this dissertation (Andersen, 1995). We adapted the Andersen Behavioral Model which is consistent with prior studies. Appendix A presents the original and adapted models.

Appendix B:

PRISMA Checklist, 2020

Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	
	23c	Discuss any limitations of the review processes used.	
	23d	Discuss implications of the results for practice, policy, and future research.	
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	
Competing interests	26	Declare any competing interests of review authors.	
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

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Downs and Black Quality Appraisal Tool

(Downs & Black, 1998)

Appendix

Checklist for measuring study quality

Reporting

1. *Is the hypothesis/aim/objective of the study clearly described?*

yes	1
no	0

2. *Are the main outcomes to be measured clearly described in the Introduction or Methods section?*
   If the main outcomes are first mentioned in the Results section, the question should be answered no.

yes	1
no	0

3. *Are the characteristics of the patients included in the study clearly described?*
   In cohort studies and trials, inclusion and/or exclusion criteria should be given. In case-control studies, a case-definition and the source for controls should be given.

yes	1
no	0

4. *Are the interventions of interest clearly described?*
   Treatments and placebo (where relevant) that are to be compared should be clearly described.

yes	1
no	0

5. *Are the distributions of principal confounders in each group of subjects to be compared clearly described?*
   A list of principal confounders is provided.

yes	2
partially	1
no	0

6. *Are the main findings of the study clearly described?*
   Simple outcome data (including denominators and numerators) should be reported for all major findings so that the reader can check the major analyses and conclusions. (This question does not cover statistical tests which are considered below).

yes	1
no	0

7. *Does the study provide estimates of the random variability in the data for the main outcomes?*
   In non normally distributed data the inter-quartile range of results should be reported. In normally distributed data the standard error, standard deviation or confidence intervals should be reported. If the distribution of the data is not described, it must be assumed that the estimates used were appropriate and the question should be answered yes.

yes	1
no	0

8. *Have all important adverse events that may be a consequence of the intervention been reported?*
   This should be answered yes if the study demonstrates that there was a comprehensive attempt to measure adverse events. (A list of possible adverse events is provided).

yes	1
no	0

9. *Have the characteristics of patients lost to follow-up been described?*
   This should be answered yes where there were no losses to follow-up or where losses to follow-up were so small that findings would be unaffected by their inclusion. This should be answered no where a study does not report the number of patients lost to follow-up.

yes	1
no	0

10. *Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?*

yes	1
no	0

External validity
All the following criteria attempt to address the representativeness of the findings of the study and whether they may be generalised to the population from which the study subjects were derived.

11. *Were the subjects asked to participate in the study representative of the entire population from which they were recruited?*
    The study must identify the source population for patients and describe how the patients were selected. Patients would be representative if they comprised the entire source population, an unselected sample of consecutive patients, or a random sample. Random sampling is only feasible where a list of all members of the relevant

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population exists. Where a study does not report the proportion of the source population from which the patients are derived, the question should be answered as unable to determine.

yes	1
no	0
unable to determine	0

12. *Were those subjects who were prepared to participate representative of the entire population from which they were recruited?*
The proportion of those asked who agreed should be stated. Validation that the sample was representative would include demonstrating that the distribution of the main confounding factors was the same in the study sample and the source population.

yes	1
no	0
unable to determine	0

13. *Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?*
For the question to be answered yes the study should demonstrate that the intervention was representative of that in use in the source population. The question should be answered no if, for example, the intervention was undertaken in a specialist centre unrepresentative of the hospitals most of the source population would attend.

yes	1
no	0
unable to determine	0

Internal validity - bias

14. *Was an attempt made to blind study subjects to the intervention they have received ?*
For studies where the patients would have no way of knowing which intervention they received, this should be answered yes.

yes	1
no	0
unable to determine	0

15. *Was an attempt made to blind those measuring the main outcomes of the intervention?*

yes	1
no	0
unable to determine	0

16. *If any of the results of the study were based on "data dredging", was this made clear?*
Any analyses that had not been planned at the outset of the study should be clearly indicated. If no retrospective unplanned subgroup analyses were reported, then answer yes.

yes	1
no	0
unable to determine	0

17. *In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls ?*
Where follow-up was the same for all study patients the answer should yes. If different lengths of follow-up were adjusted for by, for example, survival analysis the answer should be yes. Studies where differences in follow-up are ignored should be answered no.

yes	1
no	0
unable to determine	0

18. *Were the statistical tests used to assess the main outcomes appropriate?*
The statistical techniques used must be appropriate to the data. For example non-parametric methods should be used for small sample sizes. Where little statistical analysis has been undertaken but where there is no evidence of bias, the question should be answered yes. If the distribution of the data (normal or not) is not described it must be assumed that the estimates used were appropriate and the question should be answered yes.

yes	1
no	0
unable to determine	0

19. *Was compliance with the intervention/s reliable?*
Where there was non compliance with the allocated treatment or where there was contamination of one group, the question should be answered no. For studies where the effect of any misclassification was likely to bias any association to the null, the question should be answered yes.

yes	1
no	0
unable to determine	0

20. *Were the main outcome measures used accurate (valid and reliable)?*

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For studies where the outcome measures are clearly described, the question should be answered yes. For studies which refer to other work or that demonstrates the outcome measures are accurate, the question should be answered as yes.

yes	1
no	0
unable to determine	0

Internal validity – confounding (selection bias)

21. *Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?*
    For example, patients for all comparison groups should be selected from the same hospital. The question should be answered unable to determine for cohort and case-control studies where there is no information concerning the source of patients included in the study.

yes	1
no	0
unable to determine	0

22. *Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?*
    For a study which does not specify the time period over which patients were recruited, the question should be answered as unable to determine.

yes	1
no	0
unable to determine	0

23. *Were study subjects randomised to intervention groups?*
    Studies which state that subjects wereran-domised should be answered yes except where method of randomisation would not ensure random allocation. For example alternate allocation would score no because it is predictable.

yes	1
no	0
unable to determine	0

24. *Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?*

All non-randomised studies should be answered no. If assignment was concealed from patients but not from staff, it should be answered no.

yes	1
no	0
unable to determine	0

25. *Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?*
    This question should be answered no for trials if: the main conclusions of the study were based on analyses of treatment rather than intention to treat; the distribution of known confounders in the different treatment groups was not described; or the distribution of known confounders differed between the treatment groups but was not taken into account in the analyses. In non-randomised studies if the effect of the main confounders was not investigated or confounding was demonstrated but no adjustment was made in the final analyses the question should be answered as no.

yes	1
no	0
unable to determine	0

26. *Were losses of patients to follow-up taken into account?*
    If the numbers of patients lost to follow-up are not reported, the question should be answered as unable to determine. If the proportion lost to follow-up was too small to affect the main findings, the question should be answered yes.

yes	1
no	0
unable to determine	0

Power

27. *Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?*
    Sample sizes have been calculated to detect a difference of x% and y%.

	Size of smallest intervention group	
A	$<n_1$	0
B	n_1-n_2	1
C	n_3-n_4	2
D	n_5-n_6	3
E	n_7-n_8	4
F	n_9+	5

Primary Care Nurse Practitioner Survey

19. Does your practice setting have…

	Yes	No	Don't know
a. …agreements with community service agencies (e.g., health departments) to enhance services for any of your patients?	○	○	○
b. …a referral system for linking any of your patients to community programs?	○	○	○

20. Indicate whether your practice setting has each of the computerized capabilities listed below.

	Yes	No	Don't know
a. Recording patient history and demographic information	○	○	○
b. Recording clinical notes	○	○	○
c. Recording patient's medications and allergies	○	○	○
d. Ordering prescriptions	○	○	○
e. Viewing lab or imaging results	○	○	○

21. Is your practice setting regularly open to provide care on Saturdays or Sundays?
○ Yes   ○ No

22. How many nights per week is your practice setting open for patient visits during extended evening hours?
○ None   ○ 1   ○ 2   ○ 3   ○ 4   ○ 5 or more

This section asks general questions about you and your background.

23. In what year were you born? _____

24. What is your gender?   ○ Female   ○ Male   ○ Other (please specify): _____

25. What is your marital status?   ○ Never married   ○ Married   ○ Separated   ○ Divorced   ○ Widowed

26. What best describes your race?
○ White or Caucasian
○ Black or African American
○ American Indian or Alaska Native
○ Asian
○ Native Hawaiian or Other Pacific Islander
○ Other (please specify): _____

27. Are you Hispanic or Latino?   ○ Yes   ○ No

28. What is the highest educational degree you have earned?
○ Diploma in Registered Nursing   ○ Master's degree
○ Associate degree   ○ Doctorate of Nursing Practice (DNP)
○ Baccalaureate degree   ○ PhD or other doctorate
○ Other (please specify): _____

29. Where did you receive your initial registered nursing (RN) education?   ○ United States   ○ Another country

30. What year did you receive your initial RN license? _____

31. What year did you receive your initial NP license? _____

32. In which area(s) are you currently certified by a national certifying organization for NPs?
Select all that apply.
○ Acute care adult   ○ Pediatric
○ Acute care pediatric   ○ Neonatal
○ Adult   ○ Psych/Mental health
○ Gerontology   ○ Women's health
○ Family   ○ Other (please specify): _____

Thank you for completing the Primary Care Nurse Practitioner Survey!

Would you like to be entered into the lottery to win 1 of 250 $50 gift cards?   ○ Yes   ○ No

Please use the envelope provided to return your survey to: Cornell University Survey Research Institute, 391 Pine Tree Rd., Rm. 118, Ithaca, NY 14850.

Primary Care Nurse Practitioner Survey

Thank you for your help! When filling out the survey, please keep the following in mind:
● Use a black or blue pen.
● Fill in circles completely, like this: ● Not like this: ⊗ Or this: ◑
● If you mark the wrong circle by mistake, put an X through it like this: ✖   Then, fill in the correct circle.
● Mark only one response for each question unless other instructions are given.

Please answer the following questions as they relate to your primary job (the job in which you currently spend the most time).

1. Please select which best describes your main practice setting:
○ Physician practice   ○ Retail-based clinic
○ Community health center   ○ Urgent care clinic
○ Hospital-based clinic   ○ Nurse managed clinic
○ Other (please specify): _____

2. How long have you been employed in your current primary position? _____ years _____ months

3. Do you have a panel of patients for whom you are the main provider of their continuous primary care?
○ Yes, I have a panel of patients that I independently manage
○ No, I co-manage patients with other providers in my practice
○ I have a panel of patients that I independently manage AND I co-manage patients with other providers in my practice
○ Other (please specify): _____

4. What is the average number of hours you worked per week over the last month at your primary position?
_____ hours per week

5. Thinking about your main position, how much time do you spend performing the following tasks in a typical week:

a. Providing direct clinical patient care (e.g., history-taking, physical examination, related documentation, providing educational resources or referrals to assist in self-management)	_____ hours per week
b. Coordinating patient care (e.g., communicating with other clinicians, hospitals, laboratory and imaging services, pharmacists, or insurance companies)	_____ hours per week
c. Providing care management services (e.g., helping patients make appointments with subspecialists, imaging services, patient transportation, or other community resources)	_____ hours per week
d. Performing quality assurance and improvement activities (e.g., chart audits, quality assurance projects or meetings)	_____ hours per week
e. Practice leadership and administrative activities (e.g., staff management, leadership meetings)	_____ hours per week
f. Other (please specify): _____	_____ hours per week

6. On the whole, how satisfied are you with your present job?

Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied
○	○	○	○

7. Overall, based on your definition of burnout, how would you rate your level of burnout?
○ I enjoy my work. I have no symptoms of burnout.
○ Occasionally I am under stress, and I don't always have as much energy as I once did, but I don't feel burned out.
○ I am definitely burning out and have one or more symptoms of burnout, such as physical and emotional exhaustion.
○ The symptoms of burnout that I'm experiencing won't go away. I think about frustration at work a lot.
○ I feel completely burned out and often wonder if I can go on. I am at the point where I may need some changes or may need to seek some sort of help.

8. How likely are you to leave your current position in the coming year?

Very unlikely	Unlikely	Likely	Very likely
○	○	○	○

9. How often do you provide care to patients whose primary language is not English?

Very frequently	Frequently	Occasionally	Rarely	Never
O	O	O	O	O

10. How would you rate the quality of care your organization delivers as a whole? Would you say it is…

Excellent	Very good	Good	Fair	Poor
O	O	O	O	O

11. <u>How many</u> other primary care providers work at your practice setting?

_____ #NPs _____ #PAs _____ #MDs

12. For each item, please indicate the extent to which you agree that the following items are present in your practice setting. Indicate your degree of agreement by selecting <u>ONE</u> option that best applies to you.

