Title
The Nurse Practitioner Workforce in Cancer Care

Author
Coombs, Lorinda A

Publication Date
2018

Peer reviewed|Thesis/dissertation

The Nurse Practitioner Workforce in Cancer Care

by

Lorinda Adaire Coombs

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Nursing

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO

Acknowledgements

The pursuit of a dissertation is never done in a singular fashion. It takes a tribe of family, friends, pets, childcare providers and colleagues. My daughter, Ellie Lewis-Coombs was three years old when I embarked on this adventure, for six years, she and Brad have suffered through exams, papers, and absences. This product would not have been possible without the support and love of them both.

There are uncountable patients that I would like to thank for the privilege of caring for them, I appreciate their helping me understand what it is like to face your own death, a path we will all walk. For all of the patients at SFGH, Stanford, Contra Costa and Kaiser—thank you. Additionally, my stalwart friend and writing partner, who rescued me more than once with her sage advice, specifically ‘perfect is the enemy of good’ I want to thank Dr. Lauren Hunt.

I would also like to extend appreciation and gratitude to my dissertation committee for their ongoing support and guidance. Dr. Wendy Max was one of the first people that I spoke with about the program, she agreed to take me on as a student, and has been consistently cheering me on since then. Thank you for your warmth and level headed, reasonable approach to all things. Dr. Caroline Stephens was a newly minted faculty when I approached her and she has given me hours of feedback, suggestions and constructive editing, I thank you for your attention to detail. Dr. Tatjana Kolevska is someone I have known long before I entered this program, she volunteered as a guest attending at SFGH and generously gave of her knowledge, expert clinical skills and helpful advice. I truly appreciate your time in the midst of your busy oncology schedule, leadership demands and family commitments. Another faculty I would like to

acknowledge was the chair of my qualifying exam and a co-author on my literature review, Dr. Janine Cataldo, whose persistence in asking ‘but what is your question’ led me here.

To my family of origin, my sisters Moeff and Cheryl, my brother and mother thank you for your love and support. And a big thanks to my sister-editor, Wheeze for being willing to review my manuscripts during a grant application. Friends like Peg Walton and Thuy Nguyen helped provide childcare and reality checks throughout this time.

I would also like to acknowledge some of the funding that allowed this work to be completed, among them the UCSF Earle C. Anthony Social Sciences Graduate Fellowship, the UCSF Graduate Deans Health Sciences Fellowship, the Jeanie Schmit Kayser-Jones Scholarship, Oncology Nursing Society Foundation Research Doctorate Scholarship, the Hartford Center for Gerontological Nursing Excellence and the Alpha Eta Chapter of Sigma Theta Tau.

Table of Contents

List of Tables

List of Figures

Introduction

Cancer has been impacting health outcomes from the first known record of a malignancy in Egypt around 1600 B.C.E. that described tumors removed from a woman's breast. Today, half of all men and one third of all women will develop cancer in the United States (U.S.).[1] The leading cause of death for adults, age 40 to 79 years in the U.S. is cancer.[2] Although there are modifiable risk factors that contribute to developing cancer, (e.g. smoking, viral exposure and obesity),[3] one of the greatest risk factors is aging. The population of older adults, defined as age 65 years and older, are most frequently diagnosed with cancer; [4] over the next 30 years, this group will grow to an unprecedented number, with a proportional increase in the incidence and prevalence rates of cancer.

Estimates of the oncology workforce suggest there may not be enough physicians in practice to care for these older patients with cancer. In addition to newly diagnosed individuals with cancer, earlier detection and improved treatments have increased the number of cancer survivors. Cancer survivors number 14.5 million currently, and are anticipated to grow to 19 million by 2024.[5] This large patient volume will require a corresponding increased amount of care by oncology providers. The American Society of Clinical Oncology (ASCO), projected a 40 percent growth in demand for cancer care by 2025.[5] The projected growth in physician supply within the same time period will increase by only 25 percent. The shortage of oncology physicians will exacerbate the unequal access to care already experienced by patients who live in rural areas of the U.S.[6]

Currently, physician specialists such as hematologists and oncologists are regarded as the primary source of care for patients with cancer. However, other providers also play integral roles in cancer care delivery. Advanced Practice Providers, including nurse practitioners (NP) and Physician Assistants (PA) have been identified as providers of a proportion of care similar to that provided by physician specialists. The size of their workforce contribution has been described in varying amounts. A recent ASCO survey of practices that employed APPs indicated their numbers have increased dramatically, from 52% of practices employing APPs in 2014 to 73% in 2015. This dramatic growth has been especially true of the NP workforce over the past decade. The Health Resources and Service Administration (HRSA) conducted a National Sample Survey of NPs (NSSNP) in 2012 and reported 154,000 licensed NPs in the U.S.[7] The American Academy of Nurse Practitioners (AANP) has estimated the number of NPs at almost 205,000 in 2016, essentially doubling since 2007.[8]

A growing body of evidence has suggested that NPs are already providing care to patients with a wide range of malignancies in various settings.[9-11] While a few studies have estimated the number of patients NPs cared for within cancer centers and various teams, little is known about the patient characteristics of these study populations. Moreover, no studies to date have specifically examined the amount or type of cancer care NPs (or PAs) provide to older adults[12,13]

Consequently, despite mounting evidence suggesting the potential value of the NP oncology workforce to care for the growing population of older adults, there are no accurate current estimates. Research in this area has been hampered by methodological flaws, including a sole reliance upon self-report and small sample sizes;

the lack of accurate data has hindered estimations of the NP contribution to the cancer workforce or to the care of older adults with cancer.[14]

Accurate health care workforce analyses require ongoing data collection, a challenge when providers enter and leave the workforce. Physician data is compiled by the American Medical Association throughout their career, beginning with entry into medical school; this data is referred to as the Masterfile. The Masterfile contains current and historical data on 1.4 million physicians (retired and practicing), residents and medical students within the U.S. [15] This centralized database allows for accurate estimations of the physician workforce, enhancing the AMA's ability to make physician workforce projections in response to demand. The lack of a similar mechanism for accurately estimating the number of NPs has led to conflicting numbers of NP providers, depending upon what type of care was measured. The paucity of precise data on the number of NPs providing oncology care hampers the ability to project their contribution to the overall oncology workforce, and consequently measure their contribution (current or potential) to the public health issue of insufficient oncology providers.

Theoretical Approach

This research study's theoretical approach was guided by the use of frameworks that measure economic and clinical value. The concept of value in healthcare with a focus on reducing inefficiency was a tenet of the 2013 Institute of Medicine report, titled 'Delivering High Quality Cancer Care: A New Course for a System in Crisis'. After analyzing the way cancer care is currently delivered, the Committee on Improving Quality of Cancer Care concluded that a growing need for cancer care, increasing

treatment complexity, and a shrinking workforce was causing a crisis in cancer care.[16] In the health care sector, skilled providers regularly perform tasks that do not require the level of skill and training possessed by the provider performing the task.[17] Possibly, equivalent health outcomes could be achieved if health care was delivered more efficiently. The two theoretical approaches that were used include: the ASCO Conceptual Framework, an approach that measures clinical benefit for different interventions, and Transactional Cost Economics, an approach to evaluating how health care is delivered and whether it is the most efficient approach. The frameworks used to drive this research shared two goals: 1) identify and provide equal access to care at the lowest possible cost, and 2) provide the highest value of health care to create a sustainable model for patient care.

Purpose and Specific Aims

The purpose of this dissertation was to identify the current NP workforce in cancer care and to investigate if their numbers suggest they may provide an alternative source of care for the projected future increased need for cancer care, specifically for older adults. The specific aims of this dissertation are to 1) quantify the NP workforce in specialty care, with a focus on oncology, 2) identify the research on NP care in oncology, 3) measure the NP workforce caring for older adults with cancer, and what proportion they make up of the oncology workforce, 4) describe the patient population receiving care from NPs and if there are specific trends within malignancy care for which NPs or PAs provide increased amounts of care.

Overview of Chapters Two through Five

This dissertation includes the following three chapters, each an individual manuscript. Chapter two, entitled 'The Growing Nurse Practitioner Workforce in Specialty Care' is an examination of the role of NPs in specialty care using data from the National Sample Survey of Nurse Practitioners. Thirteen thousand NPs completed the survey, representing a 60 percent response rate. Of the 154,000 licensed NPs in the U.S., 48,000 reported providing some type of specialty care. Given the projected need and diminishing physician specialty workforce, NPs providing specialty care are expected to dramatically increase.

Chapter three, entitled 'A Scoping Review of the Nurse Practitioner Workforce in Oncology', is a scoping review of the literature examining what is currently known of NP oncology practice. A scoping review is a method of reviewing the literature when the topic has not been widely studied.[18] A total of 29 studies were included in the analysis, ten that met inclusion and exclusion criteria, many with methodological issues including reliance upon self-report and very small sample sizes. Out of 154,000 licensed NPs, 269 NPs (0.1% of the NP providers) in the U.S. were represented. The findings of the literature review concluded that an accurate estimation of NP care in oncology does not exist.

Chapter four is the result of a secondary data analysis of the Surveillance Epidemiology and End Results (SEER) cancer registry database linked with Medicare claims measuring NP and PA care to older adults and is entitled, 'Nurse Practitioner and Physician Assistant Workforce Provision of Cancer Care to Older Adults'. Over 7 million

claims from the 2013 SEER-Medicare data were analyzed with a focus on 2.5 million claims for malignancy care. Of the 15,227 cancer providers identified, 32% were NPs (4,806) and 24% were PAs (3,767). NPs provided increased care for rural patients (OR 1.84, 95% CI 1.65-2.05) as did PAs (OR 1.57, 95% CI 1.40-1.77) compared with physicians. Patients who received care from a NP were more likely to be female (56% vs. 48%, p=.0001) and reside in high poverty areas (21% vs. 18%, p=.05).

Chapter five synthesizes the previous chapters and presents the implications, both clinical and economic, as well as suggestions for future research to impact health policy. This is the first study that used SEER-Medicare data to evaluate non-oncologist workforce contributions. The results identify a large group of NPs and PAs, previously significantly under estimated, that provide cancer care to a growing population of older adults. These NPs and PAs are key contributors to balancing the increased need for larger amounts of cancer care with an insufficient supply of oncologists to provide clinical care. The purpose of these three manuscripts is to offer new knowledge on NP practice in oncology care and offers ground breaking information on the unique contributions of NPs, reshaping what is currently understood about how cancer care is delivered in the U.S.

Chapter 2

Paper 2: The Growing Nurse Practitioner Workforce in Specialty Care

Lorinda A. Coombs, PhD(c), FNP-BC, AOCNP

A portion of this paper was published in the Journal for Nurse Practitioners, 2015 October; 11(9): 907-909

Abstract

Context: The role of nurse practitioners (NP) evolved out of a need to fill the lack of sufficient primary care providers. Since the inception of the role in 1965, it has grown with a population focus that includes adults, families, gerontology and pediatrics. A substantial number of NPs now receive additional training and provide specialty care across internal medicine, surgical and pediatric specialties. The scope of assessing an entire workforce often exceeds the reach of a primary data research study, consequently secondary datasets are frequently used to make projections for provider groups. The Health Resources and Service Administration (HRSA) has conducted surveys of Registered Nurses (RN) every four years since 1977; and while NPs may have participated in these surveys, they were not analyzed separately but were included as RNs in the results.

Methods: The Health Resources and Service Administration (HRSA) conducted the first National Sample Survey of NPs (NSSNP) in 2012. Self-report surveys were sent to a random selection of NPs within all 50 states. The survey focused on education, distribution, and practice as well as job satisfaction, primary workplace and if the NP was in primary or specialty care.

Results: Thirteen thousand NPs completed the survey, representing a 60 percent response rate. Thirty one percent of the 154,000 licensed NPs in the U.S. reported providing some type of specialty care. Given the projected need and diminishing physician specialty workforce, NPs providing specialty care are expected to dramatically increase.