	Strongly agree	Agree	Disagree	Strongly disagree
In my organization, NP role is well understood	O	O	O	O
I feel valued by my organization	O	O	O	O
Physicians support my patient care decisions	O	O	O	O
NPs are represented in important committees in my organization	O	O	O	O
NPs are an integral part of the organization	O	O	O	O
In my practice setting, staff members have a good understanding about NP roles in the organization	O	O	O	O
I feel valued by my physician colleagues	O	O	O	O
In my organization, NPs and physicians collaborate to provide patient care	O	O	O	O
In my organization, physicians and NPs practice as a team	O	O	O	O
I regularly get feedback about my performance from my organization	O	O	O	O
Physicians in my practice setting trust my patient care decisions	O	O	O	O
Physicians may ask NPs for their advice to provide patient care	O	O	O	O
Administration is open to NP ideas to improve patient care	O	O	O	O
Administration takes NP concerns seriously	O	O	O	O
Physicians seek NPs' input when providing patient care	O	O	O	O
I do not have to discuss every patient care detail with a physician	O	O	O	O
Administration shares information equally with NPs and physicians	O	O	O	O
Administration is well informed of the skills and competencies of NPs	O	O	O	O
In my organization, I freely apply all my knowledge and skills to provide patient care	O	O	O	O
Administration treats NPs and physicians equally	O	O	O	O
Administration informs NPs about changes taking place in the organization	O	O	O	O
Administration makes efforts to improve working conditions for NPs	O	O	O	O
In my organization, there is constant communication between NPs and Administration	O	O	O	O
My organization does not restrict my ability to practice within my scope of practice	O	O	O	O
In my organization, I can provide all patient care within my scope of practice	O	O	O	O
Physicians and NPs have similar support for care management (e.g., help with patient follow-up, referrals, labs, etc.)	O	O	O	O
My organization creates an environment where I can practice independently	O	O	O	O
In my practice setting, I have colleagues who I can ask for help	O	O	O	O
There are enough ancillary staff to prepare my patients (e.g., height, weight, bring patient to examining room) for their visit	O	O	O	O

Questions? Call the Cornell University Survey Research Institute at 1-888-367-8404

Please answer the following questions as they relate to your practice setting at your main job.

13. Does your practice setting give feedback to individual clinicians or staff about their personal performance on…

	Yes	No	Don't know
a. …productivity? (e.g., RVUs per clinical session)	O	O	O
b. …quality of care for chronic illnesses? (e.g., asthma or diabetes)	O	O	O

14. At the time of a patient visit, do clinicians at your practice setting have a system of reminders (e.g., flowsheets or checklists) to follow recommended guidelines for…

	Yes, electronic	Yes, on paper	Yes, both	No	Don't know
a. Patients with asthma/COPD	O	O	O	O	O
b. Patients with cardiovascular disease	O	O	O	O	O
c. Patients with hypertension	O	O	O	O	O
d. Patients with congestive heart failure	O	O	O	O	O
e. Patients with diabetes	O	O	O	O	O

15. Does your practice setting have a <u>registry</u> that creates lists of patients who are <u>overdue</u> for their chronic disease services (e.g., hemoglobin A1c in diabetes; cholesterol in coronary artery disease)?

Yes, electronic	Yes, on paper	Yes, both	No	Don't know
O	O	O	O	O

16. Do clinicians at your practice setting use a <u>shared communication system</u> (e.g., letters, phone calls) to <u>contact patients</u>:

	Yes	No	Don't know
a. Who are due for guidelines-recommended care for chronic conditions?	O	O	O
b. After a hospitalization?	O	O	O
c. Who have not had an appointment in the practice for an extended period (longer than clinically appropriate)?	O	O	O

17. Does your practice setting have designated staff for care management services and/or care coordination?
O Yes (answer question 17b below)   O No (SKIP to question 18)

17b. If YES, which of the following care management and coordination services are provided by designated staff? <u>*Select all that apply.*</u>
O Creating and managing patient problem lists
O Providing resources to assist patients in self-management of conditions and related symptoms
O Medication management (e.g., medication reconciliation and review of allergies)
O Identifying and contacting patients when they are due for needed services
O Helping patients access community and social services including transportation
O Helping patients schedule appointments with various providers including subspecialists, imaging, and diagnostics
O Working with other clinicians, hospitals, laboratory and imaging services, pharmacists, or insurance companies to better coordinate patient care

18. In a typical week at your practice setting, how often do the following types of providers and staff act as members of your team? Please use the following definition of a team: "a group of primary care practice personnel who identify as members of a team and who work together to provide care for a panel of patients."

Members of your team	Always	Sometimes	Never
a. Primary care physicians	O	O	O
b. Nurse practitioners	O	O	O
c. Registered nurses	O	O	O
d. Licensed practical nurses or licensed vocational nurses	O	O	O
e. Physician assistants	O	O	O
f. Medical assistants	O	O	O
g. Pharmacists	O	O	O
h. Social workers	O	O	O
i. Community health workers	O	O	O
j. Nutritionists or dieticians	O	O	O
k. Physician specialists	O	O	O
l. Clerks or receptionists	O	O	O
m. Other(s) (please specify): _____	O	O	O

Appendix E:

Multicollinearity and Intraclass Correlation

Multicollinearity was assessed for covariates in Chapters Four and Five using variance inflation factors (VIFs). VIFs are used to indicate correlation between covariates as highly correlated covariates may inflate a regression coefficient or mislead interpretation of results (Columbia Public Health, n.d.) In Chapter Four, designation of Health Professional Shortage Areas was found to be highly correlated with practice type as practices designated as federally qualified health centers or community health centers are more likely to provide care in underserved areas (*Federally Qualified Health Centers (FQHCs) and the Health Center Program*, 2019; Health Resources & Services Administration, 2020). Thus, the practice type variable was removed from the final model. In Chapter Five, VIFs for all covariates were < 2 indicating low correlation between covariates.

The intraclass correlation (ICC) determines the amount of dependency among observations and was used to determine the most parsimonious models. In Chapter Five, the ICC was calculated to evaluate whether there was significant clustering of HNHC patients within primary care practices. The ICC was low for both dependent variables: all-cause ED utilization (0.03) and preventable ED utilization (0.03) demonstrating sufficient variability in clusters of patients within practices (S. Park & Lake, 2005). Based on these calculations, it was unnecessary to use multilevel models or to adjust for potential clustering.

Appendix F:

Output of Zero-Inflated Poisson Regression Models (Chapter Five)

This appendix presents the full output of the zero-inflated Poisson regression models used to analyze the association between structural capabilities and emergency department (ED) utilization in high-need high-cost (HNHC) patients with behavioral health conditions (Chapter Five: *Primary Care Practice Structural Capabilities and Emergency Department Utilization Among High-Need High-Cost Patients with Behavioral Health Conditions*). Presented below are the adjusted rate ratios of structural capabilities and ED utilization for (1) HNHC patients; (2) HNHC patients with depression; (3) HNHC patients with alcohol use; and (4) HNHC patients with substance use disorder. We ran separate zero-inflated adjusted Poisson models for each dependent variable (ED use and preventable ED use) and for each HNHC subgroup. Our independent variables of interest were four structural capabilities (1) care coordination; (2) chronic disease registries; (3) shared communication systems; and (4) after-hours care. All models adjusted for age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and practice setting (rural or urban).

Table 1

Overall HNHC Population (n = 68, 648)

	Estimate	Std. Error	z value	p value	95% CI
All-Cause ED Utilization					
Care Coordination	-0.042	0.016	-2.564	0.01	-0.074, -0.01
Chronic Disease Registries	0.002	0.016	0.14	0.889	-0.03, 0.035
Shared Communication Systems	0.007	0.017	0.421	0.673	-0.026, 0.04
After-Hours Care	0.065	0.016	3.962	<.001	0.033, 0.097
Preventable ED Utilization					
Care Coordination	-0.04	0.025	-1.62	0.105	-0.089, 0.008
Chronic Disease Registries	0.044	0.025	1.751	0.08	-0.005, 0.092
Shared Communication Systems	-0.001	0.025	-0.048	0.962	-0.051, 0.048
After-Hours Care	0.045	0.025	1.815	0.07	-0.004, 0.094

Source. Author's calculations based on linked nurse practitioner survey data and Medicare claims, 2019.

Note. ED: emergency department, HNHC: high-need high-cost. Models adjusted for age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and practice setting (rural or urban). Estimate is non-exponentiated coefficient.

Table 2

HNHC Patients with Depression (n = 12,500)

	Estimate	Std. Error	z value	p value	95% CI
All-Cause ED Utilization					
Care Coordination	-0.047	0.029	-1.623	0.105	-0.1, 0.01
Chronic Disease Registries	0.019	0.029	0.644	0.519	-0.04, 0.08
Shared Communication Systems	-0.002	0.03	-0.067	0.947	-0.06, 0.06
After-Hours Care	0.084	0.029	2.879	0.004	0.03, 0.14
Preventable ED Utilization					
Care Coordination	-0.035	0.043	-0.817	0.414	-0.12, 0.05
Chronic Disease Registries	0.089	0.044	2.043	0.041	0, 0.17
Shared Communication Systems	-0.045	0.044	-1.016	0.31	-0.13, 0.04
After-Hours Care	0.054	0.044	1.223	0.221	-0.03, 0.14

Source. Author's calculations based on linked nurse practitioner survey data and Medicare claims, 2019.

Note. ED: emergency department, HNHC: high-need high-cost. Models adjusted for age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and practice setting (rural or urban).

Estimate is non-exponentiated coefficient.

Table 3

HNHC patients with Alcohol Use (n = 1,344)

	Estimate	Std. Error	z value	p value	95% CI
All-Cause ED Utilization					
Care Coordination	-0.274	0.083	-3.282	0.001	-0.44, -0.11
Chronic Disease Registries	0.461	0.074	6.205	< .001	0.32, 0.61
Shared Communication Systems	-0.334	0.076	-4.379	< .001	-0.48, -0.18
After-Hours Care	0.035	0.077	0.451	0.652	-0.12, 0.19
Preventable ED Utilization					
Care Coordination	-0.247	0.149	-1.659	0.097	-0.54, 0.04
Chronic Disease Registries	0.672	0.121	5.572	< .001	0.44, 0.91
Shared Communication Systems	-0.687	0.12	-5.723	< .001	-0.92, -0.45
After-Hours Care	-0.112	0.128	-0.874	0.382	-0.36, 0.14

Source. Author's calculations based on linked nurse practitioner survey data and Medicare claims, 2019.

Note. ED: emergency department, HNHC: high-need high-cost. Models adjusted for age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and practice setting (rural or urban). Estimate is non-exponentiated coefficient.

Table 4

HNHC Patients with Substance Use Disorder (n = 1,751)

	Estimate	Std. Error	z value	p value	95% CI
All-Cause ED Utilization					
Care Coordination	-0.051	0.054	-0.953	0.34	-0.16, 0.05
Chronic Disease Registries	0.319	0.055	5.794	< .001	0.21, 0.43
Shared Communication Systems	-0.274	0.056	-4.903	< .001	-0.38, -0.16
After-Hours Care	0.094	0.051	1.84	0.066	-0.01, 0.19
Preventable ED Utilization					
Care Coordination	-0.045	0.078	-0.583	0.56	-0.2, 0.11
Chronic Disease Registries	0.487	0.078	6.2	< .001	0.33, 0.64
Shared Communication Systems	-0.5	0.08	-6.238	< .001	-0.66, -0.34
After-Hours Care	0.033	0.076	0.435	0.663	-0.12, 0.18

Source. Author's calculations based on linked nurse practitioner survey data and Medicare claims, 2019.

Note. ED: emergency department, HNHC: high-need high-cost. Models adjusted for age, sex, race, practice size, practice type (e.g., hospital clinic, physician practice, etc.), and practice setting (rural or urban). Estimate is non-exponentiated coefficient.

CONCEPT ANALYSIS

NURSING FORUM AN INDEPENDENT VOICE FOR NURSING WILEY

High-need high-cost patients: A Concept Analysis

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Abstract

High-need high-cost (HNHC) patients are variously defined in the literature as the small subset of the population who account for the majority of US health care costs. Lack of consensus on the defining attributes of HNHC patients has challenged the effectiveness of interventions aimed to improve disease management and reduce costs. Guided by the Walker and Avant method of concept analysis, a literature review of 2 databases (PubMed and CINAHL) was conducted. Three main subgroups of HNHC patients were identified: adults with multiple chronic conditions and functional disability, the frail elderly, and patients under 65 years old with a disability or behavioral health condition. HNHC patients are categorized by a feedback loop of acute-on-chronic health conditions, preventable health service utilization, and fragmented care. Antecedents that predispose becoming a HNHC patient include challenges accessing timely care, low socioeconomic status, unmet support, and social factors such as isolation and inadequate.

KEYWORDS
health promotion, policy/politics, public health, chronic disease management

1 | BACKGROUND

Healthcare costs are rapidly increasing across the United States and are particularly concentrated to a small subset of the population known as high-need high-cost (HNHC) patients.[1,2] HNHC patients are referred to as adults suffering from costly and chronic medical and behavioral conditions.[1,3] Compared to the average US adult, HNHC patients spend more than twice as much on out-of-pocket expenses and nearly four times as much on overall health care services and medication, exceeding $21 000 for average annual per-person spending.[1,3] Yet, interventions aimed to control costs and reduce unnecessary health care utilization in this population have proved largely ineffective,[4-8] likely due to lack of consensus on the definition and characteristics of HNHC patients.[8,9]

While HNHC patients are often referred to as the 5% of the population who account for the majority of overall US health care costs, significant heterogeneity exists in the definition of HNHC patients with regard to age, comorbidities, disability, and social needs.[1,10] Additionally, many common characteristics used to describe HNHC patients are implied rather than explicitly stated which can further exacerbate challenges in identifying this population and developing sustainable interventions.[1] Further, defining the specific attributes of HNHC patients is essential as this population will likely expand as the United States increases in numbers of older and chronically ill adults.[11-13]

The purpose of this concept analysis is to establish a clear definition of HNHC patients using Walker and Avant's (2019) framework. This analysis will provide defining attributes and cases to provide a comprehensive definition of HNHC patients that can inform future research and intervention development.

2 | METHODS

The concept of HNHC patients was analyzed using Walker and Avant's framework which includes (a) determining the aim of analysis, (b) identifying all uses of the concept, (c) determining the defining attributes, (d) constructing a model and alternative cases, (e) identifying antecedents and consequences, and (f) defining empirical referents.[14]

2.1 | Data sources

A review of the literature was conducted in October 2019 to identify current uses of the concept and determine defining attributes. Two databases were searched (PubMed and CINAHL) with no date restrictions, as well as Google Scholar, Scopus, the Commonwealth Fund, and the Agency for Healthcare Research and Quality. Search terms included *high-need*, *high-cost*, *high-need high-cost*, *high-risk*, and *high utilizer*. The search strategy was not limited to nursing and medical literature as to not bias the true nature of the concept.[14] Searches were limited to studies written in English and conducted within the United States. Additional hand searching was performed by reviewing relevant editorial articles, websites, and health services journals such as *Health Affairs*, *The American Journal of Managed Care*, and *Preventing Chronic Disease*. Broad searching strategies were utilized to evaluate all uses of the concept. To be eligible, articles must have included information relating to the defining attributes or antecedents of the concept such as demographic characteristics, medical diagnoses, or psychosocial needs. After searching the literature, 23 articles were included and critically reviewed to inform an understanding of the uses of the concept, key attributes, and model and borderline cases of HNHC patients.

3 | RESULTS

3.1 | Uses of HNHC patients

Existing healthcare literature primarily uses HNHC patients as an overarching concept which includes a variety of patient ages, demographics, and medical and social needs. These patients fall into three subgroups: (a) patients with multiple chronic conditions and functional disability, (b) the frail elderly, and (c) patients under 65 years old with a disability or a behavioral health condition.

3.1.1 | Multiple chronic conditions and functional limitations

Patients suffering from multiple (≥2) chronic conditions in addition to having a functional limitation make up the largest subgroup of HNHC patients. Functional limitations are defined as difficulty with at least one activity of daily living (ADL) such as eating, bathing, dressing, toileting, or climbing stairs.[3] Patients with both multiple chronic conditions and functional limitations have higher health service utilization, higher spending, and poorer overall health compared to chronically ill adults without any functional limitation.[3,15] This group is largely identified as adults over the age of 65 who are insured by Medicare or are dually eligible for Medicaid.[3,9,12] The most frequent chronic conditions stated explicitly in the literature for HNHC patients include hypertension, coronary artery disease, congestive heart failure, diabetes, asthma, and chronic obstructive pulmonary disease.[16,17]

3.1.2 | Frail elderly

Patients who are identified as frail elderly often have multiple functional limitations, memory disorders (e.g., dementia), or require long-term support services to live independently.[18] Frailty indicators most often used to define the frail elderly subgroup of HNHC patients include gait abnormality, malnutrition, failure to thrive, cachexia, history of fall, and presence of a decubitus ulcer.[19,20] The frail elderly account for the highest percentage of preventable spending and require interventions that are unique from other older adults addressing social needs, home support, and long term services.[18,21]

3.1.3 | Under 65 years old with disability or behavioral health conditions

This subgroup consists of younger adults with behavioral health conditions such as serious mental illness or disability who are often insured by Medicaid due to lower income or may be dually eligible for Medicaid and Medicare due to disability.[1,15] Younger adults have significant differences in quality of life, disability, and access to care compared to older adults.[22,23] Thus, segmenting younger adults allows for tailored interventions that may address the unique needs that come along with younger age such as resources needed in the school environment, social stressors, or lack of autonomy or health literacy.

3.2 | Defining attributes

Defining attributes are characteristics that are most frequently associated with the concept used to describe its true meaning and differentiate it from similar concepts.[14] The concept of HNHC patients is new and without one standardized definition.[1] Further, characteristics of HNHC patients are often implied in the literature and not fully explicated, such as preventability of health service use. This concept analysis uncovered both the implied and explicitly stated characteristics of HNHC patients: (a) acute-on-chronic health condition, (b) health service use, (c) fragmented care, and the existence of a (d) feedback loop. These characteristics apply to all subgroups.

3.2.1 | Acute-on-chronic health condition

An acute-on-chronic health condition differs from ongoing health needs as it is an acute onset of a chronic condition, also known as an acute exacerbation. Evidence surrounding HNHC patients demonstrates that acute-on-chronic health conditions are the major drivers of health services use, and thus, start the cause-and-effect system of the feedback loop.[24] HNHC patients often experience acute exacerbations as a result of inadequate disease management, social stressors (e.g., isolation or lack of housing), or poor care

coordination.[1,25] An acute health condition can include exacerbations related to a chronic medical or behavioral health condition.[1]

3.2.2 | Preventable health service utilization

HNHC patients have the highest rates of health service utilization across the outpatient and inpatient settings often resulting from acute exacerbations.[3,15,17] HNHC are three times more likely to visit the emergency department (ED) and two times more likely to be hospitalized compared to the general adult population.[3,26] Existing literature demonstrates varying rates (approximately 20%–40%) of ED visits made by HNHC patients are preventable, often due to challenges with obtaining timely and routine primary care.[3,15,21] Studies also suggest that health service utilization in this population may be amenable to change with improvements in disease management or outpatient care coordination.[1,27] Thus, a defining attribute of HNHC patients is health service use that is either emergent but preventable or primary care treatable.

3.2.3 | Fragmented care

Fragmented care is defined as care that is poorly coordinated among multiple providers and organizations due to ineffective communication, incompatible electronic health records, or inadequate discharge education.[25,28,29] Fragmented care often occurs between primary and specialty providers or between the acute and primary care settings.[3,30] HNHC patients across all subgroups can experience fragmented care across social, behavioral, and health care services.[1,15] Finally, fragmented care can lead to inadequate disease management and subsequent adverse effects such as medication errors or redundant care.[29]

3.2.4 | Feedback loop

A feedback loop is a process where inputs lead to downstream reactions causing a nonlinear cause-and-effect relationship.[31] The feedback loop is a defining attribute as it represents the relationship between an acute health condition, preventable health service utilization, and care fragmentation. Existing research implies the existence of a feedback loop by demonstrating how reducing fragmentation can impact health service utilization in HNHC patients.[32] One quasiexperimental study found that enhanced care coordination (i.e., discharge planning, follow-up appointments, and education) led to a 39% reduction in ED visits, 25% reduction in hospitalizations, and a 79% reduction in 30-day readmissions in HNHC patients.[16]

Similar research exists demonstrating that interventions focused on integrating health and behavioral resources (reducing fragmentation) can improve medication and disease management, prevent acute exacerbations, and reduce preventable health service utilization.[9,16,27,29,33] These findings validate the existence of a feedback loop by demonstrating the relationship between fragmented care, acute health conditions, and preventable health service utilization.

3.3 | Antecedents

Antecedents are defined as events that occur or characteristics that exist before becoming a HNHC patient.[14] Antecedents of HNHC patients include challenges accessing timely care, low socioeconomic status, unmet support, and social factors such as isolation and inadequate access to housing. While the vast majority (80%) of HNHC patients have insurance,[3] many report challenges accessing care after-hours, receiving a same-day answer to medical concerns, or obtaining timely care and information.[1,15] HNHC patients are more likely to be low income and subsequently cite cost-related barriers to accessing care or managing their chronic conditions, such as difficulty affording medication.[15,16]

HNHC patients also have unmet needs either with their medical care (i.e., difficulty obtaining medication), ADLs (i.e., lack of needed support with bathing or feeding), or other needs related to obtaining housing or nutritional food.[15,34] Patients with unmet needs are more likely to have acute exacerbations of ongoing medical or behavioral conditions and frequent hospitalizations and ED use.[10,15,34] HNHC patients also have high rates of psychosocial factors such as isolation and mental illness which are found to worsen medical conditions and lead to higher health service use and mortality rates.[15,35,36]

3.4 | Consequences

Consequences are defined as outcomes that occur as a result of being a HNHC patient.[14] Presence of a feedback loop allows for consequences occurring as a result of positive feedback (amplification of consequences) or negative feedback (reduction of consequences).

3.4.1 | Positive feedback loop

In a state of positive feedback, HNHC patients have poor clinical outcomes, caregiver burnout, increased risk of mortality, and persistent high spending which drives up national healthcare expenditures.[3,12,13,17] In positive feedback, fragmented care and high health service use can contribute to poor clinical outcomes including redundant health testing, polypharmacy, medication errors, and conflicting care plans.[25,37-39] HNHC patients who suffer multiple acute health conditions and complex care needs are often burdensome for caregivers leading to high rates of stress, burnout, poor care, and neglect.[34] Lastly, unlike acute and transient high costs due to short term conditions like a fracture or heart attack, HNHC patients remain high spenders over at least two years, leading to greater costs incurred by patients, health systems, and tax payers.[3,17]

3.4.2 | Negative feedback loop

In a negative feedback loop, patients have care that is well integrated between providers leading to decreased instances of acute exacerbations and preventable health service use.[16,40,41] Effective care integration is also associated with improved clinical outcomes, management of ongoing conditions, and reduced caregiver burnout.[18,42] Recent studies demonstrate that health systems may increase overall savings with decreased preventable health service utilization.[6,43]

3.5 | Empirical referents

Empirical referents are categories that demonstrate the occurrence of the concept and are used to measure the defining attributes.[14] When a concept is concrete (e.g., preventable health service use) the empirical referents may be identical to the defining attributes. There are no tools currently used to measure or identify HNHC patients overall, however, there are empirical referents for specific defining attributes. Empirical referents for fragmented care, for example, include adverse clinical outcomes such as patients receiving duplicate testing or conflicting information, ineffective communication across providers such as providers lacking medical history, diagnostic testing, or not being informed about specialist care.[44] Additionally, multiple tools exist to measure patient perception of care coordination and fragmentation.[45]

3.6 | Presentation of model and alternative cases

3.6.1 | Model case

Sarah is a 76-year-old woman presenting to the ED for the fifth time so far this year after recently being discharged for a congestive heart failure exacerbation. She complains of worsening shortness of breath, swollen ankles, fatigue, and stated that she tried to hold off coming to the ED but could not reach her primary care provide by phone. Sarah waited three days for an appointment at her primary care office and tried to relieve her shortness of breath using her asthma inhaler in the meantime. She cannot drive herself to the ED and knows that an ambulance service is covered by both her Medicare and Medicaid insurance, so she decides to call for one.

This model case illustrates all defining attributes of a HNHC patient in the subgroup of adults with multiple chronic conditions and functional disability. Sarah suffers from multiple chronic illnesses, has a functional limitation, and is dually eligible for Medicare and Medicaid insurance. She demonstrates high health service utilization due to acute exacerbations of her chronic condition. Sarah's difficulty contacting her provider is an antecedent of HNHC patients and also suggests that her ED visit may have been prevented with timely primary care intervention.

3.6.2 | Borderline case

Anthony is a 93-year-old veteran who makes consistent visits to check to both his primary and specialty care providers. He sits down every Sunday and carefully sorts out his daily pills for hypertension, high cholesterol, diabetes, and atrial fibrillation. Anthony is an active gardener and golfer and can tell when his sugar is low, so he always packs a snack. He had not been hospitalized in nearly a decade but required admission last year for an emergency cholecystectomy. He spent two weeks in an acute care center and one month in a subacute rehabilitation facility during this period. He has stayed out of the hospital since.

A borderline case is one that contains most, but not all of the defining attributes.[14] Anthony has many shared features of HNHC patients as an older adult with multiple chronic conditions and a frequent health service user. However, while Anthony did have an acute health condition, it was not an acute exacerbation of a chronic condition nor was his health service use preventable. He also lacked many of the antecedents and consequences common to HNHC patients; he has adequate access to primary and specialty care, he has no unmet needs in terms of obtaining medications or ADLs, he has stable housing and a vibrant social life.

4 | DISCUSSION

The goal of this concept analysis was to provide a clear definition of HNHC patients and to define both their implied and explicit attributes. The feedback loop in HNHC patients is validated by evidence demonstrating how effective care coordination (decreased fragmentation) can reduce acute-on-chronic health conditions and preventable health service utilization. Currently, there exists multiple health systems that are unable to share information across providers, which may exacerbate care fragmentation and adverse clinical outcomes such as medical errors, unnecessary testing, or duplicated care. Understanding the role of the feedback loop might enable the development of targeted interventions aimed at coordinating care transitions and exchanging information across providers.

Additionally, alternative payment delivery models such as accountable care organizations can provide incentives for health systems and providers to invest in long-term interventions. Both Medicaid and Medicare programs have implemented payment reforms in conjunction with specific cost-reduction targets to incentivize behavior change, track ongoing programs, and reimburse providers for activities needed for chronic disease management. These payment models demonstrate that it is feasible to reduce both out-of-pocket and overall costs incurred by health systems. Yet, more research is needed to understand how alternative payment models may be used to enhance disease management and reduce high spending in HNHC patients.

5 | LIMITATIONS

This concept analysis was restricted in the scope of the search strategy. Relevant articles may have been missed during literature review and articles were excluded that were not written in English or conducted outside the United States. While this concept analysis includes the most frequently identified defining attributes, it is not an all-inclusive summary. Many studies describing HNHC patients use claims data which may not accurately reflect complexity of comorbid conditions, socioeconomic status, health literacy, or caregiver competency. Only one qualitative study was found that interviewed HNHC patients and their caregivers to better understand their characteristics, functional needs, and adverse consequences of unmet support.[34]

6 | CONCLUSION

HNHC patients account for a large portion of national health care costs. This concept analysis identified three subgroups of HNHC patients; adults with multiple chronic conditions and functional disability, the frail elderly, and patients under 65 years old with a disability or behavioral health condition. HNHC patients are categorized by a feedback loop of acute-on-chronic health conditions, preventable health service utilization, and fragmented care which contributes to poor clinical outcomes, high spending, and increased mortality. This concept analysis can be used to inform the development of interventions targeted to distinct subgroups within the HNHC population.