Introduction

The role of nurse practitioners (NP) has evolved since its' inception in 1965 to fill a primary care workforce need. The first NP was a registered nurse who completed advanced training with a local pediatrician and began providing primary pediatric care in rural Colorado.[19] The role has subsequently grown with a diversified population focus (e.g. Family, Adult Gerontology, Pediatric, Acute Care). Training and board certification has been standardized; a minimum of a master's degree is currently required with a doctorate in nursing practice recommended by 2015.[20] Nurse practitioners train as generalists with a population focus in primary care. Many NPs continue to provide the primary or acute care they were trained to render across the age spectrum. However, a substantial number receive additional training and provide specialty care across multiple specialties including internal medicine, surgical, pediatric and mental health specialties and subspecialties.[21]

Initial education and training of NPs may focus on: (1) different populations, such as pediatric, family, adult and gerontology, psychiatric, and women's health; (2) setting, e.g. acute care and occupational health; and (3) anesthesia. The diverse training and various pathways to becoming a NP pose a problem for accurately monitoring their numbers in primary and specialty care. In addition, unlike physicians who train in one area and continue to practice in that specialty, NPs may train in one area, e.g. as a Family Nurse Practitioner (FNP), and upon graduation, specialize in another area, such as cancer care.

The different national credentialing bodies further complicate data collection on NPs. New NPs are required to pass board certification exams in order to receive their

licenses. There are currently two large organizations that offer a variety of NP certifications: the American Academy of Nurse Practitioners (AANP) and the American Nurses Credentialing Center (ANCC). In addition to the two largest board certification agencies (AANP and ANCC), there are several specialty organizations that offer additional certifications. For example, a newly graduating NP may pass the American Nurses Credentialing Committee board certification exam in Family Practice, and take an additional Certification exam, such as the Advanced Oncology Certification for Nurse Practitioners (AOCNP). If all credentialing bodies summed their numbers, the total would be an overestimation of NPs in the U.S.

The nurse practitioner workforce in primary care has been well documented [22-25] with much of the discussion focused on how the NP supply may alleviate the deficit of primary care physicians.[23] The demand of primary care is anticipated to rise with the implementation of the Affordable Care Act.[23,26,27]

National Sample Survey of Nurse Practitioners

The National Sample Survey of Nurse Practitioners was the first attempt by the Health Resources and Service Administration (HRSA) to identify the supply of NPs nationally in addition to their geographical distribution and type of role: primary care or specialty care. The results of the HRSA national survey were released two years after the data was gathered, coinciding with the publication of the most recent report from the National Center for Health Workforce Analysis. The new report documents the current growth of non-primary care advanced practice nurses (APNs), defined in the report as NPs, Clinical Nurse Specialists, Certified Nurse Midwives, and Certified Registered Nurse Anesthetists as well as estimates further increases. According to the report,

between 2010 and 2025 the growth in supply of APNs will outpace that of physicians by a large margin: APNs at 141% compared to a projected growth of physicians at 21%.[28] Both reports present new information on the current roles of NPs in health care provision as well as offer projections on significant growth in specialty areas (Table 1).

Results

In an attempt to obtain a representative sample of NPs in the U.S., HRSA acquired the lists of all active NPs through state licensing boards. A random sample of the full population of NPs from each state was sent a survey. Data was collected over a period of five months (from March 2012 through July 2012) in three waves with reminder post cards sent. The 13,000 NPs who completed the survey represent a 60 percent response rate.

Since some surveys were returned with incomplete data and not all surveys sent out were returned, the researchers used sample weights with jackknife replication to achieve variance estimation.[7] Statistical methods such as jackknife are commonly used to eliminate bias and variability by re-sampling. Originally created in 1958 by Tukey to correct for small sample numbers and create reasonable confidence intervals, it has evolved into other methods including bootstrapping. [29] A review of the code book confirmed that final sample weights were used in the analysis, and that 100 jackknife replicate weights were used to calculate variance using a weight of one.[7]

The majority of NPs continue to provide primary care; however, as the 2012 National Sample Survey of Nurse Practitioners (NSSNP) demonstrated, almost one third of the NP workforce is currently providing specialty care.[7] The NSSNP reported that in 2012, there were 154,000 licensed NPs in the United States (U.S.), and of that

number 48,000 were providing specialty care. The American Academy of Nurse Practitioners put the total number of NPs in the U.S. at 205,000 and estimated the subspecialty proportion to be approximately 31% as well.[8] Because the two sample survey methodologies are different, a direct comparison is problematic, but they do offer similar results regarding the distribution of primary care and the large number of specialty nurse practitioners (Figure 1). Oncology NPs were included in internal medicine and surgical specialties.

Discussion

The anticipated growth in non-primary care APNs is unprecedented. There are several possible explanations for the growth: the economics of educating a trained workforce, supply and demand, and the success that the NP role has had in primary care.[27] The difference in cost and time involved to train specialty physicians compared to providing additional training to NPs trained in primary care is significant. Initial training for nurse practitioners is received by completing a master's degree in nursing or a doctorate in nursing practice after obtaining a bachelor's degree. The graduate education may range from two to three years of full time depending upon the curriculum and degree. After completion of their initial education, NPs may pursue a primary care position or further specialty training during their employment in specialty areas, including medicine and surgical specialties. In contrast, specialty physicians complete their training in a minimum of nine years (including medical school, residency and fellowship); a conservative estimate for the education cost per physician is over $585,000 per physician.[30] Upon completion of their training, the average compensation for a specialty physician, an oncologist, for example, is $341,000 annually.[31] A NP who

has been board certified in oncology (Advanced Oncology Certified Nurse Practitioner) makes an average annual income of $108,668.[32]

The Association of American Medical Colleges (AAMC) anticipates a supply shortage of specialty physicians ranging between 28,000 and 63,000 by 2025.[33] Simultaneously, the demand is also anticipated to rise due to several factors: according to the U.S. Census Bureau, the number of Americans 65 years or older will more than double between 2010 and 2020[34] and the number of annual hours worked by physicians is declining, as well as the number of office visits.[35] [26] Older Americans (defined as ages 65 years and older) utilize health care at increased rates compared with other adults, specifically in rates of physician office visits and hospital outpatient department visits.[36] The combination of larger numbers of older Americans who have increased utilization of health care services, and a decrease in the number of hours and office visits available with physicians may contribute to the increased demand for specialty NPs. The greatest deficiency anticipated by the AAMC report was in the surgical specialties. Simultaneously, the largest gain in APN positions anticipated by the National Center for Health Workforce Analysis was in the surgical specialty.[28] It is not clear from the report whether the increase in surgical specialties would be for NPs in a First Assistant capacity, as Certified Registered Nurse Anesthetists, or in a pre- or post-operative care role.

Prior to the implementation of managed care, the structure of the healthcare model in the United States was with physicians at the center of the model, as the sole decision makers on patient care [30]. When a deficit of primary care physicians occurred in the mid 1990's, the NP profession increased in number and successfully filled the

primary care provider role. Equivalent outcomes between NPs and primary care physicians have been demonstrated in subsequent research. [22,23,27] In the provision of basic primary care services, physicians' additional training has not been shown to result in a measurable significant improvement in outcomes from that of nurse practitioners. [37]

Conclusion

It is clear from available data that one third of NPs in the U.S. are currently providing specialty care, and that the demand for their services will grow.[28,38] The role of the NP was created fifty years ago to address a need for rural pediatric primary care providers[19]; in the 1990's, nurse practitioners grew in number and assumed primary care provider roles in response to the primary care physician deficit.[39] Drawing from both the National Sample Survey of Nurse Practitioners, as well as the National Center for Workforce Analysis data, it appears that NPs are now responding to the need for specialty providers. The ability of the specialty NP workforce to respond will depend upon individual state's cope of practice limitations and post graduate residences or fellowships available in specialties among other considerations. In the 2010 Institute of Medicine's report on the future of nursing[14], residencies following completion of an advanced practice degree were one of the recommendations, as well as changing practice areas.[40]

Patient outcomes and cost savings analysis have not been as robustly researched in specialty areas as in primary care. Additional research is needed to clarify what further training may be necessary to transition the initial primary or acute care trained NP into specialty providers. Future research on measuring areas of specialty care will also enhance the ability to respond to increased patient need. It is clear that

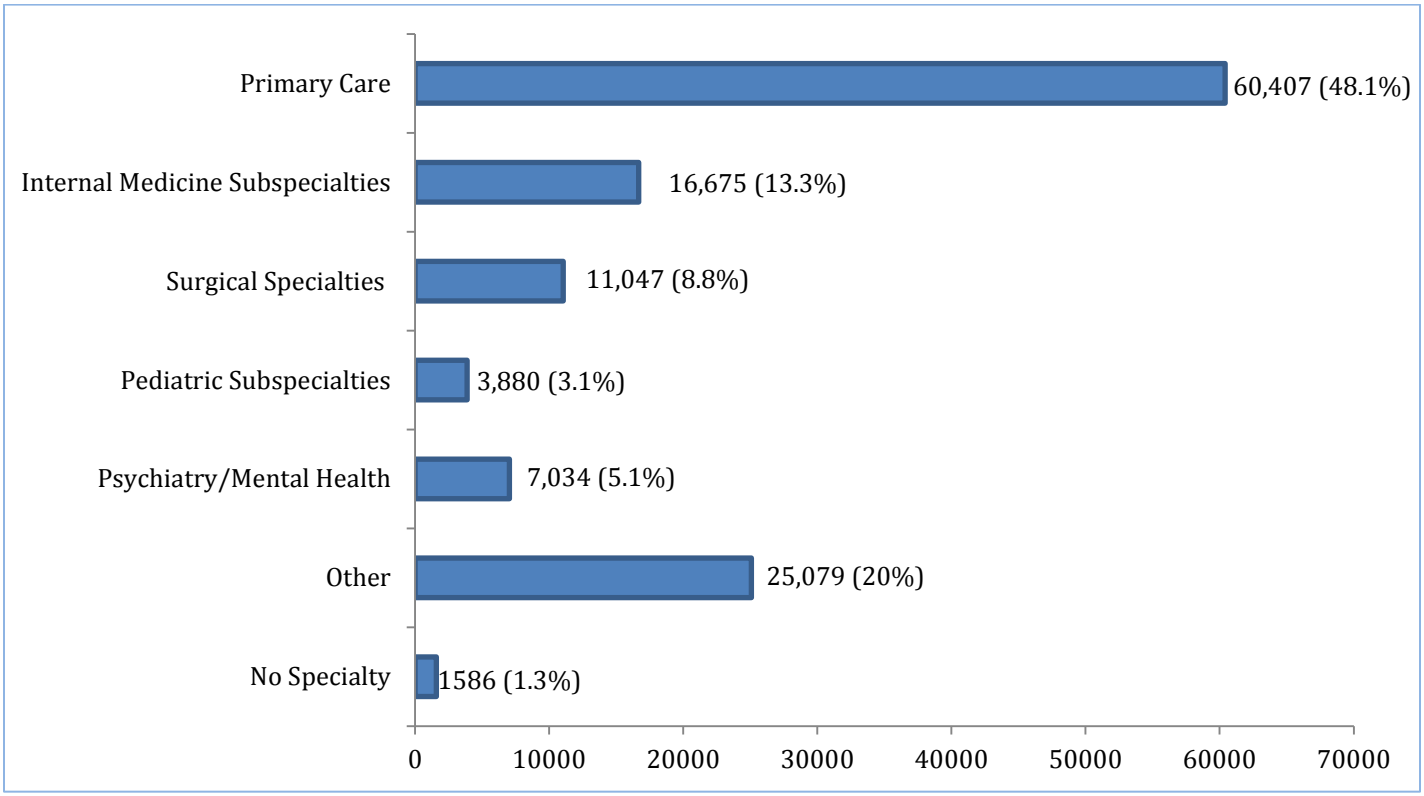
the specialty NP workforce makes up a significant portion of NP providers and that their numbers will grow as the demand for specialty services increases.

Table 1. Specialty and Sub-Specialty Care Clinician Workforce

Workforce Role Year	**2010**	**2025**
Physicians	73%	59%
Advanced Practice Nurses	19%	30%
Physician Assistants	8%	11%

Source: 2014 HRSA Non-Primary Care Specialty and sub-specialty Clinical Supply Projections to 2025

Figure 1. Practice Specialty for NPs providing patient care



Source: 2012 National Sample Survey of Nurse Practitioners

Chapter 3

Paper 1: A Scoping Review of the Nurse Practitioner Workforce in Oncology

Lorinda A. Coombs, PhD(c), FNP-BC, AOCNP

This paper has been published in Cancer Medicine, 2016 August; 5(8): 1908-16

Abstract

Objectives*:* Although there is clear evidence that Nurse Practitioners (NP) are providing care in oncology, a thorough review has not been conducted. A systematic review methodology was selected to minimize bias, reduce chance effects and provide a transparent process. However after refining initial results, the dissimilarity of study designs and lack of overlapping outcome variables prohibited systematic review completion. A scoping review was undertaken because the topic has not been previously studied extensively.