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REFERENCES

1. Long P, Abrams M, Anderson G, et al. *Effective care for high needs patients: opportunities for improving outcomes, value and health.* 2017. Accessed June 24, 2019. https://lccn.loc.gov/2017041343
2. Zodet M. *Characteristics of persons with high health care expenditures in the U.S. civilian noninstitutionalized population.* 2016. Accessed July 24, 2019. http://www.meps.ahrq.gov/mepsweb/data_files/publications/mr23/mr23.pdf
3. Hayes SL, Salzberg CA, Mccarthy D, et al. High-need, high-cost patients: who are they and how do they use health care? *Commonw Fund.* 2016;26:1-14.
4. Coleman EA, Eilertsen TB, Magid DJ, Conner DA, Beck A, Kramer AM. The association between care coordination and emergency department use in older managed care enrollees. *Int J Integr Care.* 2002;2:e03.
5. Boult C, Reider L, Leff B, et al. The effect of guided care teams on the use of health services. *Arch Intern Med.* 2011;171(5):460-466. https://doi.org/10.1001/archinternmed.2010.540
6. Powers BW, Modarai F, Palakodeti S, et al. Impact of complex care management on spending and utilization for high-need, high-cost Medicaid patients. *Am J Manag Care.* 2020;26(2):E57-E63. https://doi.org/10.37765/ajmc.2020.42402
7. Weppner WG, Davis K, Tivis R, et al. Impact of a complex chronic care patient case conference on quality and utilization. *Transl Behav Med.* 2018;8(3):366-374. https://doi.org/10.1093/tbm/ibx082
8. Bleich SN, Sherrod C, Chiang A, et al. Systematic review of programs treating high-need and high-cost people with multiple chronic diseases or disabilities in the United States, 2008–2014. *Prev Chronic Dis.* 2015;12(197):1-16. https://doi.org/10.5888/pcd12.150275
9. Blumenthal D, Chernof B, Fulmer T, Lumpkin J, Selberg J. Caring for high-need, high-cost patients—an urgent priority. *N Engl J Med.* 2016;375(10):909-911. https://doi.org/10.1056/nejmp1608511
10. Keeney T, Belanger E, Jones RN, Joyce NR, Meyers DJ, Mor V. High-need phenotypes in Medicare beneficiaries: drivers of variation in utilization and outcomes. *J Am Geriatr Soc.* 2019;00(00):1-8. https://doi.org/10.1111/jgs.16146
11. Coughlin TA, Long SK. Health care spending and service use among high-cost Medicaid beneficiaries, 2002-2004. *Inquiry.* 2009;46(4):405-417. https://doi.org/10.5034/inquiryjrnl_46.4.405
12. Chamberlain AM, Rutten L, Jacobson DJ, et al. Multimorbidity, functional limitations, and outcomes: interactions in a population-based cohort of older adults. *J Comorbidity.* 2019;9:1-9. https://doi.org/10.1177/2235042X19873486
13. Stanton M, Rutherford M. *The high concenration of U.S. health care expenditures.* 2006. Accessed July 24, 2019. http://www.meps.ahrq.gov/PrintProducts/PrintProdLookup.asp?ProductType=
14. Walker LO, Avant KC. *Strategies for theory construction in nursing.* 6th ed. Pearson; 2019.
15. Ryan J, Abrams MK, Doty MM, Shah T, Schneider EC. How high-need patients experience health care in the United States. *Commonw Fund.* 2016;43:1-19.
16. Bailey JE, Surbhi S, Wan JY, et al. Effect of intensive interdisciplinary transitional care for high-need, high-cost patients on quality, outcomes, and costs: a quasi-experimental study. *J Gen Intern Med.* 2019;34(9):1815-1824. https://doi.org/10.1007/s11606-019-05082-8
17. Figueroa JF, Zhou X, Jha AK. Characteristics and spending patterns of persistently high-cost Medicare patients. *Health Aff.* 2019;38(1):107-114. https://doi.org/10.1377/HLTHAFF.2018.05160
18. McCarthy D, Ryan J, Klein S. Models of care for high-need, high-cost patients: an evidence synthesis. *Commonw Fund.* 2015;31:1-19.
19. Joynt KE, Figueroa JF, Beaulieu N, Wild RC, Orav EJ, Jha AK. Segmenting high-cost Medicare patients into potentially actionable cohorts. *Healthcare.* 2017;5(1-2):62-67. https://doi.org/10.1016/j.hjdsi.2016.11.002
20. Kim DH, Schneeweiss S. Measuring frailty using claims data for pharmacoepidemiologic studies of mortality in older adults: evidence and recommendations. *Pharmacoepidemiol Drug Saf.* 2014;23(9):891-901. https://doi.org/10.1002/pds.3674
21. Figueroa JF, Maddox KEJ, Beaulieu N, Wild RC, Jha AK. Concentration of potentially preventable spending among high-cost medicare subpopulations. *Ann Intern Med.* 2017;167(10):706-713. https://doi.org/10.7326/M17-0767
22. Adams ML. Difference between younger and older US adults with multiple chronic conditions. *Prev Chronic Dis.* 2017;14(76):1-14. https://doi.org/10.5888/pcd14.160613
23. Okoro CA, Hollis NTD, Cyrus AC, Griffin-Blake S. Prevalence of disabilities and health care access by disability status and type among adults—United States, 2016. *Morb Mortal Wkly Rep.* 2018;67(32):882-887. https://doi.org/10.15585/mmwr.mm6732a3

24. Schamess A, Foraker R, Kretovics M, et al. Reduced emergency room and hospital utilization in persons with multiple chronic conditions and disability receiving home-based primary care. *Disabil Health J.* 2017;10(2):326-333. https://doi.org/10.1016/j.dhjo.2016.10.004

25. Anderson G, Horvath J. The growing burden of chronic disease in America. *Public Health Rep.* 2004;119(3):263-270. https://doi.org/10.1016/j.phr.2004.04.005

26. Bélanger E, Silver B, Meyers DJ, et al. A retrospective study of administrative data to identify high-need Medicare beneficiaries at risk of dying and being hospitalized. *J Gen Intern Med.* 2019;34(3):405-411. https://doi.org/10.1007/s11606-018-4781-3

27. Joynt KE, Gawande AA, Orav EJ, Jha AK. Contribution of preventable acute care spending to total spending for high-cost. *JAMA.* 2013; 309(24):2572-2578. https://doi.org/10.1001/jama.2013.7103

28. Peterson K, Helfand M, Humphrey L, Christensen V, Carson S. *Evidence brief: effectiveness of intensive primary care programs.* 2013. Accessed August 9, 2019. https://www.ncbi.nlm.nih.gov/books/NBK384618/pdf/Bookshelf_NBK384618.pdf

29. Frandsen BR, Joynt KE, Rebitzer JB, Jha AK. Care fragmentation, quality, and costs among chronically ill patients. *Am J Manag Care.* 2015;21(5):355-362.

30. Rust G, Ye J, Baltrus P, Daniels E, Adesunloye B, Fryer GE. Practical barriers to timely primary care access: impact on adult use of emergency department services. *Arch Intern Med.* 2008;168(15): 1705-1710. https://doi.org/10.1001/archinte.168.15.1705

31. Diaz R, Behr JG, Tulpule M. A system dynamics model for simulating ambulatory health care demands. *Simul Healthc.* 2012;7(4):243-250. https://doi.org/10.1097/SIH.0b013e318259d134

32. Hardin L, Kilian A, Muller L, Callison K, Olgren M. Cross-continuum tool is associated with reduced utilization and cost for frequent high-need users. *West J Emerg Med.* 2017;18(2):189-200. https://doi.org/10.5811/westjem.2016.11.31916

33. Coleman EA, Parry C, Chalmers S, Min S. The care transitions intervention. *Arch Intern Med.* 2006;166:1822-1828. https://doi.org/10.1002/9781118785775.ch13

34. Beach SR, Schulz R, Friedman EM, Rodakowski J, Martsolf RG, James AE. Adverse consequences of unmet needs for care in high-need/high-cost older adults. *Journals Gerontol Soc Sci.* 2018;1-12. https://doi.org/10.1093/geronb/gby021

35. DuGoff EH, Buckingham W, Kind AJ, Chao S, Anderson GF. Targeting high-need beneficiaries in Medicare advantage: opportunities to address medical and social needs. *Commonw Fund.* 2019;2019:1-14. http://www.ncbi.nlm.nih.gov/pubmed/30938944

36. Manemann SM, Chamberlain AM, Roger V, et al. Perceived social isolation and outcomes in patients with heart failure. *J Am Heart Assoc.* 2018;7:1-7. https://doi.org/10.1161/JAHA.117

37. Bodenheimer T. Coordinating care—a perilous journey through the health care system. *N Engl J Med.* 2008;358(10):1064-1071. https://doi.org/10.1056/nejmhpr0706165

38. Dufour I, Chouinard MC, Dubuc N, Beaudin J, Lafontaine S, Hudon C. Factors associated with frequent use of emergency-department services in a geriatric population: a systematic review. *BMC Geriatr.* 2019; 19(185):1-9. https://doi.org/10.1186/s12877-019-1197-9

39. Institute of Medicine*The future of nursing: leading change, advancing health.* Washington, DC: National Academies Press; 2011https://doi.org/10.1111/j.1755-6686.1999.tb00003.x

40. Harris LJ, Graetz I, Podila PSB, Wan J, Waters T, Bailey JE. Characteristics of hospital and emergency care super-utilizers with multiple chronic conditions. *J Emerg Med.* 2016;50(4):203-214. https://doi.org/10.1016/j.jemermed.2015.09.002

41. Blumenthal D, McCarthy D, Shah TB. Academic medical centers and high-need, high-cost patients: a call to action. *Acad Med.* 2018;93(11): 1617-1619. https://doi.org/10.1097/ACM.0000000000002334

42. Garnett A, Ploeg J, Markle-Reid M, Strachan PH. Self-management of multiple chronic conditions by community-dwelling older adults: a Concept Analysis. *SAGE Open Nurs.* 2018;4:1-16. https://doi.org/10.1177/2377960817752471

43. Berkowitz SA, Parashuram S, Rowan K, et al. Association of a care coordination model with health care costs and utilization. *JAMA Netw Open.* 2018;1(7):1-14. https://doi.org/10.1001/jamanetworkopen.2018.4273

44. Sarnak DO, Ryan J. How high-need patients experiences the health care system in nine countries. *Commonw Fund.* 2016;1:1-14.

45. Agency for Healthcare Research and Quality. Care coordination measure for primary care survey. 2016. https://www.ahrq.gov/ncepcr/care/coordination/quality/index.html
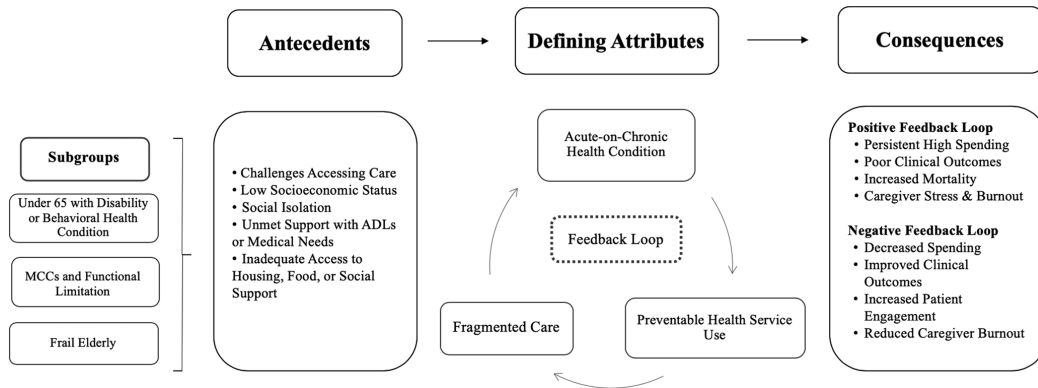
APPENDIX

FIGURE A1 Defining attributes of high-need high-cost patients. This model demonstrates the defining attributes, antecedents, and consequences relating to all subgroups of HNHC patients. ADLs, activities of daily living; MCC, multiple chronic conditions

R E S E A R C H

A Systematic Review of Primary Care and Payment Models on Emergency Department Use in Patients Classified as High Need, High Cost

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Contribution to Emergency Nursing Practice

- Frequent and discontinuous ED care may diminish high quality practice delivery.
- Four primary care and payment models are used to mitigate frequent ED use in high need, high cost patients: care management, care coordination, intensive primary care, and alternative payment models.
- Recommendations for translating the findings of this paper into emergency clinical practice include enhancing critical thinking about effective primary care referral practice at ED discharge and advocating for elements of primary care models and specific resources for in real time in the ED setting for high need, high cost patients.

Abstract

Introduction: Reducing costly and harmful ED use by patients classified as high need, high cost is a priority across health care systems. The purpose of this systematic review was to evaluate the impact of various primary care and payment models on ED use and overall costs in patients classified as high need, high cost.

Methods: Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a search was performed from January 2000 to March 2020 in 3 databases. Two reviewers independently appraised articles for quality. Studies were eligible if they evaluated models implemented in the primary care setting and in patients classified as high need, high cost in the United States. Outcomes included all-cause and preventable ED use and overall health care costs.

Results: In the 21 articles included, 4 models were evaluated: care coordination (n = 8), care management (n = 7), intensive primary care (n = 4), and alternative payment models (n = 2). Statistically significant reductions in all-cause ED use were reported in 10 studies through care coordination, alternative payment models, and intensive primary care. Significant reductions in overall costs were reported in 5 studies, and 1 reported a significant increase. Care management and care coordination models had mixed effects on ED use and overall costs.