Design: The literature review was conducted between October 2014 and March 2015 using PubMed®, the Cumulative Index to Nursing and Allied Health Sciences (CINAHL®), Web of Science, Journal Storage (JSTOR®), Google Scholar and SCOPUS®. Using the scoping review criteria, the research question was identified 'How much care in oncology is provided by NPs?' Key search terms were kept broad and included: "NP" AND "oncology" AND "workforce".

Results: A total of 29 studies were included in the analysis, ten that met inclusion and exclusion criteria. Out of 154,000 licensed NPs, 269 NPs (0.1% of the NP providers) in the U.S. were represented. An accurate estimation of NP care in oncology does not currently exist. Many of the studies had methodological problems due to reliance upon self-report and small sample sizes.

Introduction

The quality of cancer care may be compromised in the near future because of work force issues. Several factors are poised to significantly impact the oncology health provider work force: an aging population, an increase in the number of cancer survivors and expansion of health care coverage for the previously uninsured.

The number of Americans 65 years or older will grow to an unprecedented number, more than doubling between 2010 and 2050.[34] As a large proportion of the United States grows older, cancer incidence and prevalence rates are expected to rapidly increase.[34] Cancer is the second leading cause of death in the United States, [41] and disproportionately affects adults ages 65 years and older.[42] Although there are modifiable risk factors that contribute to developing cancer, (e.g. smoking, viral exposure and physical activity),[3] one of the greatest risk factors is aging. The increased risk of developing cancer with age is linked to deoxyribonucleic acid (DNA) methylation changes that impact gene silencing and activation with age.[43] Unlike other cancer risk factors, DNA methylation changes are not greatly affected by behavioral change. Moreover, earlier detection and improved cancer treatments have extended life expectancy, thus the number of cancer is increasing. Currently, there are 14.5 million cancer survivors and by 2024, that number will increase to 19 million.[44] In addition, as a result of the Affordable Care Act (ACA), millions of previously uninsured Americans now have insurance and access to health care increasing the demand for services.[45]

In 2014, the American Society of Clinical Oncologists (ASCO) released a report titled “The State of Cancer Care in the United States,” noting that not only are the number of people with cancer diagnoses expected to increase, but access to cancer

care is unequal and anticipated oncologist shortages could have a further negative impact on care.[44] ASCO anticipates that there will be a shortage of 1,500 oncologists and the shortage could be exacerbated by other factors including early physician retirement due to higher levels of burnout among oncologists.[44] The 2014 report revised an earlier 2010 workforce analysis that had projected even a higher shortage of oncologists.[46] Using an input-output model of oncology and radiation oncology services, ASCO estimates a 40% growth in demand by 2025,but only a 25% growth in physician supply in the same time period.[45] Physician shortages in primary care have been addressed by utilizing nurse practitioners (NP) to fill the workforce gap;[27] a similar model may succeed in oncology.

Advanced Practice Provider Workforce

The NP workforce has grown significantly since the first registered nurse (RN) completed advanced training in 1965.[19] The Health Resources and Service Administration (HRSA) conducted a National Sample Survey of NPs (NSSNP) in 2012, and reported a total of 154,000 licensed NPs.[21] The American Academy of Nurse Practitioners (AANP) currently reports the total number of nurse practitioners (NPs) in the U.S. at 205,000.[8]

Advanced practice providers were included in the 2015 ASCO report; these providers were defined as NPs, Doctors of Nursing Practice (DNP) and Physician Assistants (PA).[44] The results of the practice survey indicated that 2,700 DNP/NPs were employed,[44] no further specific information on advanced practice providers was available. The authors noted in the report that NPs and DNPs were able to prescribe chemotherapy and, at the time of publication, had independent practice in 20 states.

Since the report was published, the number of states where NPs have independent practice has increased from 20 to 22 states.[47]

While many of the NPs surveyed provided primary care, a large number worked in surgical and internal medicine specialties, such as oncology. The National Center for Health Workforce Analysis predicted a significant growth of advanced practice nurses (APN) between 2010 and 2025, with physician growth estimates at 21% and APN at 141%. Included in the survey of APNs were Certified Registered Nurse Anesthetists (CRNA), NPs, and Certified Nurse Midwives (CNM).[48] The APN growth is anticipated to be particularly significant in the non-primary care areas (i.e., specialties and subspecialties).

Despite the evidence of increasing numbers of NPs providing oncology care; there has not been a systematic review of the literature to evaluate the quantity of care NPs deliver to adults in oncology. Therefore, the purposes of this review are to: describe the amount of the oncology care provided by NPs to adults with cancer, describe the amount of care given to older adults with cancer by NPs.

Scoping Review Methodology

Although there is clear evidence that NPs are providing care in oncology,[9,10,49] a thorough review of the literature describing that care has not been conducted. Initially, a systematic review of the literature was planned. The systematic review methodology was selected to minimize bias, reduce chance effects and provide a clear and transparent process. However, after refining the initial results (confirmed with a second, blinded reviewer), the research designs included observational, quasi-experimental and randomized control trials. The dissimilarity of the study designs and lack of overlapping

outcome variables prohibited completion of a systematic review. Because the research topic has not been extensively studied previously, the decision was made to conduct a scoping review of the literature.

A scoping review is a method of reviewing the literature that synthesizes knowledge, incorporates multiple study designs and summarizes the findings with the goal of informing practice, impacting policy and identifying future research priorities.[50] Scoping reviews summarize research findings when the topic has not been extensively studied.[18] In contrast to systematic reviews that focus on randomized controlled trials, scoping reviews may include a diverse range of study designs and methodologies.[50]

In 2005, the first framework for scoping reviews was proposed by Arksey and O'Malley and involved five steps: Identify the research question, identify the relevant studies, select studies that met specified criteria, chart data, and summarize results. The optional sixth step was consultation with stakeholders that may involve perspectives different from the data included.[50] According to Daud (2013), "Scoping studies aim to map the literature on a particular topic or research area and provide an opportunity to identify key concepts, gaps in the research; and types and sources of evidence to inform practice, policymaking, and research ". The current scoping review framework includes: identification of the research question in a broad manner, identification of relevant studies in as comprehensive process as possible, selection of studies with an established inclusion/exclusion criteria, extraction of data, and a descriptive results summary.[51]

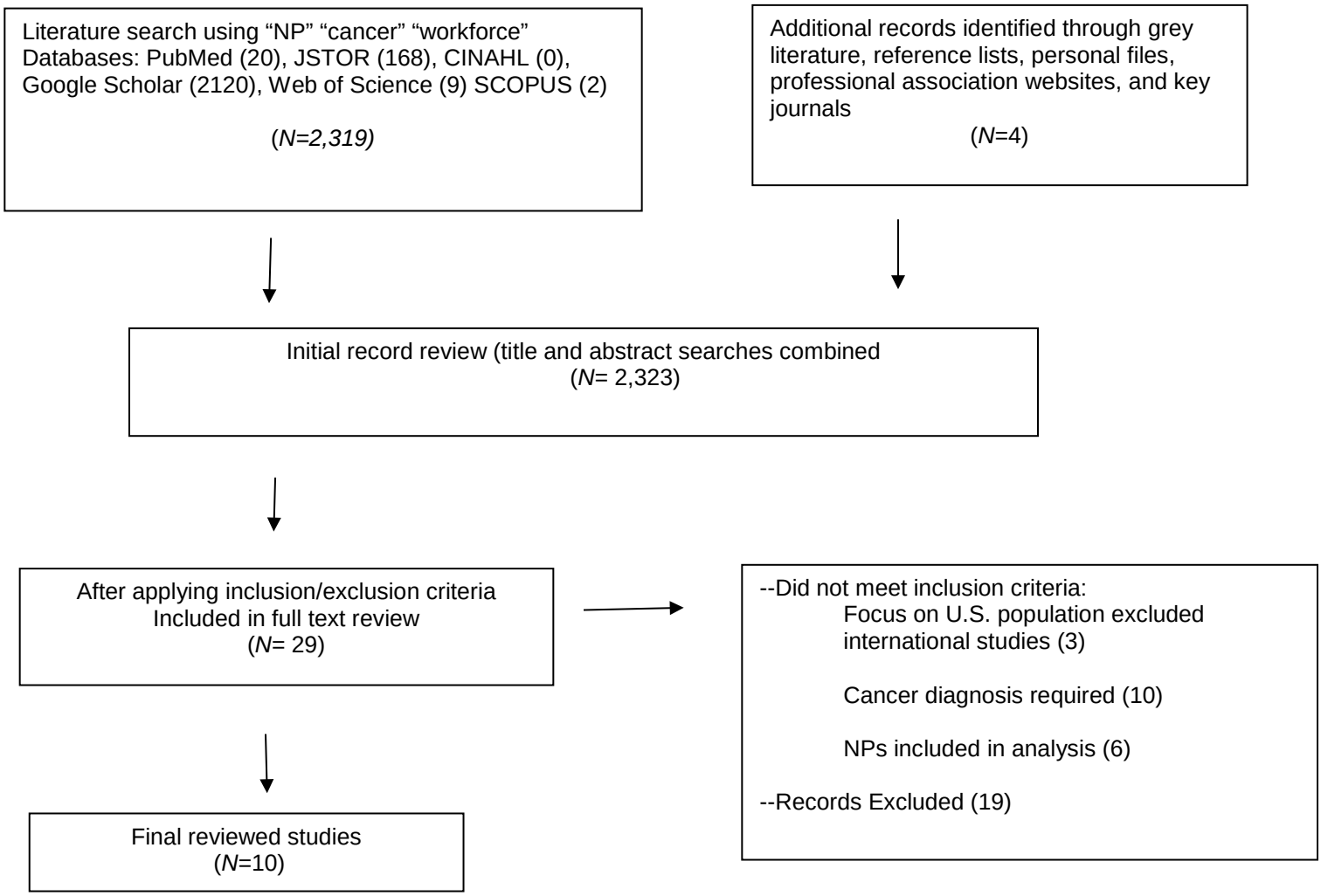
Methods

Between October 2014 and March 2015 an electronic literature search of English language articles was conducted using PubMed®, the Cumulative Index to Nursing and Allied Health Sciences (CINAHL®), Web of Science, Journal Storage (JSTOR®), Google Scholar, and SCOPUS®. Using the scoping review criteria, the research question was identified ‘How much care in oncology is provided by NPs?’ Key search terms were kept broad and included: “NP” AND “oncology” AND “workforce”.

Following the scoping review framework, multiple databases were used to produce a comprehensive list of relevant studies. The search resulted in 2,120 studies in Google Scholar, 168 studies in JSTOR ®, 20 studies in PubMed®, 9 studies in Web of Science, 2 studies in SCOPUS®, and 0 studies from CINAHL®. A total of 2,319 studies were evaluated by title and year. Grey literature was included in the search and resulted in an additional 4 studies for a cumulative total of 2,323 studies.

Grey literature has been defined as “non-conventional, fugitive, and sometimes ephemeral publications. This may include: reports, theses, conference proceedings, bibliographies, technical and commercial documentation, and official documents not published commercially”.[52]

Literature Search Flowchart



Identification of Relevant Studies

Since the focus of the scoping review was to assess the quantity of care provided by NPs to patients with cancer in the U.S., the search was limited to studies done in the U.S. The diagnosis of cancer was a required inclusion criteria, and studies were included if the patient population sampled had comorbidities in addition to a cancer diagnosis, i.e. Congestive Heart Failure (CHF), Chronic Obstructive Pulmonary Disease (COPD), Human Immunodeficiency Virus (HIV), End Stage Renal Disease (ESRD).

The focus of the scoping review was NPs in oncology; other advanced practice registered nurses such as clinical nurse specialists (CNS), CRNAs, and certified nurse midwives (CNM) were not included in the review. Although CNMs, CRNAs and CNSs may be involved in providing care to patients with a cancer diagnosis, their role is typically limited to procedures (CRNA), pregnancies (CNM) or patient education (CNS), and is not a usual source of care for oncology patients. If studies included PAs with NPs in their analysis, they were included in the review; however, studies that focused only on PAs only were excluded.

Because the first significant oncology workforce report that included NPs was published in 2005,[53] the literature was searched from 2005 through 2015. Given the temporal and adaptive nature of the oncology workforce supply and changing demands due to an aging population, grey literature and additional studies that were identified by searching bibliographies, abstracts and poster presentations were included.

After eliminating duplicates and application of inclusion and exclusion criteria to the abstracts, 29 studies remained. To minimize study selection bias in the literature search, a second blinded reviewer was given a 10% sample of the 2,323 research articles with the inclusion and exclusion criteria and to perform a review of the titles and abstracts. Using the inclusion and exclusion criteria, the reviewer's search of the abstracts yielded the same 29 studies; confirming a lack of bias in the search strategy.

Further review of the 29 full texts resulted in a total of 10 studies that met all of the inclusion and exclusion criteria. Data extracted from these studies included: (1) outcome variables measured, (2) study design, (3) data used and method of data collection, (4) provider type (e.g. NP, PA) and total number, (5) patient population, (6)

malignancy type, (7) setting (e.g. ambulatory, academic, private, inpatient) and (8) state scope of practice.

Initially, age group and economic impact were included in the assessment tables. However, specific information on age groups was consistently not available; only one study included a productivity analysis of NP and PA care, with no associated financial data. Because no information was available to analyze the economic impact of NP involvement in patient care, it was not included in this review.

Four tables divided by study design were developed and include: six cross-sectional studies (Table 1), two randomized controlled trials (Table 2), one quasi-experimental study (Table 3), and one retrospective cohort (Table 4).

Results

The outcome variables in the 10 included studies of this scoping review are diverse. They range from: (1) provider and patient satisfaction assessment, (2) NP function, (3) recommendations for enhancing NP roles, (4) identification of practice and physician characteristics that employ NPs, and (5) assessment of NPs in palliative care interventions. The diverse range of variables examined demonstrates the need for a comprehensive assessment of the oncology care currently provided by NPs.

As shown in Table 1, six of the 10 studies in this review were cross-sectional and their focus was on identification and collection of data on NP function, recommendations for NP role enhancement, and assessment of the NP presence in radiation oncology. The number of NPs included in the sample was difficult to identify, since three of the studies did not include specific information on the number of providers, and instead reported the percentage of centers that utilized NPs.[11,54,55] The sample of NPs included

in the scoping review ranged from one to 111, and of the seven studies that reported the number of NPs, six had 37 NPs or fewer in their sample.

As shown in Table 2, two of the 10 studies in this review were randomized control studies and focused on NPs provision of palliative care. One study measured patient resource utilization with a telephone intervention, and the other used a patient quality of life measurement and hospice knowledge changes from baseline to establish the impact of a NP palliative care intervention. Although the total number of NPs in the study was not included in the report, an e-mail inquiry to the study authors confirmed the number in both studies was three.

As shown in Tables 3 and 4 the remaining two studies were quasi-experimental (Table 3) and retrospective (Table 4) in design. The quasi-experimental study assessed provider and patient satisfaction with three different visit models and included six NP providers in the study. The longitudinal study evaluated oncology workforce changes in Nebraska over five years and included 37 individual NP providers.

Discussion

The important findings of this scoping review include: (1) an accurate estimation of NP care in oncology does not currently exist; (2) many of the studies included in this review had methodological problems due to a reliance upon self-report and small sample sizes; (3) the total number of NP providers included in this review were 269 out of 154,000 licensed NPs,[21] representing only 0.1% of the licensed NP population in the U.S.; (4) academic settings were more likely to utilize NPs than private practice settings; (5) there was equal representation of NP providers among inpatient and outpatient

settings, there was also no evidence that certain oncology specialties (e.g. breast, lung, bone marrow transplants, etc.) had disproportionate amounts of NP care; and finally (6) there was no concordance between state scope of practice and the number of NPs in the oncology workforce.

The main aim of the review was to quantify the care provided by NPs to patients with cancer. Several of the studies evaluated aspects of NP care, i.e. recommendations for role enhancement,[56] NP presence in radiation oncology ,[57] NP function [55] and practice characteristics that employ NPs;[54] but no studies evaluated the amount of care provided. The lack of a comprehensive study surveying the full scope of NP care in oncology severely limits the ability to answer the primary research question. Without accurate data on the NP oncology workforce, it is impossible to address to what degree or even whether their contribution could impact the anticipated insufficient supply of oncology physicians.

Problematic Methodology

Four of the 10 studies relied completely upon either written or on-line self-report surveys[12,55-57] without independent verification of the information. Of the remaining six studies, two relied upon proxies (administrators, practice manager or physician) to report data on NPs;[11,54] only four studies had objective data on NP numbers and practice.[13,58] The four studies that included verified data on NP care in oncology account for 46 of the total number of 269 NPs included in all of the studies in this scoping review. The small number of NPs (i.e., three) represented in the randomized controlled studies, illustrate the uneven quality of studies conducted on NP oncology care in the

U.S. Four of the largest studies in this scoping review represented the majority of the NPs represented within the review and relied upon a single online survey to gather data.[12,55-57]

Several of the studies had only one or two NP providers in the sample (Table 4) [59,60] and the complete scoping review results are based on 269 NPs (93 from the ASTRO radiation oncology workforce survey), representing only 0.1 percent of the NPs in the U.S. The small number of NPs represented in the research coupled with the significant projected increase in specialty NP care by the Center for Health Workforce Analysis illustrates the gap in knowledge of NP practice in oncology.

Setting

Academic institutions were included in all of the 10 studies reviewed. The strong representation of NPs in the academic oncology workforce may be a result of the impact from the resident duty work hour limitation imposed by the Accreditation Council for Graduate Medical Education (ACGME). In 2003 the ACGME set the resident work hour limit at an 80-hour week, this reduced the number of hours that residents were available to provide patient care. In addition to the reduced work hours, the ACGME also mandated one day off a week from patient care, further reducing the labor provided by residents.[61] Although private practices were included in several of the studies,[54,57,58] the lack of a specific analysis on how much care was provided by NPs in the private practice environment prohibits further generalizations. Nine out of the 10 studies included both inpatient and outpatient settings; this suggests that the impact of ACGME reduced work hours has impacted both outpatient ambulatory oncology patient care as well those patients requiring hospitalization.

Malignancy Subtypes and Inpatient/Ambulatory Care Settings

There was evidence of NP care of patients across all malignancy subtypes, and no evidence of a trend for increased care within any specific solid tumor or hematologic malignancy type. Only one study [54] specifically focused on the employment of NPs and PAs in providing breast cancer care. This may be a result of the data not being included in the analysis, or, more likely that NPs are utilized throughout multiple different oncology specialties. There was also equal representation of inpatient and outpatient care settings among the studies included in the scoping review.

State Scope of Practice

Scope of practice was included in the analysis to assess if any pattern of NP patient care emerged across the scope of practice spectrum. Scope of practice was defined according to the AANP simplified definition, separating NP practice into three categories: Full, Reduced and Restricted (Figure 1).[47]

Full practice was defined as “state practice and licensure law provides for NPs to evaluate patients, diagnose, order and interpret diagnostic tests, initiate and manage treatment—including prescribing medications—under the exclusive licensure authority of the state board of nursing”.[47] Reduced practice was defined as “state and licensure law reduces the ability of NPs to engage in at least one element of NP practice. State requires a registered collaborative agreement with an outside health discipline in order for the NP to provide patient care”.[47] And restricted was defined as “state practice and licensure law restricts the ability of a NP to engage in one element of NP practice. State requires supervision, delegation, or team-management by an outside health discipline in order for the NP to provide patient care”.[47]

There was no pattern of increased NP use in any of the three categories of practice: four states were represented in full or independent practice (CT, NE, NH, WA), five studies were completed in reduced practice states (AL, MO, NY, PA, UT) and five studies were conducted in restricted practice states (MI, FL, MA, TX). Although some primary care literature has suggested that full scope of practice encourages NP practice, this finding was not supported in evaluating NP care in oncology.

Strengths and Limitations of this Review

The use of a second blinded review for ten percent of the total abstracts and titles from the initial search strategy was a strength of this study. While the addition of a third reviewer to evaluate complete articles may have enhanced the methodological rigor of this review, the benefit may have been limited. It is possible that the exclusion of results prior to 2005 may have reduced the overall number of relevant research studies included in this review. The overall rating for the design, methodology and analysis of the included studies was fair.

Conclusion

This scoping review offers an examination of current knowledge on the oncology NP workforce. Significant gaps in the literature exist: on the number of NPs providing oncology care, the amount of care provided, and on the amount of care delivered to older adults. There is also great variation in the NP provider role, evident from the wide range of NP functions assessed in the studies included in this scoping review.

Recommendations for future research include an accurate, comprehensive identification of the NP workforce, an objective analysis of the amount of care provided

and an evaluation of the financial impact of NP care in oncology. Given the established presence of NPs in oncology, the predicted growth of older adults who will require increased amounts of care and the anticipated deficit of oncologists, an accurate portrait of the NP workforce in oncology is critical.

Table 1. Results summary – Cross Sectional studies

Study	Dependent Variable Focus	Design and Data Used Method of data collection	Provider Type Specialty or Subspecialty N=total providers	Malignancy Type	Setting (Ambulatory or Inpatient) Private or Academic	State (Scope of Practice)
Britell 2010	Identify NP and PA function in WA, e.g. type of practice, work role, research participation	Cross-sectional Self Report Survey, 50% response rate.	NPs and PAs—Response to survey may not have been identified providers.	Not specified	25 total=8 single specialty, 7 multi-, 6 hospital based and 4 academic	WA— Full Practice
Friese 2010	Practice and physician characteristics that employed NP/PAs.	Cross sectional over 2 years (6/2005 to 2/2007) using SEER data Mailed Survey to Physicians in L.A. and Detroit	Not specified	Breast Cancer	Both Private and Academic, setting not distinguished.	MI and CA— Restricted Practice
Hinkel 2010	Identify how NCI-designated cancer centers use NP/PAs and pilot a productivity tool.	Cross Sectional, convenience sample from NCI Cancer Centers. Online survey 4/2004-5/2004 for 4-hour clinic block. Only 176 were included in productivity analysis (Med Onc, Heme/BMT, SurgOnc).	206 NPs/PAs NP=111 PA=95 Med Onc=71 (34%) Heme/BMT=57 SurgOnc= 48 RadOnc=6 NeuroOnc=4 Palliative=4 Other=4	All included.	All academic affiliated NCI Cancer Centers, both inpatient and outpatient.	15 NCI centers in 13 states. Restricted Practice: CA, FL, MA, MI, TX, Reduced Practice: AL, MO, NY, PA, UT Full Practice: NE, WA

Study	Dependent Variable Focus	Design and Data Used Method of data collection	Provider Type Specialty or Subspecialty N=total providers	Malignancy Type	Setting (Ambulatory or Inpatient) Private or Academic	State (Scope of Practice)
McCorkle 2012	Formulate recommendations for enhancing NP/PA roles within multidisciplinary teams	Cross Sectional study Online Survey of NPs and PAs in NCI Cancer Center from 10/12/2010-11/4/2010 included MD surveys, focus groups and "consultation with outside experts"	32 NP/PAs sampled (19 NPs and 13 PAs) in NCI-designated Cancer Center Breast =11 Heme =11 Lung=10 G.I.=9 Head/Neck =8 CNS=7 Melanoma =6 GU=4 GYN=4 Sarcoma=3	All included.	Both—at one Northeastern NCI Cancer Center rebuilding hospital.	CT—Full Practice
Moote 2011	Collect data on NP/PA use in academic medical centers	Cross sectional study of UHC affiliated academic centers (107) and hospitals (233)—Response rate of 35%--Survey conducted from 7/2009-9/2009 included organizational assessment by COO, CMO, chief PA/NP	Of the 26 centers responding, 24 (92% of sample) reported using NPs in Oncology. 14 (54%) reported using PAs in Onc.	Not mentioned in study—	Both 26 ACGME centers from across the country with varied states (map of responding centers in article).	Varied, depending upon region of ACGME reporting.