Discussion: Studies that significantly reduced ED use had shared features, including frequent follow-up, multidisciplinary team-based care, enhanced access, and care coordination. Identifying primary care models that effectively enhance access to care and improve ongoing chronic disease management is imperative to reduce costly and harmful ED use in patients classified as high need, high cost.

Key words: Population health; Chronic disease; Primary health care; Emergency service

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Introduction

ED use has been rising steadily across the United States for the past 30 years.[1,2] Recurrent ED use is responsible for high costs of care, ED crowding, adverse patient outcomes, and

TABLE 1
Search terms for PubMed, Embase, and CINAHL

Database	Search terms
PubMed	(("Emergency Medical Services"[Mesh] OR emergency department*[tiab] OR emergency room*[tiab] OR health care util*[tiab]) AND ("Primary Health Care"[Mesh] OR primary care*[tiab] OR care coordin*[tiab] OR "Case Management"[Mesh] OR "Disease Management"[Mesh] OR "Case Managers"[Mesh] OR care manag*[tiab] OR disease manag*[tiab] OR "after-hours care") AND ("Dual MEDICAID MEDICARE Eligibility"[Mesh] OR "Medicare"[Mesh] OR "high-need high-cost" OR "high need high cost" OR "high cost" OR "high-cost" OR "high risk" OR "high utilizer")
Embase	('emergency department'/exp OR 'emergency department' OR 'emergency room' OR 'emergency visit') AND ('case manager'/exp OR 'care coordinator'/exp OR 'care coordinator' OR 'primary medical care'/exp OR 'primary medical care' OR 'out-of-hours care'/exp OR 'out-of-hours care' OR 'disease management') AND ('high-need' OR 'high-need high-cost' OR 'high-cost' OR 'high-utilizer' OR 'high-risk')
CINAHL	((MH "Emergency Service+") OR "emergency department" OR "emergency room" OR "health care utilization" OR "emergency visit") AND ((MM "Primary Health Care") OR "primary care" OR "primary practice" OR (MM "Case Management") OR (MM "Case Managers") OR (MM "Nursing Care Coordination (Saba CCC)") OR (MM "Multidisciplinary Care Team+") OR (MM "Disease Management+")) AND ((MM "Medicare") OR (MM "Medicaid") OR "high-need" OR "high-need high-cost" OR "high-cost" OR "high-risk" OR "high-utiliz*" OR "dual* eligibl*"))

increased mortality.[3-5] Extensive evidence demonstrates the impact of frequent ED use on emergency nurses' ability to provide high-quality care, contributing to delays in antibiotic and analgesic administration, increased frequency of medication errors, and increased risk of stress and exposure to violence toward staff.[3,6] Frequent ED use is particularly harmful for patients classified as high need, high cost (HNHC), the small subset (5%) of adults who account for the majority of US health care costs.[7-9]

Patients classified as HNHC are defined as adults suffering from multiple (at least 2) chronic conditions with additional functional limitation (eg, difficulty bathing or feeding) or other complex psychosocial needs (eg, frailty, mental illness, or social isolation).[7-9] Owing to high rates of multimorbidity, patients classified as HNHC require ongoing and coordinated disease management between the primary and acute care settings.[8,10] Yet, many patients classified as HNHC experience challenges accessing timely care or reaching their provider.[9] Consequentially, patients classified as HNHC are 3 times more likely to use the emergency department than the average US adult and more likely to have an ED visit categorized as preventable through timely and routine primary care.[8-10] Thus, a patient classified as HNHC, for example, might be a Medicare-insured adult suffering from congestive heart failure, diabetes, and obesity who has visited the emergency department 3 times in the

past month with worsening shortness of breath and lower-extremity swelling after failing to reach their primary care provider for 3 days.

Frequent and discontinuous ED care threatens the effectiveness of ongoing outpatient disease management owing to gaps in communication, inadequate discharge education, or poor care coordination between the acute and primary care settings.[11,12] Health systems are eager to identify strategies that effectively improve primary care delivery for patients classified as HNHC to reduce subsequent ED use.[13] Specific primary care models that expand accessibility to care and improve care coordination have been shown to reduce ED use.[14-16] For example, after-hours care (eg, access to evening and weekend hours) is associated with lower all-cause and nonurgent ED use.[16,17] Yet, the evidence is limited on how various primary care models affect ED use in the population of patients classified as HNHC with complex and chronic illnesses.

Frequent ED use also contributes to disproportionately high spending in the population of patients classified as HNHC.[18] Patients classified as HNHC spend more than twice as much on out-of-pocket expenses and nearly 4 times as much on medication and overall health care services as the average US adult.[10,18] Alternative payment models such as accountable care organizations have been identified as strategies to curb spending and incentivize providers for achieving high-quality outcomes for patients classified as

TABLE 2
Data extraction table

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Bailey et al[32] (2019)	Quasi-experimental	2235 model: 285 control: 1950	Age >18 y, Medicare, Medicaid, dual eligible, >2 hospitalizations or ED visits in last 6 mo, >1 chronic condition	Care coordination	Nonprofit health system in a medically underserved area in Tennessee, including (1) screening by nurses (2) patient engagement (3) medication and disease management (4) discharge planning and care coordination (5) community-based follow-up	Medicaid enrollees experienced 1.96 times fewer ED visits ($P <$ .05)	No significant difference	Decreased medical expenditures in model group (−$8690 per 6-month period; [95% CI, −$14 441 to −$2939]; $P <$ .005) Medicaid subgroup experienced an adjusted average decrease of −$15 998 (95% CI, −$24 427 to −$7568; $P <$ .001)
Baker et al[34] (2013)	Retrospective matched cohort study	1767	>2 clinic visits, Medicare, at least 1 of 3 conditions	Care management and telehealth	Two multispecialty clinics in Oregon and Washington offering care management integrated with telehealth for patient education and daily review of clinical needs	No significant difference		
Berkowitz et al[41] (2018)	Pretest/posttest	4686	Age >18 y, >1 chronic condition, visited PCP in last year, Medicare or Medicaid	Care coordination	Comparison of Medicare and Medicaid participants from 2012 to 2016 in Maryland: (1) discharge planning (2) daily interdisciplinary rounds (3) patient education (4) medication management (5) telephone follow-up after discharge (6) skilled home care and remote patient monitoring	90-d ED visit rates were reduced for Medicaid-insured patients by 133 per 1000 beneficiary episodes ($P <$ .01) No significant difference for Medicare-insured patients		For Medicaid-insured patients: aggregate cost of care was reduced by $59.8 million ($4295 per beneficiary episode; $P <$ .01) No significant difference for Medicare-insured patients

continued

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TABLE 2
Continued

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Boult et al[28] (2011)	Randomized controlled trial	850	Age >65 y, "high risk" defined using claims-based predictive model	Care coordination	Fourteen primary care teams in 8 community-based primary care practices across Baltimore, MD, and Washington, DC: (1) comprehensive home assessment (2) creation of evidence-based care guide with patient (3) monthly patient monitoring (4) transitional care support (5) care coordination (6) self-management and patient education	No significant difference		No significant difference
Brown et al[30] (2005)	Pretest/posttest	17	>1 chronic condition, >1 inpatient admission in past year, life expectancy >3 y	Intensive primary care	(1) Longer appointment times for evaluation interviews (2) multidisciplinary assessment and follow-up (3) Frequent visits (weekly initially) (4) 24-h availability of a team member on call	Average ED visits were significantly different with pretest 6.9 visits and posttest 4.9 visits (P = .05) ED visits per month were not significantly different		No significant difference
Bui et al[42] (2019)	Pretest/posttest	1342	Age >18 y, >1 chronic condition, Medicare or Medicaid insured, identified as "high risk" by referral or risk-prediction model	Care management	Primary care-embedded case management with multidisciplinary teams, including a case manager, community health worker, health behavior specialist, and clinicians to provide individualized care	No significant difference		

continued

TABLE 2
Continued

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Capp et al[35] (2017)	Retrospective cohort	3802 model: 406 control: 3396	Age >18 y, >2 ED visits/hospital admissions in last 180 d	Community-based care coordination	A multidisciplinary program, part of a large urban academic medical center in Colorado: (1) intensive medical, behavioral health, and social care coordination services (2) home visits within 60 days of an ED visit or hospital discharge (3) behavioral screening and education with a provider, care coordinator, health coach, behavioral health evaluator, and community health worker	27.9% fewer ED visits ($P < .05$)		
Coleman et al[16] (2002)	Case control (nested)	297 cases (used the emergency department): 103 Controls (did not use the emergency department): 194	Age >65 y, multiple chronic conditions, history of high use or physician referral	Care coordination	Large group-model health maintenance organization in Denver metropolitan area offering the following: (1) timely follow-up after a change in treatment (2) care planning with few decision makers involved (3) patient self-report of care coordination	No significant difference	No significant difference	
Cross et al[40] (2017)	Longitudinal cohort	17 443	2 more conditions, enrollment in same primary practice with same provider for duration of study	Alternative payment models	Multiyear engagement by primary care practices in a pay-for-value program part of Blue Cross Blue Shield of Michigan	Lower odds of incurring any ED visit over time compared with control patients (OR, 0.88; $P = .0002$) No significant difference in number of ED visits overall ($+3.2\%$, $P = .132$)		No significant difference over the 4-y study period

continued

TABLE 2
Continued

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Hardin et al[63] (2016)	Pretest/posttest	339	Age >18 y, >3 hospital or ED visits in past 12 mo	Care management	Conducted from 2012 to 2015 at an inner-city tertiary care hospital with a socioeconomically diverse and highly vulnerable population: (1) chart review with root-cause analysis (2) interdisciplinary care management plan with weekly follow-up (3) EMR integration	ED visits reduced by 43% (P < .001)		Total direct expenses reduced by 46% (P < .001) ED expenditures reduced by 50% (P < .001)
Komaromy et al[32] (2019)	Quasi-experimental	770	Age >18 y, enrolled in Medicaid-managed care, >2 chronic conditions, either 1 hospitalization or >3 ED visits in past 6 mo	Intensive primary care	6 outpatient intensivist teams across New Mexico offering the following: (1) patient-centered interdisciplinary team care (2) motivational interviewing (3) care planning (4) walk-in appointments and after-hours support using a 24-h on-call system	Odds of an ED visit 12 months postenrollment were 53% lower (OR 0.47; 95% CI, 0.39–0.58) in exposed group		No significant difference
Newcomer et al[36] (2004)	Prospective cohort with control group	3079 Model: 1537 Control: 1542	Age >65 y, >1 chronic condition	Preventive care management	(1) Health-risk screening and planning (2) Ongoing monitoring (3) Caregiver and client support (4) Medication/treatment adherence (5) Transitional care	No significant difference		
Ouayogodé et al[47] (2020)	Cross-sectional study	1 402 582	Age >65 y, complex needs defined as frailty or >2 conditions	Care management	2017-2018 National Survey of ACOs evaluating the following: (1) chronic care management (2) predictive-risk stratification (3) transitional care	No significant difference		No significant difference

continued

TABLE 2
Continued

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Peikes et al[37] (2018)	Prospective cohort with control group	1 730 958 Model: 565 674 Control: 1 165 284	Spending 30% above the average	Alternative payment models	Multipayer support for 502 practices to implement the following: (1) enhanced access to care (2) preventive care (3) risk-stratified care management and care coordination (4) patient engagement	Slowed growth in ED visits by 2% (P < .008)	No significant difference	No significant difference in costs of care, regardless of Medicare financial support
Powers et al[29] (2020)	Randomized controlled trial	253 Model: 71 Control: 127	Adult Medicaid patients in the top 5% of total expenditures or Chronic Illness Intensity Index score with >3 ED visits or >2 hospitalizations or >2 conditions	Care coordination	Multidisciplinary care team at CareMore Health in Memphis, TN, consisting of a community health worker, a social worker, and a provider: (1) comprehensive medical, social, behavioral assessment (2) individualized care plan (3) frequent (at least weekly) follow-up	No significant difference		Patients randomized to complex care management had 37% lower total medical expenditures (adjusted difference, −$7732 per member per year; [95% CI, −$14 914 to −$550]; P = .036)
Ritchie et al[44] (2016)	Pretest/posttest	152	Age >18 y, >5 ED visits or >2 hospitalizations in the past 12 mo	Care management	Geriatric Resources for the Assessment and Care of Elders program implemented in 4 primary care clinics at a large urban academic medical center: (1) individualized care planning (2) comprehensive in-home assessment by a nurse practitioner/social worker team alongside a geriatrician, mental health liaison, and pharmacist	Decline in the median number of ED visits (5.5 to 0, P = .015) after enrollment in program		

continued

TABLE 2
Continued

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Schraeder et al[38] (2008)	Prospective cohort with control group	670 Model: 400 Control: 277	Age >65 y, determined to be high risk for mortality, functional decline, or increased health service use from screening survey	Care management	Collaborative care management in a multispecialty physician group practice across rural and urban Illinois offering the following: (1) risk identification (2) comprehensive assessment (3) collaborative planning (4) health monitoring (5) patient education (6) transitional care	No significant difference		No significant difference
Schuttner et al[45] (2018)	Pretest/posttest	65	Age >18 y, >1 chronic illness, >2 ED visits within 12 mo	Care coordination and after-hours care	Interprofessional care program (nutrition, behavioral health, pharmacy, and care coordination) implemented in an ambulatory clinic affiliated with a large academic care system in California located in an ambulatory clinic with extended hours and same-day urgent care access	12% monthly decrease in ED visits after model ($P < .001$)	17% monthly decrease in preventable ED visits ($P = .043$)	40 prevented visits over 21 m resulting in $93 000 cost savings, no statistical significance reported
Sledge et al[49] (2006)	Randomized controlled trial	96 Model: 47 Control: 49	Age >18 y, >2 hospital admissions per year in the 12 to 18 mo before recruitment	Intensive primary care	Urban, academically affiliated clinic offering the following: comprehensive interdisciplinary medical and psychosocial assessment (2) follow-up ambulatory case management for 1 year	No significant difference	No significant difference	No significant difference

continued

TABLE 2
Continued

Author (year)	Study design	Sample	Definition of HNHC	Primary care model	Model definition	Result: All-cause ED use	Result: Preventable ED use	Result: Costs
Weppner et al[39] (2018)	Prospective cohort with control group	208 Model: 104 Control: 104	Patients selected from an interprofessional academic primary care clinic based in a VA medical center. Need risk prediction estimating the probability of hospitalization or death in the next 90 d	Care coordination	Patient-aligned care teams within a VA primary care clinic consisting of an interprofessional hour-long conference to develop and integrate care plan in medical record and coordinate follow-up and outreach	No significant difference		
Zulman et al[31] (2017)	Randomized controlled trial	583 Model: 150 Control: 433	Top 5% of overall facility costs or top 5% of VA patients. Need risk prediction	Intensive primary care	Intensive multidisciplinary team-based program in the VA Health Care System: (1) comprehensive patient assessments (2) intensive case management (3) care coordination (4) social and recreational services	No significant difference		Significant increase in monthly person-level primary care costs (D-in-D [SE] = $30 [$14])

HNHC, high need, high cost; PCP, primary care provider; EMR, electronic medical record; ACO, accountable care organization; VA, Veterans Affairs; OR, odds ratio; D-in-D, difference-in-differences analysis.