Study	Dependent Variable Focus	Design and Data Used Method of data collection	Provider Type Specialty or Subspecialty N=total providers	Malignancy Type	Setting (Ambulatory or Inpatient) Private or Academic	State (Scope of Practice)
Vichare 2013	Assess radiation oncology workforce	Cross sectional Data from 2012 ASTRO online workforce survey 19% response rate=6765 out of 35,000	1047 Radiation oncologists, 1231 radiation therapists, 890 dosimetrists, 1105physicists, 93 NPs 25 PAs 484 RNs	Any malignancy requiring radiation.	21% academic, 25.2% hospital, 53.3% private	All states

Table 2. Results summary – Randomized Control Trial studies

Study	Dependent Variable Focus	Design and Data Used Method of data collection	Provider Type Specialty or Subspecialty N=total providers	Malignancy Type	Setting (Ambulatory or Inpatient) Private or Academic	State (Scope of Practice)
Bakitas 2009	Resource use with NP palliative care telephone intervention, secondary outcome-patient mood.	RCT of 322 newly diagnosed stage IV cancer patients (stage III for lung cancer) Enrolled 11/03-5/07	NPs—2 with palliative care training	All types	Ambulatory care in academic institution	NH— Full Practice
Dyar 2012	QOL and hospice knowledge change from baseline (using FACT-T) with NP palliative care intervention.	RCT of planned 50 patients (enrollment closed after Bakitas study results) accrued 26 patients. Used FACT-G and LASA instruments for baseline and one month after NP intervention.	NPs—1 with palliative care training	Noted in analysis breast—12, lung—2, prostate—1, other—11	Ambulatory care in academic institution	FL— Restricted Practice

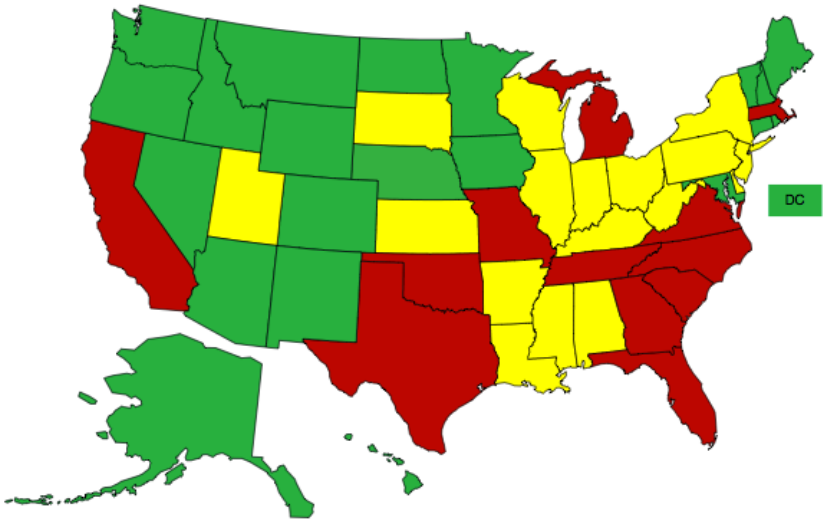
Table 3. Results summary –Quasi-Experimental Studies

Study	Dependent Variable Focus	Design and Data Used Method of data collection	Provider Type Specialty or Subspecialty N=total providers	Malignancy Type	Setting (Ambulatory or Inpatient) Private or Academic	State (Scope of Practice)
Buswell 2009	Assess provider and patient satisfaction with 3 different visit models (Shared visit model SVM, Independent visit model IVM, Mixed visit model MVM). Measure productivity and revenue.	Eleven teams of NP/PA/MDs followed for 3 months and 1-year retrospective fee analysis for revenue The specific numbers of NPs/PAs and MDs not detailed. Patient satisfaction from 68 patient interviews. Fees and patient visits (new and established) Revenue generation was measured by technical fees, only pro fees for MDs.	11 teams that included 6 NPs	Not specified.	Ambulatory Academic setting.	MA— Restricted Practice

Table 4. Results summary – Retrospective study

Study	Dependent Variable Focus	Design and Data Used Method of data collection	Provider Type Specialty or Subspecialty N=total providers	Malignancy Type	Setting (Ambulatory or Inpatient) Private or Academic	State (Scope of Practice)
Chandak 2014	Evaluate oncology workforce changes in Nebraska over 5 years.	Retrospective analysis of Health Professions Tracking Data, maintained by University of Nebraska (relies on self report and semi-annual hospital/clinic surveys).	Medical, surgical and radiation oncology. 37 NPs 126 MDs 25 PAs	Not specified.	Both Private and Academic, both ambulatory and inpatient.	NE— Full Practice

Figure 2. AANP 2015 NP State Practice Environment



Full Practice **Reduced Practice** **Restricted Practice**

Source: State Nurse Practice Acts and Administrative Rules 2015 Updated 5.20.2015

Appendix A:

Comparative Recommendations to Enhance Arksey and O'Malley's Six Framework Stages

Arksey and O'Malley's Framework Stage 2005)		Daudt's Adapted Recommendations (2012)
1. Identifying the research question: This step guides the search strategy and all the subsequent steps. Research questions should be broad in nature in order to generate breath of coverage.		1. Conduct considerable research about scoping studies to ensure an appropriate match between the scoping methodology and the research interest. Consider the methodology's objectives, boundaries, and the types of research that it can best support. 2. Link the purpose of the research with the research question and attend to suggestions to clarify concepts within the research question.
2. Identifying relevant studies: This step is as comprehensive as possible and involves searching for research evidence using different sources		1. Remain flexible to revise the research question and/or search terms. 2. Build both a multidisciplinary and inter-professional team. Include someone experienced with scoping studies and suitable stakeholders if possible. 3. Choose a small suitable group from the larger research team of qualified researchers and professionals with enough breadth of expertise for this stage to ensure timely completion of the study.
3. Study selection: This step is based on inclusion/exclusion criteria developed post hoc after familiarity with the literature is established. A team approach is suggested but not imperative.		1. For large research teams, take a three-tiered approach to study selection. Divide entire team into smaller teams with responsibility for equal portions of the selected studies. Ask each person to review his/her selected studies for inclusion or exclusion. Have each small team compare its results. If disagreement, involve a third reviewer. 2. Assess the quality of studies to be either included or excluded for charting. Quality can be assessed using validated instruments
4. Charting the data: This step consists of collecting data according to key issues and themes. Two main categories of data are suggested: general information about the study and specific information related to the research question.		1. Conduct a trial charting exercise and group consultation to determine if adjustments should be made to the chart (variables being measured) and to ensure that the research team is charting consistently. 2. Create a comprehensive chart, involving both high-level data and micro-level data, in order to capture a rich set of data. 3. Hold frequent meetings to ensure effective communication about consistent charting. Hold additional longer meetings when necessary. 4. For large research teams, take a three-tiered approach to charting the data. Divide entire team into smaller teams

Arksey and O'Malley's Framework Stage 2005)		Daudt's Adapted Recommendations (2012)
		with responsibility for equal portions of the selected studies. Pick different team members from stage #3. Ask each person to review his/her selected studies for inclusion or exclusion. Have each small team compare its results. Have one independent reviewer read and chart all studies. Have independent reviewer compare his/her charting with the charting of all other team members. Discuss any discrepancies. 5. Improve data management by assigning each study a unique identifying number to avoid confusion.
5. Collating, summarizing, and reporting the results: This step includes a descriptive numerical summary related to the general information collected and a thematic construction of the specific information collected.		1. Engage a small working group from the larger team to make meaning out of the data and to make choices about the data on which to focus.
6 Consultation; This step is optional. Consultation with key stakeholders may provide additional sources of information and offer different perspectives on the data collected.		1. If there are stakeholders who were not part of your research team, engage in a consultation process with them. Consult stakeholders only if the actual scoping study results are germane. 2. Recognize that the inability to share a scoping study's findings with stakeholders may be an indication that future research must be done beyond the scoping study in order to make a meaningful contribution to professional practice.

Chapter 4

Nurse Practitioner and Physician Assistant Care for Older Adults with Cancer: A Hidden Workforce

Lorinda A. Coombs, PhD(c), FNP-BC, AOCNP

Abstract

Background/Objectives: Cancer is most frequently diagnosed in adults over the age of 65 years in the United States (U.S.) Access to cancer care is unequal and the anticipated insufficient supply of oncology physicians may further worsen access to services. The growth of older adults with the corresponding increase in cancer prevalence necessitates the need to characterize Nurse Practitioner (NP) and Physician Assistant (PA) oncology workforce.

Design: In this observational, cross-sectional analysis, we examined all ambulatory care malignancy claims from the 2013 Surveillance, Epidemiology, and End Results (SEER) registry linked with Medicare. We identified Fee-for-service Medicare recipients over age 65 years with a cancer diagnosis who received ambulatory care and the providers who cared for them, as identified by the taxonomy codes associated with their National Provider Identifier number.

Results: An analysis of over 7 million claims yielded 2.5 million claims for malignancy-specific care. Of the 15,227 cancer providers identified, 32% were NPs (4,806), 28% were double boarded hematology/oncology physicians (4,222), 24% were PAs (3,767), 11% were singled boarded medical oncologists (661), 2.6% were gynecology oncologists (403) and 2.4% were single boarded hematologists (368). Compared to physicians, NPs and PAs were more likely to provide care to rural patients (OR 1.84, 95% CI 1.65-2.05 and OR 1.57, 95% CI 1.40-1.77, respectively). Patients who received NP care were more likely to be female, and reside in high poverty areas. Evaluation of

NP care vs. no NP care revealed that NPs were more likely to see female patients (56% vs. 48%, p=.0001) and those who resided in high poverty areas (21% vs. 18%, p=.05). **Conclusions:** Our study identified a large number of previously unrecognized NPs and PAs providing cancer care to older adults, especially in the Southern U.S., in rural settings and for poorer older adults.

Introduction

The population of the United States is aging, and, the incidence of cancer, which disproportionately impacts older adults is also anticipated to increase.[2] In 2017, there were over 1.6 million new cancer diagnoses, with almost half a million of those new diagnoses in older adults.[62] The leading cause of death for adults, age 40 to 79 years in the United States (U.S.) is cancer[2] with adults over the age of 65 years most frequently diagnosed.[63] It is widely recognized that access to cancer care is unequal, and the anticipated oncologist shortages could have a further negative impact.[44] Other significant demands on the oncology workforce include the large number of cancer survivors. Because of earlier detection and improved treatments, the number of cancer survivors is increasing; there are 14.5 million cancer survivors currently and by 2024, this number will increase to 19 million.[44]

According to a 2013 Institute of Medicine report[16], the current approach to delivering cancer care must be reinvented. After analyzing the way it is currently delivered, the Committee on Improving the Quality of Cancer Care concluded that the growing need for cancer care, increasing treatment complexity, and a shrinking workforce was causing a crisis in cancer care.[16] Because of significant strides in cancer treatment, increased numbers of older survivors with cancer require care and support across the treatment continuum. This challenge represents a potential opportunity to maximize our current oncology workforce. Unfortunately, most of what is currently known about the cancer workforce is based on physician and registered nurse surveys, with very little data on nurse practitioners (NP) and physician assistants (PA) in the cancer workforce.

Nurse Practitioners are advanced practice nurses with graduate education and additional population focused training; similarly PAs receive graduate degrees and provide medical care in multiple specialties, including oncology. There is evidence that both NPs and PAs currently provide oncology care.[9,10,54] Although workforce research has been conducted on oncology physicians for years using data from the Center for Medicare and Medicaid (CMS) and from the American Medical Association, no studies to date have measured the NP and PA oncology workforce with similar data.

The anticipated growth of the older population with the corresponding increase in malignancy diagnoses and those surviving cancer has fueled the need to better characterize the NP and PA workforce. This study provides important information to address this gap, by examining two objectives: 1) Measure the NP workforce caring for older adults with cancer, and identify if there are differences in the clinical or demographic characteristics of patients who received NP care and those who did not, and 2) Identify what proportion NPs and PAs comprise of the cancer workforce.

Methods

In this observational, cross-sectional study, we analyzed ambulatory care data from the Surveillance, Epidemiology and End Result (SEER) registry to identify patients who received care from NPs, PAs and physician specialists. We obtained the most recently available SEER data (2013) linked to Medicare's master enrollment files and analyzed all ambulatory claims submitted from January 1, 2013 through December 31, 2013. All adults over the age of 65 years with a cancer diagnosis who were Medicare beneficiaries in 2013 were included in the analysis because this group is the largest recipients of cancer care. Individuals diagnosed with autopsy after death were censored

since they had not received any cancer care. Several different files within SEER-Medicare were used to identify socio demographic information on patients, malignancy types and services rendered by the providers. Since most cancer care is in an outpatient clinic or infusion center (not a hospital), the provider analysis was focused on ambulatory care, and only ambulatory claims were included in the analysis. The University's Committee on Human Subject Research deemed this study exempt.

Data Sources

SEER Registry Data. Population based cancer incidence statistics have been collected by the SEER program since 1973,[64] and currently include 18 catchment areas that cover 28% of the U.S. population.[65] The data is drawn from cancer registries located within strategic sites, chosen to represent the demographics of the U.S. population. The SEER dataset was linked to CMS Medicare claims for the first time in 1991 by matching individual identifiers from SEER to Medicare's master enrollment files. It is updated every three to four years. The SEER-Medicare linked data include all Medicare eligible persons appearing in the SEER data who were diagnosed with cancer through 2011, and their Medicare claims through 2013.[66] All cancer patients reported to SEER registries are cross-matched with a master file of Medicare enrollment. Patients with cancer who have Medicare are included in the data, as are all of their oncology providers.

Outpatient (OUTPAT). The Outpatient file contains claims data on services provided by institutional outpatient providers, including hospital outpatient departments, dialysis centers and infusion centers. The file contains International Classification of

Disease 9 (ICD-9) codes, dates of service and reimbursement amount. Outpatient files also include information on care provided in ambulatory environments by oncology providers. Data included in the OUTPAT file provided information on the amount of care provided by NPs, PAs and MDs was used to analyze how much care was provided to patients with specific cancer types using the ICD-9 malignancy codes.

National Claims History (NCH). The NCH carrier claims file contains data on providers (e.g., NPs, PAs, MDs and pharmacists). This file was used specifically to measure the amount of care provided. Billing for professional services is processed through the NCH claims file, including fee-for-service claims. Each encounter in the NCH file includes a procedural code describing the nature of the billed services and has an ICD-9 code attached to the claim. An analysis of the carrier claim file provided additional information on the amount of care for various malignancy types. Most of the claims data within the NCH file is from professional services and contains information on providers including MDs and NPs providing care under part B of Medicare.

Patient Entitlement and Diagnostic Summary File (PEDSF). The PEDSF contains one record per person for patients in the SEER database who have been matched with Medicare enrollment records. Of people who were reported by the SEER registries to have been diagnosed with cancer at age 65 years or older, 94% were matched with Medicare enrollment records. The data in the PEDSF file include Medicare entitlement and utilization data, as well as demographic and comorbid conditions.

Independent Variables

Patient Demographics. Patient demographic variables were identified using the PEDSF and included: sex (male, female), race (white, black or African American, Asian, Hispanic or Latino, American Indian, Other), age (<65, 65-69, 70-74, 75-79, 80-84, 85+), geographical location of care, population density (categorized as rural/urban) and income (low, medium, high). Geographical location of care was identified using the 18 SEER sites. These sites were initially grouped into nine geographic regions: New England, Middle Atlantic, East North Central Midwest, West North Central Midwest, South Atlantic, East South Central, West South Central, Mountain and Pacific, then further consolidated into four regions Northeast, Midwest South and West.

Population density was defined according to the 2010 Census definitions of urban and rural. Rural areas were defined those having a population of less than 19,000. Urban and big metros areas were defined as those having populations of more than 20,000. Income was defined according to the 2013 federal poverty level, identified as $19,530 for a family of three. [67] We used census data that identified regions of poverty using weighted averages by zip code regions. These regions were grouped into low, medium and high poverty areas. Low poverty reflected patient residence in a census tract where less than five percent of all households were at or below the FPL, moderate poverty represented five to 19% of all households at or below the FPL and high poverty included 20 to 100% of households at or below the FPL

Malignancy Diagnoses. All malignancies were included in the analysis and were identified within the NCH carrier claims using the International Classification of Diseases, Ninth Revision (ICD-9). Malignancy diagnoses were grouped into the eight

most common malignancies for older adults[68] (hematologic, including lymphomas, gastrointestinal, breast, genitourinary, lung, head and neck, gynecologic, melanoma); the remaining diagnoses were categorized as 'other'. The 'other' category included sarcomas, central nervous system cancer, squamous cell of the skin and all of the remaining less common malignancy types. Cancer stages were divided into metastatic and non-metastatic, identified through the ICD9 code and histology codes. To identify care received for an individual patient, the malignancy type was identified using the histology codes within the PEDSF file Historically, the SEER data identified patients with metastatic disease at the time of diagnosis, but did not include the specific site of metastases. Consequently, the patients with metastatic disease in the analysis were identified as such at the time they were included in the registry. However, because some patients had more than one malignancy, care was also evaluated using the NCH claims data with ICD-9 codes.

Providers. All providers in the data were identified using the taxonomy associated with their National Provider Identification (NPI) number. The NPI number is a unique 10-digit identifier required by the Health Insurance Portability and Accountability Act for use in all health information transmissions involving patient care, including billing and claims.[69] While a crosswalk file matches the provider's NPI number with their taxonomy group, the claims within the SEER-CMS dataset include an encrypted NPI number to protect the identity of the provider. The associated taxonomy code categorizes the type and specialization of healthcare providers and is updated at regular intervals.[70,71]

Research studies conducted in primary care have evaluated NP and MD care within Medicare claims using NPI numbers.[72]

National Provider Identifier numbers and associated taxonomy codes were used to identify and categorize all providers within the 2013 data. Providers were grouped into the following categories: nurse practitioners (NP; code 50), physician assistants (PA; code 97), hematologists (Heme; code 82), medical oncologists (Med Onc; code 90), hematologists/oncologists (Heme/Onc; code 83) and gynecology oncologists (Gyn Onc; code 98).

To ensure the NP and PA provider group did not include physicians, the sample was validated using a second approach. Since NPs and PAs are paid for Medicare covered services at 85% of the physician rate under the Medicare Physician Fee Schedule, it is possible to separately identify these groups by charges for the same Evaluation and Management (E/M) billing code. The differences in charges based on commonly used ambulatory care new patient and follow up patient E/M billing codes (992201-992205, 992211-99215) were used to validate provider type using 30% of the total sample. No conflicts between the Medicare charge and taxonomy code were identified.

Statistical Analyses

Descriptive statistics such as range, frequency, and distribution were used to describe the patient sociodemographic and clinical characteristics, as well as the provider type, quantity of care and location. Although the focus of this paper was to measure the NP and PA effort in cancer care provision, in order to provide context, an initial analysis of all providers within the dataset was conducted.

Statistics on all providers within the data (including non-cancer specialists) were generated first, and then a second analysis was performed that was limited to providers focused on cancer care. Chi-square statistics were used to compare NPs, PAs and physicians to identify significant differences in their geographical location, and whether they provided care in an urban or rural setting. Sociodemographic and clinical patient characteristics including malignancy type were analyzed with Chi-square statistics to compare patients who received any care from an NP to those who received none.

Chi-square statistics were also used to compare NP and PA provider groups with specialty MDs across all of the included malignancy types. An unadjusted odds ratio with 95% confidence intervals was estimated to describe the likelihood of care by NPs, PAs or MDs for the various malignancies. Post-hoc pairwise tests were used for variables with more than two categories. Statistical analyses were performed using SAS version 9.3 (SAS Institute, Inc, Cary, NC) and Stata software, version 15 (Stata Corp., College Station, TX).

Results

There were 7.7 million SEER-Medicare ambulatory claims in 2013. After limiting claims to those for services specific to malignancy care, 2.55 million remained. These claims represented 201,237 adults with cancer and the care that was provided by128,971 unique providers (Appendix A).

Study Cohort

Of the 201,237 patients included in the analysis 16,764 (8.3%) received care from an NP. Sample characteristics of patients who received care from an NP are

reported in Table 1. Patients who received NP care differed from those who did not in terms of age, gender, area income, number and type of malignancies as well as the presence of metastatic disease.

Age of the patients who received NP care and those who did not were similar, with the exception of each end of the age spectrum. Differences between patients who received care from NPs and those who did were not seen in patients less than 65 years of age with a greater percentage receiving care by NPs (17% NP care vs. 13% non-NP care, p=<.05). Patients age 85 years and older had a smaller amount of care by NPs (9% vs. 12%, p=<.05). There was a significant difference in the distribution of care by gender between with an increased number of females seen by NPs (56% vs. 48%, p=.0001). The distribution of patients in high poverty areas was significantly greater in the NP care group compared to the non-NP care group (21% vs. 18%, p=.05), and lower in the low poverty areas although not statistically significant.

In an evaluation of all patients who received care from all providers, breast (26% vs. 23%, p=<.05), hematologic (22% vs. 13%, p=<.05) and GI malignancies (17% vs. 15%, p=<.05) were more likely to be cared for by an NP compared to those with a GU malignancy (24% vs. 35%, p=<.05) or melanoma (12% vs. 8%, p=<.05). These results differed than an analysis focused on malignancy specific providers. Twice as many patients with metastatic disease received NP care compared with those who received no NP (10% vs. 5%, p=<.05). Patient who had had more than one malignancy were also more likely to receive care from an NP compared to the non-NP care cohort (p=<0.0001). Race and ethnicity evaluation yielded similar rates of care across the various ethnic groups, although the sample was overwhelmingly white (83%).

Providers

Of the 128,971 unique providers identified, 15,227 were oncology specific providers of interest. The remaining providers included surgeons, radiologists, anesthesiologists, plastic surgeons, general surgeons and internal medicine physicians. (Appendix B). Of the 15,227 cancer providers, 32% were NPs (4,806), 28% were double boarded hematology/oncology physicians (4,222), 24% were PAs (3,767), 11% were singled boarded medical oncologists (661), 2.6% were gynecologic oncologists (403) and 2.4% were single boarded hematologists (368). Together NPs and PAs made up 56.2% of the cancer specific workforce in this sample and specialty oncology physicians made up 43.6%.

Malignancy Types

An evaluation of claims data for malignancy care that included all providers demonstrated that NPs provided a consistent proportion of care across all malignancy types. However, a more detailed examination of only cancer specific providers yielded measurable differences. Malignancy claims analyzed by provider groups demonstrated that the majority of claims were from Heme/Onc physicians, followed by Med Onc physicians, NPs, Gyn Onc physicians, PAs and Heme physicians. The largest number of malignancy claims submitted was for hematologic care; consequently, it was used as the referent for comparisons.

NPs were almost twice as likely to care for patients with ‘Other’ malignancies (OR 1.85, 95% CI 1.76-1.94) as physicians (Table 3). ‘Other’ malignancies included less common malignancies or unspecified ones including: central nervous system (CNS) malignancies, skin (not basal or melanoma) and sarcomas. Additionally, NPs were more

likely to care for patients with Genitourinary malignancies (OR1.17, 95% CI 1.14-1.20) and Head and Neck cancers (OR 1.15, 95% CI 1.10-1.19) compared to physicians. NPs were less likely to care for patients with GI and breast. As previously mentioned, this differed than the results for malignancy care when all providers were included. In that patient analysis, breast, hematologic and GI malignancies received more NP care compared to non-NP care.

PAs were more than five times as likely to provide care for patients with 'Other' malignancies (OR 5.33, 95% CI 4.99-5.63) than physicians (Table 4). PAs were more likely to care for patients with Head and Neck cancers (OR 1.59; 95% CI 1.49-1.69), Genitourinary cancers (OR 1.31, 95% CI 1.26-1.37) and melanoma (OR 1.27, 95% CI. 1.27-1.35) compared to physicians.

Geographical location

The majority of the patients were located in an urban or suburban area; however, patients who resided in rural areas were almost twice as likely to receive care from a NP (OR 1.84, 95% CI 1.65-2.05) as shown in Table 6. PAs were also more likely to provide rural cancer care than physicians (OR 1.57, 95% CI 1.40-1.77) as shown in Table 7.

The largest group of providers in the SEER-CMS data was located in the Western region of the U.S. and this was true across all provider types, both cancer specific and all others as demonstrated in Supplemental Table 2. As a result, the West was used as the reference for analysis of bivariate odds that evaluated the geographic distribution of care between NPs and physicians, as well as PAs and physicians. The widest range of providers was in the South, with a significant difference in the distribution of the oncology workforce (p=<0.0001). NPs comprised over one third (38%)

of the cancer workforce in the South compared with Heme/Onc physicians (26%), PAs (9%), Med Onc (9%), Gyn Onc (3%) and Heme physicians (1%). There was an increased likelihood of NP care in the South compared with physicians (OR 1.36, 95% 1.24-1.49) and a decreased likelihood of NP care in the Northeast (OR 0.71, 95% 0.64-0.79) as shown in Table 6.

PAs provided a consistent proportion of care across the regions with a slightly larger proportion in the Northeast (16%) compared to the other regions. However, in comparison with physicians, PAs were less likely to provide care in the Northeast (OR 0.49, 95% CI 0.43-0.54), Midwest (OR 0.86, 95% CI 0.77-0.97), or South (OR 0.82, 95% CI 0.74-0.91) as shown in Table 7.