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HNHC.[19-21] Yet, little research has been done to understand how innovative payment models outside of typical fee-for-service models may affect downstream ED use and overall health care costs in the population of patients classified as HNHC. Thus, the purpose of this systematic review was to identify existing primary care–based models and evaluate their impact on ED use and overall costs in patients classified as HNHC.

Methods

SEARCH STRATEGY

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were used as a foundation for this review.[22] A comprehensive literature search was performed by 1 author (A.B.) in PubMed, Embase, and CINAHL for peer-reviewed studies published from January 2000 to March 2020. The search strategy used Medical Subject Headings and field descriptions that were combined with general search terms. The Medical Subject Headings terms "emergency medical services," "emergency department," "primary health care," and "primary care" were used in conjunction with terms describing patients classified as HNHC. We used terms to describe both patients classified as HNHC as well as patients who are frequent ED users (ie, "high-need," "high-cost," "high-need high-cost," "high-risk," and "high utilizer") to be as inclusive as possible. Medicare and Medicaid search terms were also included to ensure the inclusion of a broad spectrum of patients. Additional searches were performed by manually searching relevant journals and reference lists of included articles in the *Journal of Emergency Nursing*, *Academic Emergency Medicine*, *Journal of Emergency Medicine*, *The American Journal of Managed Care*, and *Annals of Family Medicine*. Table 1 provides the search terms used for all databases.

ELIGIBILITY CRITERIA

Studies were included if they (1) evaluated primary care or payment models based in the primary care setting, (2) evaluated the outcomes "ED use" and "costs," (3) were conducted in the US, and (4) included adults classified as HNHC who were aged above 18 years. The authors selected studies that either explicitly included the term "HNHC patients" or sampled their populations using HNHC indicators (ie, adults with at least 2 chronic conditions, high frequency of acute care use, or top 5% of total expenditures).

Studies were excluded if they (1) did not fit the inclusion criteria, (2) were considered gray literature (eg, editorials, conference abstracts, or unpublished manuscripts),

and (3) were not written in English. Models that were implemented exclusively in the hospital setting or in specialty practices (eg, radiology, ophthalmology, or postoperative surgery clinics) were excluded because these participants were not generalizable.

DATA EXTRACTION

Data were extracted from each article on the basis of a priori–defined categories established in previous research and systematic reviews of ED use.[23,24] For each study, data were extracted referring to study design, sample, definition of population of patients classified as HNHC, model type and definition, and outcomes. The outcomes of interest included all-cause ED use, preventable ED use, and overall costs. Table 2 presents the data extraction from each study.

QUALITY APPRAISAL

Two authors (A.B. and S.K.) independently reviewed and appraised each of the 21 studies using the Downs and Black tool.[25] The Downs and Black tool consists of 27 questions surrounding population characteristics, generalizability, assessment of confounders, and appropriateness of statistical analyses.[25] Individual subscales as well as overall total score on the Downs and Black tool have demonstrated high internal consistency as well as test-retest and interrater reliability for both randomized and nonrandomized studies.[25] The Downs and Black tool has been modified for items that do not apply to nonrandomized studies or when adequate information is not provided to calculate power.[26,27] The modified Downs and Black tool has a maximum score of 28.

The Downs and Black tool consists of 5 subscales: (1) reporting, (2) external validity, (3) bias, (4) confounding, and (5) power. All items have "yes," "no," or "unable to determine" responses and are scored as 0 (no) or 1 (yes), except for the reporting subscale (0 to 2). The reporting subscale addresses whether the study provides sufficient information to develop an unbiased assessment of the findings, such as a list of principal confounders. The external validity subscale evaluates whether the findings are generalizable to the population from which the study subjects were drawn. Finally, the power subscale addresses whether the findings could be due to chance.

Results

LITERATURE SEARCH

After removing duplicates, our initial search yielded 2140 titles. Two authors independently screened the studies for eligibility, leaving 51 full-text studies to be evaluated. Of
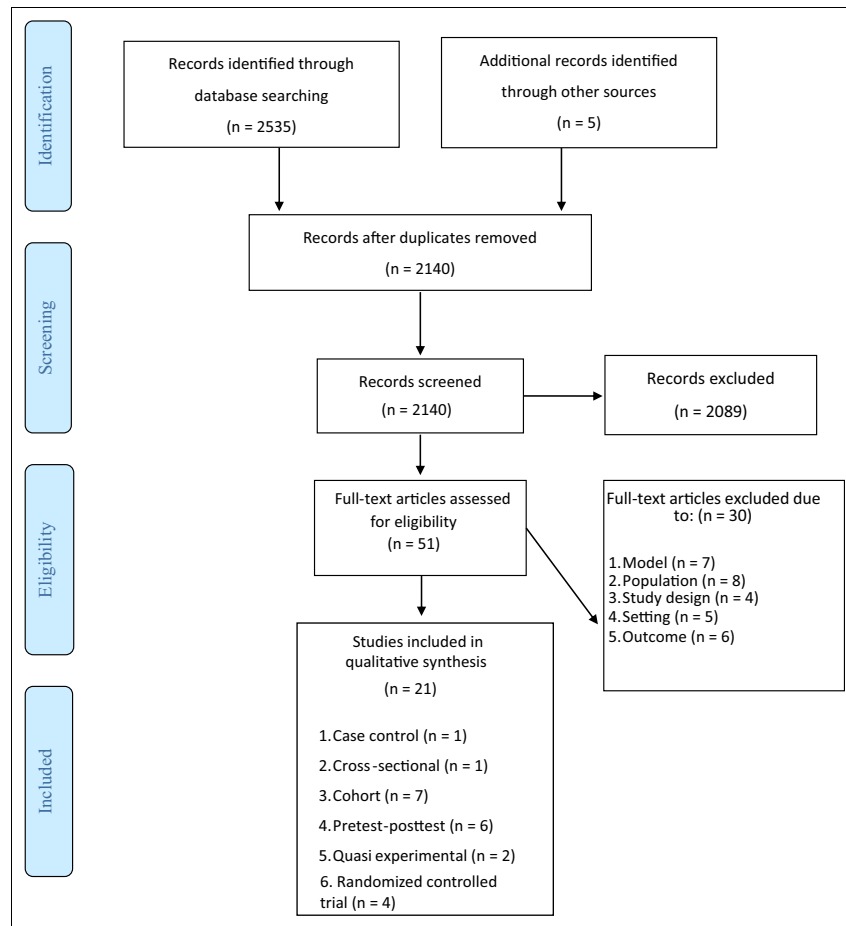
FIGURE

Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.[22]

these, 30 articles were excluded owing to differing populations (n = 8), settings (n = 5), and outcomes (n = 6). Studies were also excluded if the models were not based in the primary care setting (n = 7) or if they were not published in peer-reviewed journals (n = 4). The Figure demonstrates the search strategy and eligibility using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.[22]

DESCRIPTION OF INCLUDED STUDIES

The outcomes of interest included all-cause ED use, preventable ED use, and overall costs. Table 2 presents the data extraction from each study. The final review included 21 studies that met the eligibility criteria. Of these, 4 studies were randomized controlled trials,[28-31] and 2 were quasi-experimental studies.[32,33] Seven studies were cohort studies, including 2 retrospective cohorts,[34,35] 4 prospective cohorts

Only 2 studies reported statistically significant differences in all-cause ED use,[43,44] no studies reported significant findings related to preventable ED use, and 1 reported significant reductions in cost.[43]

Hardin et al[43] developed and tested a care management model at an inner-city tertiary care hospital serving a highly vulnerable and socioeconomically diverse population, including many patients experiencing homelessness, unemployment, substance abuse, and psychiatric illness. The study was conducted with 339 patients classified as HNHC and included root-cause analysis of high health service use, interdisciplinary management, and frequent follow-up, demonstrating a 43% reduction in mean ED visits ($P < .001$) and reductions for both total direct expenses (47%, $P < .001$) and ED expenditures (50%, $P < .001$). Ritchie et al[44] evaluated the impact of a care management model consisting of individualized care planning managed by a large interdisciplinary team; home assessments; and primary care, mental health, and pharmacist consultations. Over 100 observation days, median ED visits significantly declined postimplementation (from 5.5 to 0; $P < .05$) for 152 adults classified as HNHC.

Intensive Primary Care

The intensive primary care model is a team-based, multidisciplinary approach to increase the intensity, frequency, and accessibility to primary care services to support patients classified as HNHC.[8,48] Four studies evaluated the impact of intensive primary care on patients classified as HNHC.[30,32,49] Traditional primary care settings often lack the ability to effectively manage and support the complex care required for patients classified as HNHC.[48] Of the 4 studies, 2 demonstrated significant reductions in ED use,[30,32] and 1 showed a significant difference in overall costs when patients were enrolled in intensive primary care models.[31]

Brown et al[30] implemented an intensive primary care model consisting of longer appointment times for evaluation interviews, multidisciplinary assessment and follow-up, weekly visits, and 24-hour availability of a team member on call. Among the patients classified as HNHC who were enrolled, average ED visits were significantly decreased (6.9 preimplementation to 4.9 postimplementation, $P = .05$), but no significant difference was found in ED visits per month. Komaromy et al[32] conducted a quasi-experimental study of 6 outpatient intensivist teams across New Mexico supporting Medicaid patients classified as HNHC through motivational interviewing, care planning, walk-in appointments, and after-hours care using an on-call system. For pa-

tients enrolled in the intensive primary care model, the odds of an ED visit 12 months postenrollment were 53% lower (odds ratio 0.47; 95% CI, 0.39–0.58) than for those receiving usual care.

Zulman et al[31] conducted a randomized controlled trial of 583 patients classified as HNHC receiving intensive outpatient care in the Veterans Affairs Health Care System. Patients classified as HNHC were enrolled with multidisciplinary teams and received comprehensive patient assessments, intensive care management and coordination, and social services. This model found no significant differences in ED use, but it was associated with a significant increase in monthly person-level primary care costs (difference-in-differences analysis [SE] = $30 [$14]).

Alternative Payment Models

Two studies evaluated alternative payment models consisting of value-based payments to align incentives and improve care for patients classified as HNHC.[37,40] Alternative payment models have been increasingly implemented across the US to improve access and quality of primary care while allocating limited resources more effectively.[19] In particular, these payment models incentivize quality over quantity of care by reimbursing providers for primary care activities that are often excluded from the fee-for-service payment structure (eg, care management, phone follow-up, and extended time).[11,50,51]

Cross et al[40] evaluated the effects of a multiyear pay-for-value payment model on patients classified as HNHC assigned to primary care providers participating in Blue Cross Blue Shield of Michigan's physician group incentive program. The patients enrolled in the program had lower odds of incurring an ED visit over the 4-year period than the control group (odds ratio, 0.88; $P < .01$), despite not differing in the number of ED visits. Peikes et al[37] tested the impact of the Comprehensive Primary Care Initiative developed by the Centers for Medicare & Medicaid Services, including multipayer support for practices to enhance primary care delivery, patient engagement, and disease management activities. The patients enrolled in these practices reduced all-cause ED visits by 2% ($P < .05$) over the 4-year initiative. There were no significant differences in preventable ED visits.

Discussion

This review synthesized 21 studies evaluating various primary care and payment models and their impact on ED use and overall costs in the population of patients classified

with control groups,[33-39] and 1 longitudinal cohort.[40] In addition, 6 pretest-posttest studies,[30,41-45] 1 nested case control,[46] and 1 cross-sectional study were included.[47]

QUALITY APPRAISAL RESULTS

The studies ranged in score from moderate (score = 17[35] out of a total score of 28) to high quality (score = 25[28,31]) on the Downs and Black tool (Supplemental Table 1). The factors that led to lower-quality scores across all studies included items related to randomization, blinding of treatment and outcome assessment, and allocation concealment. A large proportion of the studies (16 out of 21) either did not report a power calculation or did not have sufficient power to detect a treatment effect. Overall, all studies demonstrated high quality for the reporting and external validity subscales, indicating a low risk of bias.