Discussion

This is the first study to use national SEER-Medicare data to measure the NP and PA workforce caring for older adults with cancer. Findings revealed a large proportion of ambulatory cancer care is provided by both NPs and PAs. The magnitude of these health care providers' contribution to cancer care for older adults has not been previously recognized. The American Society of Clinical Oncology (ASCO) began conducting annual oncology workforce surveys that included NPs and PA in 2015. Estimates from their 2015 report measured the NP workforce at 2,700 and identified 1,100 PAs.[73] These numbers underestimate the NP and PA workforce compared with our analysis of the 2013 SEER-Medicare data, which identified 4,806 NPs and 3,767 PAs.

Although a rigorous methodology was used to measure the oncology physician workforce in the ASCO report (including the American Medical Association's Master

Physician List and the CMS Physician Compare dataset), only third party proxy reports were used to identify the NP and PA workforce. This may explain the difference between our findings and their workforce survey result and also serves to illustrate the importance of a more detailed, rigorous methodology. Our study results are based on a larger, and more representative sample, it also represents the first attempt to measure the NP and PA cancer working utilizing a similar methodology which has been used to identify oncology physicians.

Overall, the annual physician workforce measured by ASCO was significantly larger than that found in our study, with the exception of the gynecology oncologists, whose number was estimated at 456 by ASCO compared with 403 in our study. The ASCO survey identified 11,894 hematologists, medical oncologists and hematology/oncology specialists, whereas we found only 6,251. This may reflect a smaller population of specialists who provide cancer care for fee-for-service Medicare recipients, or a large population of pediatric oncologists who would not be represented in our data. An additional explanation may be that only half of all of the cancer specialists are providing care for older adults.

Consistent with research examining the NP contribution to primary care, we found that NPs provided a substantial amount of cancer care for poorer and rural patients.[74] The majority of patients in this population (75%) lived in moderate or high poverty areas, identified by using U.S. Census zip code data. Physician specialists provided more care for those patients who resided in higher income areas and NPs provided more care for patients who resided in lower income areas, a finding consistent with prior research studies.[75,76] The SEER sites included in the geographical South,

Kentucky, Louisiana and rural Georgia are some of the poorest in the U.S.[77] The relatively large presence of NPs providing cancer care to poorer patients may be explained by the increased presence of NPs in the South compared with the relatively large presence of physician specialists in the more affluent regions of the Northeast.

Rural cancer care providers comprised a small portion of the total workforce, slightly more than ten percent (Table 5). However, NPs in rural cancer settings made up more than half of these cancer care providers. Previous studies have documented the challenges that residents of rural America face in health care access, especially cancer care, but have only measured physician specialist contributions.[78,79] Multiple studies have confirmed that physician specialists tend to practice in urban areas;[80] for example, one study identified 134 specialists per 10,000 people in urban areas compared with 40 specialists per 10,000 in rural areas.[81] A recent review of Medicare claims by Loresto et al. in 2017, identified patients who used only NPs for their primary care to be younger, have lower socioeconomic status and reside in a non-metropolitan area.[74] Our findings suggest that NPs are currently providing cancer care to a substantial portion of the rural population and may be a further solution to addressing these inequities in cancer care.

The analysis of patients who received NP care revealed several other trends. Women with cancer were more likely to receive care from a NP by a significant margin, an increased proportion of breast or gynecological care by NPs compared with MDS did not explain this difference. Additionally, a large proportion of patients younger than 65 years also received increased amount of their care from NPs.

Medicare beneficiaries are generally older than 65 years and if younger than 65, usually are recipients as a result of disability. Research in primary care has

demonstrated a disproportionate amount of care provided by NPs to disabled adults. Our research study supports a similar conclusion for recipients of NP cancer care in 2013. Physicians provided more care for elderly patients older than 85 years, which may indicate increased complexity of care needs for older adults with multiple co-morbidities.

Although NPs and PAs are often grouped together within oncology and collectively referred to as ‘Advanced Practice Providers’, our findings suggest there are some critical differences between where they provide care and for which type of malignancy. PAs, possibly in part due to licensing and oversight requirements, tended to provide care in regions that were similar to physician specialists in our data, almost perfectly synchronized with medical oncologists. PAs must practice with a collaborating physician, whereas NPs scope of practice is more variable and may encompass independent practice. In our analysis, NPs tended to provide relatively more cancer care to rural patients, and patients who resided in the South.

NPs provided care to a similar range of malignancies as physicians, with the exception of relatively more care for ‘other’ malignancies than physicians. Both NPs and PAs provided a larger proportion of care for ‘other’ malignancies than physicians. A sample of ‘other’ claims was reviewed, and the most commonly identified diagnosis ‘Not Otherwise Specified’ malignancy usually involved the skin. PAs also had a wider range of differences than NPs in malignancy type cared for compared with physician specialists, providing less care for breast and lung cancers. This may be a reflection of the relationship between advanced stage cancer diagnosis and residence in higher poverty areas rather than a reflection of clinical care trends.[82]

Our study has several limitations. First, it is a cross-section of care providers and may underestimate certain specialists, given the older population in our study. Second, only fee-for-service Medicare beneficiaries are included in this data, which resulted in an under-representation of managed care recipients. Managed care recipients may have different rates of care from the various providers, as well as different rates of malignancies. Research on NPs in primary care have identified that NPs are more prevalent in managed care areas; consequently the contribution to the cancer workforce may be further under-represented in this data. A third limitation was the inability to identify and quantify 'incident to' billing. Incident to billing is a mechanism that allows reimbursement at 100% of the prevailing rate rather than using the NP fee schedule (85% of the rate) if the physician is involved in the care provision. The size of incident to billing in the SEER-Medicare dataset is unknown; so the magnitude of its' contribution to underrepresentation of NP care efforts is also unknown. Finally, the SEER-Medicare linked dataset was designed for an epidemiological representation of cancer incidence and prevalence in the U.S. and although it has previously been used to measure the physician and radiation oncologist workforce, there are limitations to using it to make workforce policy recommendations. However, it remains an important tool for quantifying the previously hidden NP and PA workforce.

Conclusion

The U.S. health care system is facing an imminent increase in the rate of cancer diagnoses as a result of the aging of the population. This will occur within the setting of an unevenly distributed and inadequately powered cancer workforce. Our study results identified the contribution of NPs and PAs who provided cancer care to these older

adults. The results are based on data from 2013, and in the ensuing five years, significant health policy changes have occurred, including the Affordable Care Act which reduced the uninsured number from 18% to 12%[83] with subsequent increased demand for cancer care providers. Delivering high value cancer care has become a priority with a focus on making quality cancer care accessible, and integrating delivery with teams of care providers.

Our results suggest that NPs are making a significant contribution to cancer care, especially in the Southern U.S., in rural settings and to poorer older adults. Given the select population in our data and he limitations associated with identifying NP contributions using Medicare data, this figure is almost certainly an underestimation of the actual amount of NP provided care.

Finally, solutions to the rising demands for cancer care will need to maximize every health care provider's contribution. Previously, the contributions of NPs and PAs to cancer care were hidden, not recognized or measured adequately; our study is the first attempt to quantify their efforts to care for older adults with cancer. Future studies on associated patient outcomes and cost effectiveness are necessary to adequately assess their contribution. Nevertheless, this study is an important starting point for which future workforce surveys can be compared. NPs and PAs have great potential to help reduce the shortage of cancer care providers for older patients, and possibly for other patients with cancer. Understanding the nature of this workforce is a first step toward determining how to optimize NP and PA utilization to meet the future needs of caring for an older population with cancer.

Table 1. Socio-Demographic Patient Characteristics

	Total Patients (n=201,237)	Patient with any care from NP (n =16,764)	Patient with no care from NP (n=184,473)	P value
Age, N(%)				†
< 65	26524(13)	2774(17)	23750(13)	
65 to < 70	45350(23)	4028(24)	41322(22)	
70 to < 75	43858(22)	3640(22)	40218(22)	
75 to < 80	35871(18)	2794(17)	33077(18)	
80 to < 85	26734(13)	2009(12)	24725(13)	†
85 +	22900(11)	1519(9)	21381(12)	†
Gender, N(%)				
Male	102842(51)	7417(44)	95425(52)	
Female	98395(49)	9347(56)	89048(48)	†
Race/Ethnicity, N(%)				†
White	166126(83)	14161(84)	151965(82)	
Black or African American	18401(9)	1559(9)	16842(9)	
Asian	6107(3)	332(2)	5775(3)	
Other	4412(2)	259(2)	4153(2)	
Hispanic or Latino	3949(2)	257(2)	3692(2)	
American Indian or Alaska Native	649(0)	60(0)	589(0)	
Malignancy Count, N(%)				
1	152458 (76)	11995(72)	140463 (76)	
2	39061 (19)	3706 (22)	35355 (19)	†
3 or more	9718 (5)	1063 (6)	8655 (5)	†
Metastatic	10858(5)	1619(10)	9239(5)	†
Malignancy Types				
Genitourinary	69189(33)	4053(24)	65136(35)	†
Breast	47526(23)	4417(26)	43109(23)	†
Gastrointestinal	29784(14)	2850(17)	26934(15)	†
Hematological	27885(13)	3628(22)	24257(13)	†
Melanoma	23995(11)	1332(8)	22663(12)	†
Lung	16191(8)	1681(10)	14510(8)	†
Other	13139(6)	1086(6)	12053(7)	0.06
Head and Neck	12570(6)	977(6)	11593(6)	†
Gynecological	11239(5)	1247(7)	9992(5)	†
Area Income N(%)				
Low Poverty[1]	52636(26)	3937(23)	48699(26)	
Moderate Poverty[2]	109295 (55)	9152 (55)	100143 (54)	
High Poverty[3]	37168 (20)	3478 (21)	33690 (18)	†

†= p=<0.05

[1]Low Poverty reflects residence in a census tract where <5% of all household are at or below the Federal Poverty Level (FPL)

[2]Moderate Poverty reflects residence in a census tract where 5% to <20% of households are at or below FPL

[3]High Poverty reflects residence in a census tract where 20% to 100% of households are at or below the FPL

Table 2. Malignancy Claims by Cancer Workforce

	Total Malignancy Claims	Nurse Practitioner	Physician Assistants	Hematologists	Hematologists /Oncologists	Medical Oncologists	Gynecological Oncologists	
		N, (Row%)						
Overall, %	1,412,927	53,867(3)	28,428(2)	53,841(4)	973,212(69)	275,771(19)	27,808(2)	P-value
Malignancy Type								
Hematological (reference)	473,870	16,678(4)	8,613(2)	27,913(6)	342,674(72)	76,607(16)	1,385(0)	Reference
Gastrointestinal	196,148	6,349(3)	2,482(1)	6,861(4)	141,697(72)	37,543(19)	1,216(1)	†
Breast	191,453	6,668(3)	2,176(1)	5,063(3)	139,998(73)	36,939(19)	609(0)	†
Lung	140,090	5,048(4)	1,569(1)	4,242(3)	99,208(71)	29,961(21)	62(0)	†
Genitourinary	100,935	6,040(6)	3,960(4)	2,979(3)	62,652(62)	25,188(25)	116(0)	†
Gynecological	76,580	3,050(4)	1,238(2)	1,545(2)	38,190(50)	9,485(12)	23,072(30)	†
Head and Neck	31,617	1,891(6)	1,510(5)	842(3)	20,773(66)	6,512(21)	89(0)	†
Other*	25,703	2,286(9)	45,96(18)	538(2)	13,084(51)	5,087(20)	112(0)	†
Melanoma	18,044	718(4)	515(3)	405(2)	11,744(65)	4,624(26)	38(0)	†
All Metastatic	158,487	5,139(3)	1,769(1)	3,453(2)	103,192(65)	43,825(28)	1,109(1)	†

*Other malignancies include CNS, skin, sarcoma and other neoplasms.