PRIMARY CARE MODELS AND OUTCOMES

This review identified 4 models currently used to support primary care for patients classified as HNHC: (1) care coordination, (2) care management, (3) intensive primary care, and (4) alternative payment models. This review reports significant findings for the outcomes, including all-cause ED use, preventable ED use, and overall costs.

Care Coordination

Eight studies evaluated care coordination models, defined as models that focus on the organization and integration of patient care activities across all patients and providers involved to effectively share information and achieve safer care.[28,29,33,35,39,41,45,46] There was wide variability in model components and activities across studies; yet, all care coordination models included multidisciplinary assessment, comprehensive discharge planning, disease education, medication management, and follow-up or remote monitoring with patients.

Of the 8 studies implementing care coordination, 4 demonstrated statistically significant reductions in all-cause ED use,[33,35,41,45] 1 demonstrated reductions in preventable ED use,[45] and 4 reported reductions in overall costs.[29,33,41,45] One study that evaluated 3802 patients classified as HNHC with high ED use involved pre- and post-implementation of a multidisciplinary, community-based care coordination model integrated in an urban, academic medical center in Colorado.[35] This model integrated community medical, behavioral, and social services in conjunction with home visits and frequent follow-up. The study

showed 29.7% fewer ED visits ($P < .05$) after patients classified as HNHC were enrolled.[35] A study by Schuttner et al[45] enrolled 65 patients classified as HNHC in an ambulatory clinic affiliated with a large academic care system within southern California. The clinic offered interprofessional care coordination and behavioral health services alongside after-hours and same-day urgent care. Patients classified as HNHC reported a significant 12% monthly decrease in all-cause ED visits ($P < .001$) and a 17% monthly decrease in preventable ED visits ($P < .05$) resulting in a $93 000 cost savings over 21 months.[45]

The study with the largest sample size among care coordination models compared the outcomes of 4686 Medicare and Medicaid patients classified as HNHC over 4 years in Maryland as part of the Johns Hopkins Community Health Partnership.[41] Berkowitz et al[41] found that of the 1000 Medicaid beneficiary episodes, ED visits were reduced by 133 visits over the 90-day study period ($P < .01$), and costs per Medicaid beneficiary episode were reduced by $4295 ($P < .01$).[41] There was no statistically significant reduction in ED visits or costs of care for Medicare patients. Similarly, Bailey et al[33] found that significant changes in ED use were limited to Medicaid (rather than Medicare) patients enrolled in their program, with a 39% decrease in ED use ($P < .05$). Exposure to the care coordination model was associated with an average decrease in medical expenditures of $8690 over 6 months (95% CI,–$14 441 to –$2939).[33] Additional subgroup analyses demonstrated again that the decrease in costs was limited to Medicaid patients, with an adjusted average decrease of $15 998 (95% CI, –$24 427 to –$7568; $P < .001$) in total Medicaid expenditures compared with the patients in usual care.

Finally, Powers et al[29] conducted a randomized controlled trial among patients classified as HNHC enrolled in a program offering multidisciplinary care coordination and care planning with a primary care provider, community health worker, and social worker. No significant reductions in ED use were found; yet, the patients randomized to the program had 27% lower total medical expenditures than the patients in usual care (absolute reduction of $7732 per patient per year, $P < .05$).

Care Management

Care management is a primary care model referring to activities often led by nurses to support disease management, assess health needs, facilitate communication with providers, and navigate the health system.[8,47] Seven studies evaluated care management, and all incorporated interdisciplinary collaborative care, individualized assessment, risk identification, monitoring, and patient education.[34,36,38,41,43,44,47]

Only 2 studies reported statistically significant differences in all-cause ED use,[43,44] no studies reported significant findings related to preventable ED use, and 1 reported significant reductions in cost.[43]

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Discussion

This review synthesized 21 studies evaluating various primary care and payment models and their impact on ED use and overall costs in the population of patients classified

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as HNHC. Studies were of moderate to high quality. There were 4 major primary care models examined across the studies, including (1) care coordination, (2) care management, (3) intensive primary care, and (4) alternative payment models. Overall, 10 studies reported significant differences in all-cause ED use.[30,32,35,37,40,43-45]

The studies included in this review were of acceptable quality; yet, a little more than half of the studies (11 out of 21) showed no significant difference in ED use. These findings could be attributed to small sample sizes, insufficient power to detect a treatment effect, or because of variability in the outcomes evaluated. For example, although some primary care models found no significant changes in use or spending, they might have demonstrated positive results for patient-reported outcomes or quality of care. In addition, the lack of significant difference in ED use may be partially explained by the fact that one-size-fits-all models of care have had mixed results in the population of patients classified as HNHC owing to heterogeneity in diagnoses, symptom severity, medical literacy, and social needs.[52] Patients classified as HNHC have high rates of multimorbidity, often with additional functional limitations, disability, and socioeconomic challenges such as social isolation or housing instability.[8,10] Individualizing models of care to the unique medical and social needs of patients classified as HNHC is imperative to making sustainable improvements in quality of care and ED use.[8,53,54]

Both studies evaluating alternative payment models demonstrated significant reductions in ED use.[37,40] These findings are consistent with recent research that shows that the adoption of patient-centered medical homes is associated with lower ED use, specifically among patients with chronic illness.[55] In existing fee-for-service payment structures, health systems are reimbursed for the services they provide and are disincentivized to invest in care models that might reduce outpatient or inpatient use.[56-58] In addition, research has found that aggregate savings in prevented acute care visits might not be substantial enough to have a large effect on overall spending within the population of patients classified as HNHC.[59] Thus, implementing alternative payment models may be an effective strategy to align incentives and reimburse providers and health systems for high-quality care delivery for patients classified as HNHC.[11,19,20]

Limitations

This study has some limitations, including the potential for missed studies during the selection process. Given the lack of standardization in the definition of patients classified as HNHC, studies may have been missed that evaluated patients classified as HNHC but used a unique definition. Because this systematic review includes cohort and cross-sectional studies, causation between primary care models and ED use cannot be established. Finally, most of the studies (16 out of 21) either did not report a power calculation or did not have sufficient power to detect a treatment effect.

Implications for Emergency Clinical Care

Although enhancing primary care delivery can improve access to care and ongoing disease management, no model will successfully reduce acute care use if the emergency department is, in fact, where patients prefer to receive care. Nurses in the emergency department can play an integral role in assessing the individual preferences and unique needs of patients classified as HNHC. This review can educate emergency nurses as they discuss the availability and quality of primary care models at practices where patients classified as HNHC patients receive care to advocate for specific resources (eg, psychiatry or social work) or care models (eg, care coordination or care management) in real time within the ED setting.

Conclusions

This review identified 4 models currently used to enhance primary care delivery to patients classified as HNHC: care coordination, care management, intensive primary care, and alternative payment models. Consistent with recent research, care coordination and care management had mixed effects on both ED use and overall costs. Future research should explore why variability exists in the effectiveness of primary care models within the population of patients classified as HNHC. Contextualizing these findings will enable a better understanding of how to enhance primary care delivery and ongoing disease management for this population of patients classified as costly and complex.

Author Disclosures

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2021.01.012.

REFERENCES

1. Bernstein AB, Hing E, Moss AJ, Allen KF, Siller AB, Tiggle RB. Health care in America: Trends in Utilization. National Center for Health Statistics 2003. Accessed May 23, 2019. www.cdc.gov/nchs/data/misc/healthcare.pdf

2. Tang N, Stein J, Hsia RY, Maselli JH, Gonzales R. Trends and characteristics of US emergency department visits, 1997-2007. *JAMA*. 2010;304(6):664-670. https://doi.org/10.1001/jama.2010.1112

3. Morley C, Unwin M, Peterson GM, Stankovich J, Kinsman L. Emergency department crowding: a systematic review of causes, consequences and solutions. *PLoS One*. 2018;13(8):1-42. https://doi.org/10.1371/journal.pone.0203316

4. Van den Heede K, Van de Voorde C. Interventions to reduce emergency department utilisation: a review of reviews. *Health Policy (New York)*. 2016;120(12):1337-1349. https://doi.org/10.1016/j.healthpol.2016.10.002

5. Kulstad EB, Sikka R, Sweis RT, Kelley KM, Rzechula KH. ED overcrowding is associated with an increased frequency of medication errors. *Am J Emerg Med*. 2010;28(3):304-309. https://doi.org/10.1016/j.ajem.2008.12.014

6. Hunsaker S, Chen HC, Maughan D, Heaston S. Factors that influence the development of compassion fatigue, burnout, and compassion satisfaction in emergency department nurses. *J Nurs Scholarsh*. 2015;47(2):186-194. https://doi.org/10.1111/jnu.12122

7. Cohen S, Yu W. Statistical brief #354: The concentration and persistence in the level of health expenditures over time: estimates for the U.S. population, 2008–2009. Published January 2012. Accessed July 18, 2019. https://meps.ahrq.gov/data_files/publications/st354/stat354.pdf

8. Long P, Abrams M, Milstein A, et al. *Effective Care for High Needs Patients: Opportunities for Improving Outcomes*. National Academy of Medicine, 2017. Accessed June 24, 2019. https://lccn.loc.gov/2017041343

9. Ryan J, Abrams MK, Doty MM, Shah T, Schneider EC. How high-need patients experience health care in the United States. The Commonwealth Fund, December 2016. https://www.commonwealthfund.org/publications/issue-briefs/2016/dec/how-high-need-patients-experience-health-care-united-states

10. Hayes SL, Salzberg CA, Mccarthy D, et al. High-need, high-cost patients: who are they and how do they use health care? Population-based comparison of demographics, health care use, and expenditures. *Issue Brief (Commonw Fund)*. 2016;26:1-14. https://pubmed.ncbi.nlm.nih.gov/27571599/.

11. Clarke JL, Bourn S, Skoufalos A, Beck EH, Castillo DJ. An innovative approach to health care delivery for patients with chronic conditions. *Popul Health Manag*. 2017;20(1):23-30. https://doi.org/10.1089/pop.2016.0076

12. Engel KG, Buckley BA, Forth VE, et al. Patient understanding of emergency department discharge instructions: where are knowledge deficits greatest? *Acad Emerg Med*. 2012;19(9):E1035-E1044. https://doi.org/10.1111/j.1553-2712.2012.01425.x

13. Blumenthal D, Anderson G, Burke S, Fulmer T, Jha AK, Long P. *Tailoring Complex-Care Management, Coordination, and Integration for High-Need, High-Cost Patients: A Vital Direction for Health and Health Care*. Washington, DC: NAM Perspective. Discussion Paper, National Academy of Medicine; 2016. https://doi.org/10.31478/201609q

14. Rust G, Ye J, Baltrus P, Daniels E, Adesunloye B, Fryer GE. Practical barriers to timely primary care access: impact on adult use of emergency department services. *Arch Intern Med*. 2008;168(15):1705-1710. https://doi.org/10.1001/archinte.168.15.1705

15. Lowe RA, Localio AR, Schwarz DF, et al. Association between primary care practice characteristics and emergency department use in a Medicaid managed care organization. *Med Care*. 2005;43(8):792-800. https://doi.org/10.1097/01.mlr.0000170413.60054.54

16. O'Malley AS. After-hours access to primary care practice linked with lower emergency department use and less unmet medical need. *Health Aff (Millwood)*. 2013;32(1):175-183. https://doi.org/10.1377/hlthaff.2012.0494

17. Jerant A, Bertakis KD, Fenton JJ, Franks P. Extended office hours and health care expenditures: a national study. *Ann Fam Med*. 2012;10(5):388-395. https://doi.org/10.1370/afm.1382

18. Figueroa JF, Zhou X, Jha AK. Characteristics and spending patterns of persistently high-cost Medicare patients. *Health Aff (Millwood)*. 2019;38(1):107-114. https://doi.org/10.1377/hlthaff.2018.05160

19. Mccarthy D, Klein S, Cohen A. The Road to Accountable Care: Building Systems for Population Health. Published October 2015. Accessed October 2020. https://www.commonwealthfund.org/sites/default/files/documents/___media_files_publications_case_study_2014_oct_1768_mccarthy_road_to_accountable_care_case_studies_synthesis.pdf

20. O'Malley AS, Rich EC, Sarwar R, et al. How accountable care organizations use population segmentation to care for high-need, high-cost patients. *Issue Brief (Commonw Fund)*. 2019;2019:1-17. https://pubmed.ncbi.nlm.nih.gov/30645057/

21. Brown RS, Peikes D, Peterson G, Schore J, Razafindrakoto CM. Six features of Medicare coordinated care demonstration programs that cut hospital admissions of high-risk patients. *Health Aff (Millwood)*. 2012;31(6):1156-1166. https://doi.org/10.1377/hlthaff.2012.0393

22. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med*. 2009;6(7):e1000100. https://doi.org/10.1371/journal.pmed.1000100

23. Bleich SN, Sherrod C, Chiang A, et al. Systematic review of programs treating high-need and high-cost people with multiple chronic diseases or disabilities in the United States, 2008-2014. *Prev Chronic Dis*. 2015;12:E197. Published correction appears in *Prev Chronic Dis*. 2016;13:E31. https://doi.org/10.5888/pcd12.150275

24. Morgan SR, Chang AM, Alqatari M, Pines JM. Non-emergency department interventions to reduce ED utilization: a systematic review. *Acad Emerg Med*. 2013;20(10):969-985. https://doi.org/10.1111/acem.12219

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25. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health*. 1998;52(6):377-384. https://doi.org/10.1136/jech.52.6.377

26. O'Connor SR, Tully MA, Ryan B, Bradley JM, Baxter GD, McDonough SM. Failure of a numerical quality assessment scale to identify potential risk of bias in a systematic review: a comparison study. *BMC Res Notes*. 2015;8:224. https://doi.org/10.1186/s13104-015-1181-1

27. Soril LJ, Leggett LE, Lorenzetti DL, Noseworthy TW, Clement FM. Characteristics of frequent users of the emergency department in the general adult population: a systematic review of international healthcare systems. *Health Policy (New York)*. 2016;120(5):452-461. https://doi.org/10.1016/j.healthpol.2016.02.006

28. Boult C, Reider L, Leff B, et al. The effect of guided care teams on the use of health services: results from a cluster-randomized controlled trial. *Arch Intern Med*. 2011;171(5):460-466. https://doi.org/10.1001/archinternmed.2010.540

29. Powers BW, Modarai F, Palakodeti S, et al. Impact of complex care management on spending and utilization for high-need, high-cost Medicaid patients. *Am J Manag Care*. 2020;26(2):e57-e63. Published correction appears in *Am J Manag Care* 2020;26(3):132. https://doi.org/10.37765/ajmc.2020.42402

30. Brown KE, Levine JM, Fiellin DA, O'Connor P, Sledge WH. Primary intensive care: pilot study of a primary care–based intervention for high-utilizing patients. *Dis Manag*. 2005;8(3):169-177. https://doi.org/10.1089/dis.2005.8.169

31. Zulman DM, Chee CP, Ezeji-Okoye SC, et al. Effect of an intensive outpatient program to augment primary care for high-need veterans affairs patients a randomized clinical trial. *JAMA Intern Med*. 2017;177(2):166-175. https://doi.org/10.1001/jamainternmed.2016.8021

32. Komaromy M, Bartlett J, Gonzales-van Horn SR, et al. A novel intervention for high-need, high-cost Medicaid patients: a study of ECHO care. *J Gen Intern Med*. 2019;35(1):21-27. https://doi.org/10.1007/s11606-019-05206-0

33. Bailey JE, Surbhi S, Wan JY, et al. Effect of intensive interdisciplinary transitional care for high-need, high-cost patients on quality, outcomes, and costs: a quasi-experimental study. *J Gen Intern Med*. 2019;34(9):1815-1824. https://doi.org/10.1007/s11606-019-05082-8

34. Baker LC, MacAulay DS, Sorg RA, Diener MD, Johnson SJ, Birnbaum HG. Effects of care management and telehealth: a longitudinal analysis using medicare data. *J Am Geriatr Soc*. 2013;61(9):1560-1567. Published correction appears in *J Am Geriatr Soc* 2013;61(11):2062 https://doi.org/10.1111/jgs.12407

35. Capp R, Misky GJ, Lindrooth RC, et al. Coordination program reduced acute care use and increased primary care visits among frequent emergency care users. *Health Aff (Millwood)*. 2017;36(10):1705-1711. https://doi.org/10.1377/hlthaff.2017.0612

36. Newcomer R, Maravilla V, Faculjak P, Graves MT. Outcomes of preventive case management among high-risk elderly in three medical groups: a randomized clinical trial. *Eval Health Prof*. 2004;27(4):323-348. https://doi.org/10.1177/0163278704270011

37. Peikes D, Dale S, Ghosh A, et al. The comprehensive primary care initiative: effects on spending, quality, patients, and physicians. *Health Aff (Millwood)*. 2018;37(6):890-899. https://doi.org/10.1377/hlthaff.2017.1678

38. Schraeder C, Fraser CW, Clark I, et al. Evaluation of a primary care nurse case management intervention for chronically ill community dwelling older people. *J Clin Nurs*. 2008;17(11c):407-417. https://doi.org/10.1111/j.1365-2702.2008.02578.x

39. Weppner WG, Davis K, Tivis R, et al. Impact of a complex chronic care patient case conference on quality and utilization. *Transl Behav Med*. 2018;8(3):366-374. https://doi.org/10.1093/tbm/ibx082

40. Cross DA, Cohen GR, Lemak CH, Adler-Milstein J. Sustained participation in a pay-for-value program: impact on high-need patients. *Am J Manag Care*. 2017;23(2):e33-e40.

41. Berkowitz SA, Parashuram S, Rowan K, et al. Association of a care coordination model with health care costs and utilization: The Johns Hopkins Community Health Partnership (J-CHiP). *JAMA Netw Open*. 2018;1(7):e184273. https://doi.org/10.1001/jamanetworkopen.2018.4273

42. Bui LP, Hill-Briggs F, Durkin N, et al. Does an all-condition case management program for high-risk patients reduce health care utilization in Medicaid and medicare beneficiaries with diabetes? *J Diabetes Complications*. 2019;33(6):445-450. https://doi.org/10.1016/j.jdiacomp.2018.12.011

43. Hardin L, Kilian A, Muller L, Callison K, Olgren M. Cross-continuum tool is associated with reduced utilization and cost for frequent high-need users. *West J Emerg Med*. 2017;18(2):189-200. https://doi.org/10.5811/westjem.2016.11.31916

44. Ritchie C, Andersen R, Eng J, et al. Implementation of an interdisciplinary, team-based complex care support health care model at an academic medical center: impact on health care utilization and quality of life. *PLoS One*. 2016;11(2):e0148096. https://doi.org/10.1371/journal.pone.0148096

45. Schuttner L, Zhang Z, Kuo A. Reducing ER use through a trainee-designed, interprofessional care group for high-utilizing chronically ill patients: a pilot program. *J Interprof Educ Pract*. 2018;9:1-12. https://doi.org/10.1016/j.xjep.2017.08.010

46. Coleman EA, Eilertsen TB, Magid DJ, Conner DA, Beck A, Kramer AM. The association between care coordination and emergency department use in older managed care enrollees. *Int J Integr Care*. 2002;2:e03. https://doi.org/10.5334/ijic.69

47. Ouayogodé MH, Mainor AJ, Meara E, Bynum JPW, Colla CH. Association between care management and outcomes among patients with complex needs in medicare accountable care organizations. *JAMA Netw Open*. 2019;2(7):1-13. https://doi.org/10.1001/jamanetworkopen.2019.6939

48. Edwards ST, Peterson K, Chan B, Anderson J, Helfand M. Effectiveness of intensive primary care interventions: a systematic review. *J Gen Intern Med*. 2017;32(12):1377-1386. https://doi.org/10.1007/s11606-017-4174-z

49. Sledge WH, Brown KE, Levine JM, et al. A randomized trial of primary intensive care to reduce hospital admissions in patients with high

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utilization of inpatient services. *Dis Manag.* 2006;9(6):328-338. https://doi.org/10.1089/dis.2006.9.328

50. Berenson RA, Horvath J. Confronting the barriers to chronic care management in Medicare. *Health Aff (Millwood).* 2003;22(Suppl 1):W3-37-W3-53. https://doi.org/10.1377/hlthaff.w3.37

51. Holtrop JS, Luo Z, Alexanders L. Inadequate reimbursement for care management to primary care offices. *J Am Board Fam Med.* 2015;28(2):271-279. https://doi.org/10.3122/jabfm.2015.02.140207

52. Keeney T, Belanger E, Jones RN, Joyce NR, Meyers DJ, Mor V. High-need phenotypes in Medicare beneficiaries: drivers of variation in utilization and outcomes. *J Am Geriatr Soc.* 2020;68(1):70-77. https://doi.org/10.1111/jgs.16146

53. Joynt KE, Figueroa JF, Beaulieu N, Wild RC, Orav EJ, Jha AK. Segmenting high-cost Medicare patients into potentially actionable cohorts. *Healthc (Amst).* 2017;5(1-2):62-67. https://doi.org/10.1016/j.hjdsi.2016.11.002

54. Schneider EC, Shah TB. Cold water or rocket fuel? Lessons from the Camden "hot-spotting" randomized controlled trial. February 11, 2020. Accessed October 2020. https://www.healthaffairs.org/do/10.1377/hblog20200210.86393/full/

55. David G, Gunnarsson C, Saynisch PA, Chawla R, Nigam S. Do patient-centered medical homes reduce emergency department visits? *Health Serv Res.* 2015;50(2):418-439. https://doi.org/10.1111/1475-6773.12218

56. Blumenthal D, Chernof B, Fulmer T, Lumpkin J, Selberg J. Caring for high-need, high-cost patients - an urgent priority. *N Engl J Med.* 2016;375(10):909-911. https://doi.org/10.1056/nejmp1608511

57. McCarthy D, Ryan J, Klein S. Models of care for high-need, high-cost patients: an evidence synthesis. *Issue Brief (Commonw Fund).* 2015;31:1-19. https://www.commonwealthfund.org/publications/issue-briefs/2015/oct/models-care-high-need-high-cost-patients-evidence-synthesis

58. Hochman M, Asch SM. Disruptive models in primary care: caring for high-needs, high-cost populations. *J Gen Intern Med.* 2017;32(4):392-397. https://doi.org/10.1007/s11606-016-3945-2

59. Joynt KE, Gawande AA, Orav EJ, Jha AK. Contribution of preventable acute care spending to total spending for high-cost Medicare patients. *JAMA.* 2013;309(24):2572-2578. https://doi.org/10.1001/jama.2013.7103

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SUPPLEMENTAL TABLE 1
Continued

Author (Year)	Bailey et al[52] (2019)	Baker et al[34] (2013)	Berkowitz et al[41] (2018)	Boult Et al[28] (2011)	Brown et al[50] (2005)	Bui et al[42] (2019)	Capp et al[35] (2017)	Coleman et al[66] (2002)	Cross et al[40] (2017)	Hardin et al[43] (2016)	Komaromy et al[32] (2019)	Newcomer et al[36] (2004)	Ouayogodé et al[67] (2020)	Peikes et al[37] (2018)	Powers et al[29] (2020)	Ritchie et al[44] (2016)	Schraeder et al[38] (2008)	Schutner et al[65] (2018)	Sledge et al[19] (2006)	Wepper et al[19] (2018)	Zulman et al[31] (2017)
13. Staff, places, and facilities representative of population	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14. Participants blinded to treatment	0*	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0	0	0*	0	0*
15. Researchers blinded to outcome assessment	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0	0	0*	0	0*
16. Data dredging clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17. Analysis adjusted for length of follow-up	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18. Appropriate statistical tests performed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19. Compliance with model was reliable	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20. Outcome measures were reliable and valid	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21. Participants recruited from same-source population	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
22. All participants recruited over same time period	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1
23. Participants randomized to treatment	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1
24. Allocation of treatment concealed from investigators and participants	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	1	0	0*
25. Adequate adjustment for confounding	1	1	1	1	0*	1	1	1	0*	0*	1	1	1	1	1	0*	1	1	0*	1	1

continued

SUPPLEMENTAL TABLE 1
Continued

Author (Year)	Bailey et al[32] (2019)	Baker et al[34] (2013)	Berkowitz et al[41] (2018)	Boult Et al[28] (2011)	Brown et al[30] (2005)	Bui et al[42] (2019)	Capp et al[55] (2017)	Coleman et al[46] (2002)	Cross et al[40] (2017)	Hardin et al[43] (2016)	Komaromy et al[52] (2019)	Newcomer et al[56] (2004)	Ouayogodé et al[67] (2020)	Peikes et al[57] (2018)	Powers et al[29] (2020)	Ritchie et al[44] (2016)	Schraeder et al[58] (2008)	Schutiner et al[45] (2018)	Sledge et al[49] (2006)	Wepper et al[39] (2018)	Zulman et al[31] (2017)
13. Staff, places, and facilities representative of population	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14. Participants blinded to treatment	0*	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0	0	0*	0	0*
15. Researchers blinded to outcome assessment	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0	0	0*	0	0*
16. Data dredging clearly described	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17. Analysis adjusted for length of follow-up	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18. Appropriate statistical tests performed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19. Compliance with model was reliable	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20. Outcome measures were reliable and valid	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21. Participants recruited from same-source population	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
22. All participants recruited over same time period	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
23. Participants randomized to treatment	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
24. Allocation of treatment concealed from investigators and participants	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	1	0	0*
25. Adequate adjustment for confounding	1	1	1	1	0*	1	1	1	0*	0*	1	1	1	1	1	0*	1	1	0*	1	1

continued

SUPPLEMENTAL TABLE 1
Continued

Author (Year)	Bailey et al[52] (2019)	Baker et al[54] (2013)	Berkowitz et al[41] (2018)	Boult Et al[28] (2011)	Brown et al[30] (2005)	Bui et al[42] (2019)	Capp et al[35] (2017)	Coleman et al[46] (2002)	Cross et al[60] (2017)	Hardin et al[43] (2016)	Komaromy et al[52] (2019)	Newcomer et al[36] (2004)	Ouayogodé et al[67] (2020)	Peikes et al[57] (2018)	Powers et al[29] (2020)	Ritchie et al[44] (2016)	Schraeder et al[38] (2008)	Schutmer et al[45] (2018)	Sledge et al[49] (2006)	Weppner et al[59] (2018)	Zulman et al[31] (2017)
26. Losses to follow-up taken into account	1	1	0*	1	1	0*	0*	1	0*	0*	1	1	1	1	1	1	1	1	1	1	1
Power																					
27. Sufficient power to detect treatment effect	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1
Total out of 28	21	19	20	25	20	22	16	24	17	18	23	24	23	22	22	19	22	23	22	24	25

Total score for the modified Downs and Black scale = 28.

Item 5: If a list of principal confounders was provided, studies received a score of 2; they received a score of 1 if the list was partially provided; and 0 if no confounders were described.

Item 27: Studies received 1 if they explicitly stated that sufficient power was reached, and 0 if power was not reached or there was no report of power calculation (Downs and Black, 1998; O'Connor et al, 2015).

* Unable to determine.