†

64

Table 3. Odds Ratio: Bivariate Association of NP and MD claims by Malignancy Type

	NP		MD		Odds of NP Care	
					OR (95% CI)	
Malignancy Type						
Hematological (reference)	16,678(4)		44,8579(96)		Ref	
Gastrointestinal	6,349(3)		187,317(97)		0.96 (0.94-0.98)	†
Breast	6,668(3)		182,609(96)		0.92 (0.90-0.94)	†
Lung	5,048(4)		133,473 (96)		0.98 (0.95-1.00)	
Genitourinary	6,040(6)		90,935(94)		1.17 (1.14-1.20)	†
Gynecological	3,050(4)		72,292(96)		1.02 (0.98-1.06)	
Head and Neck	1,891(6)		28,216(94)		1.15 (1.10-1.19)	†
Other*	2,286(9)		18,821(89)		1.85 (1.76-1.94)	†
Melanoma	718(4)		16,811(96)		1.03 (0.97-1.09)	
Metastatic	5,139(3)		151,579(97)		0.92 (0.90-0.95)	†

MD = Hematologists, Hematologists/Oncologists, Medical Oncologists, and Gynecological Oncologists

† p<0.05

65

Table 4. Odds Ratio: Bivariate Association of PA and MD claims and Malignancy Type

	PA		MD		Odds of PA Care	
					OR (95% CI)	
Malignancy Type						
Hematological (reference)	8,613(2)		448,579(98)		Ref	†
Gastrointestinal	2,482(1)		187,317(99)		0.88 (0.85-0.92)	†
Breast	2,176(1)		182,609(99)		0.82 (0.79-0.84)	†
Lung	1,569(1)		133,473(99)		0.82 (0.79-0.84)	†
Genitourinary	3,960(4)		90,935(96)		1.31 (1.26-1.37)	†
Gynecological	1,238(2)		72,292(98)		0.91 (0.88-0.95)	†
Head and Neck	1,510(5)		28,216(95)		1.59 (1.49-1.69)	†
Other*	4,596(20)		18,821(80)		5.33 (4.99-5.69)	†
Melanoma	515(3)		16,811(97)		1.27 (1.19-1.35)	†
Metastatic	1,769(1)		151,579(99)		0.87 (0.84-0.91)	

MD = Hematologists, Hematologists/Oncologists, Medical Oncologists, and Gynecological Oncologists

† p<0.05

Table 5. Geographic Region of Ambulatory Cancer Workforce in 2013 SEER Medicare Claims

	Total	NP	PA	Heme	Heme/Onc	Med Onc	Gyn Onc	
	N=15,227	N=4,806	N=3,767	N=368	N=4,222	N=1,661	N=403	
	Column (%)	Row (%)						P value
		31.5%	24.7%	2.4%	27.7%	10.9%	2.6%	
Geographic Region								
Northeast	3,105(23)	858(28)	580(16)	111(4)	953(31)	491(16)	112(4)	†
Midwest	2,414(16)	715(30)	650(11)	60(2)	684(28)	256(11)	49(2)	0.1392
South	4,515(28)	1,723(38)	1034(9)	66(1)	1,163(26)	416(9)	113(3)	†
West (reference)	5,076(32)	1,500(30)	1,494(10)	130(3)	1345(27)	486(10)	121(2)	1
Rural vs Urban								
Urban (Reference)	13,075(89)	3,948(30)	3,177(11)	337(3)	3,768(29)	1,490(11)	355(3)	1
Rural	2,140(11)	853(40)	587(8)	31(1)	451(21)	170(8)	48(2)	†

*Percentages are calculated on non-missing cases. There are <= 2% of observations with missing values.
† p<0.0001

Table 6. Odds of NP Care vs. MD Care by Region and Rural/Urban Status

Geographic Region	NP		MD	Odds of NP Care	
Northeast	858(34)		1,667(66)	0.71(0.64-0.79)	†
Midwest	715(41)		1,049(59)	0.95 (0.94-1.06)	
South	1,723(50)		1,758(50)	1.36 (1.24-1.49)	†
West	1,500(42)		2,082(58)	Ref	

Rural / Urban	NP		MD	Odds of NP Care	
Urban	3,948(40)		5,950(60)	Ref	
Rural	853(55)		700(45)	1.84(1.65-2.05)	†

MD = Hematologists, Hematologists/Oncologists, Medical Oncologists, and Gynecological Oncologists

† $p<0.05$

Table 7. Odds of PA Care vs. MD Care by Region and Rural/Urban Status

Geographic Region		PA		MD	Odds of PA Care	
Northeast		580(26)		1,667(74)	0.49(0.43-0.54)	†
Midwest		650(38)		1,049(62)	0.86(0.77-0.97)	†
South		1,034(37)		1,758(63)	0.82(0.74-0.91)	†
West		1,494(42)		2,082(58)	Ref	

Rural/Urban		PA		MD	Odds of PA Care	
Urban		3,177(35)		5,950(65)	Ref	
Rural		587(46)		700(54)	1.57(1.40-1.77)	†

MD = Hematologists, Hematologists/Oncologists, Medical Oncologists, and Gynecological Oncologists

† $p<0.05$

67

Appendix A. Claims for SEER-CMS 2013

Claim Description	Number of Claims	ICD-9 Malignancy Code Diagnoses	Providers (N)	Patients (N)
All OUTPAT and NCH claims for 2013	7,737,937		304,221	245,857
Claim provider not missing not a DME Supplier	7,134,017		254,515	243,068
Has an ICD-9 Malignancy Code	2,552,841	2,942,656 [1]	128,971	201,237

[1]Some claims had more than one malignancy
<2% of claim provider identifiers missing

OUTPAT = Outpatient file contained claims data on services provided by institutional outpatient providers.
NCH= NCH carrier claims file contains data on providers (e.g., NPs, PAs, MDs, pharmacists, etc.).
DME= Durable Medical Equipment

This study used the linked SEER-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors. The authors acknowledge the efforts of the National Cancer Institute; the Office of Research, Development and Information, CMS; Information Management Services (IMS), Inc.; and the Surveillance, Epidemiology, and End Results (SEER) Program tumor registries in the creation of the SEER-Medicare database.

Appendix B. List of Other Providers

HCFASPEC Code	Specialty Description	Frequency
1	General Practice	1,062
2	General Surgery	3,888
3	Allergy Immunology	145
4	Otolaryngology	2,102
5	Anesthesiology	5,951
6	Cardiology	4,302
7	Dermatology	4,389
8	Family Practice	13,630
9	Interventional Pain Management	184
10	Gastroenterology	3,250
11	Internal Medicine	19,873
13	Neurology	1,470
14	Neurosurgery	915
15	Obstetrics	13
16	Obstetrics Gynecology	2,137
18	Ophthalmology	2,263
19	Oral Surgery (dental only)	136
20	Orthopedic Surgery	1,061
22	Pathology	4,378
24	Plastic and Reconstructive Surgery	989
25	Physical Medicine and Rehabilitation	364
26	Psychiatry	187
28	Colorectal Surgery (formerly Proctology)	357
29	Pulmonary Disease	1,974
30	Diagnostic Radiology	10,986
32	Anesthesiologist Assistant	282
33	Thoracic Surgery	384
34	Urology	3,644
36	Nuclear Medicine	310
37	Pediatric Medicine	194
38	Geriatric Medicine	391
39	Nephrology	2,224
40	Hand Surgery	66
42	Certified Nurse Midwife	13
43	Certified Registered Nurse Assistant (CRNA)	3,573
44	Infectious Disease	640
46	Endocrinology	1,228
62	Psychologist	1
65	Physical Therapist	186
66	Rheumatology	633
67	Occupational Therapist	25

HCFASPEC Code	Specialty Description	Frequency
68	Clinical Psychologist	65
71	Registered Dietitian/Nutrition Professional	23
72	Pain Management	142
76	Peripheral Vascular Disease	9
77	Vascular Surgery	437
78	Cardiac Surgery	179
79	Addiction Medicine	7
80	Licensed Clinical Social Worker	19
81	Critical Care (Intensivists)	190
84	Preventive Medicine	37
85	Maxillofacial Surgery	114
86	Neuropsychiatry	3
89	Certified Clinical Nurse Specialist	55
91	Surgical Oncology	338
92	Radiation Oncology	2,103
93	Emergency Medicine	9,573
94	Interventional Radiology	399
.	Sleep Medicine	3
.	Interventional Cardiology	1

Supplemental Table 1. Malignancy Claims with All Provider Types

	Total Malignancy Claims	NP	PA	Heme	Heme/ Onc	Med Onc	Gynecological Onc	Other providers	
		N, (Row%)							
Overall, (%)	N=2,942,656	53,867(2)	28,428(1)	53,841(2)	973,212(33)	275,771(9)	27,808(1)	1,529,729(52)	P-value
Non Metastatic									
Hematological (reference)	816,763	16,678(2)	8,613(1)	27,913(3)	342,674(42)	76,607(9)	1,385(0)	342,893(42)	reference
Genitourinary	453,106	6,040(1)	3,960(1)	2,979(1)	62,652(14)	25,188(6)	116(0)	352,171(78)	<.0001
Breast	325,523	6,668(2)	2,176(1)	5,063(2)	139,998(43)	36,939(11)	609(0)	134,070(41)	<.0001
Gastrointestinal	322,487	6,349(2)	2,482(1)	6,861(2)	141,697(44)	37,543(12)	1,216(0)	126,339(39)	<.0001
Lung	265,541	5,048(2)	1,569(1)	4,242(2)	99,208(37)	29,961(11)	62(0)	125,451(47)	<.0001
Head and Neck	161,339	1891(1)	1,510(1)	842(1)	20,773(13)	6,512(4)	89(0)	129,722(80)	<.0001
Other*	138,288	2,286(2)	4,596(3)	538(0)	13,084(9)	5,087(4)	112(0)	112,585(81)	<.0001
Gynecological	122,297	3,050(2)	1,238(1)	1,545(1)	381,90(31)	9,485(8)	23,072(19)	45,717(37)	<.0001
Melanoma	51,897	718(1)	515(1)	405(1)	11,744(23)	4,624(9)	38(0)	33,853(65)	<.0001
Any Metastatic	285,415	5,139(2)	1,769(1)	3,453(1)	103,192(36)	43,825(15)	1,109(0)	126,928(44)	<.0001

*Other malignancies include CNS, skin, sarcoma and other neoplasms.

Supplemental Table 2. Medicare SEER All Providers of Ambulatory Malignancy Care Comparison

		Total	NP	PA	Heme	Heme/Onc	Med Onc	Gyn Onc	All other providers		
		N=128,971	N=4,806	N=3,767	N=368	N=4,222	N=1,661	N=403	N=113,744		
		Column (%)	Row (%)							P value	
Geographic Division	New England	Middle Atlantic	3.7%	2.9%	0.3%	3.2%	1.3%	0.3%	88.2%		
	East North Central Midwest	8,467(8)	326(4)	286(3)	29(0)	347(4)	221(3)	34(0)	7,224(85)	<.0001	
	West North Central Midwest	17,971(15)	532(3)	294(2)	82(0)	606(3)	270(2)	78(0)	16,109(90)	<.0001	
	South Atlantic	9,457(9)	240(3)	237(1)	30(0)	389(4)	131(1)	24(0)	8,406(89)	<.0001	
	East South Central	7,467(7)	475(6)	413(2)	30(0)	295(4)	125(2)	25(0)	6,104(82)	<.0001	
	West South Central	16,428(15)	586(4)	549(1)	23(0)	611(4)	184(1)	57(0)	14,418(88)	<.0001	
	Mountain	9,114(7)	750(8)	278(1)	27(0)	302(3)	106(1)	32(0)	7,619(84)	<.0001	
	Pacific (reference)	8,156(6)	387(5)	207(2)	16(0)	250(3)	126(2)	24(0)	7,146(88)	<.0001	
	Missing*	7,785(7)	370(5)	345(2)	22(0)	304(4)	133(2)	27(0)	6,584(85)	<.0001	
		43,568(25)	1,130(3)	1,149(1)	108(0)	1,041(2)	353(1)	94(0)	39,693(91)		1
		558	10	9	1	77	12	8	441		
Geographic Region	Northeast	Midwest									
	South	26,438(23)	858(3)	580(2)	111(0)	953(4)	491(2)	112(0)	23,333(88)	<.0001	
	West (reference)	16,924(17)	715(4)	650(2)	60(0)	684(4)	256(2)	49(0)	14,510(86)	<.0001	
	Missing*	33,698(28)	1,723(5)	1,034(1)	66(0)	1,163(3)	416(1)	113(0)	29,183(87)	<.0001	
		51,353(32)	1,500(3)	1,494(1)	130(0)	1,345(3)	486(1)	121(0)	46,277(90)		1
		558	10	9	1	77	12	8	441		
Rural vs Urban	Urban (Reference)	Rural									
	Missing*	115,717(89)	3,948(3)	3,177(1)	337(0)	3,768(3)	1,490(1)	355(0)	102,642(89)		1
	Missing*	131,77(11)	853(6)	587(1)	31(0)	451(3)	170(1)	48(0)	11,037(84)	<.0001	
	Missing*	77	5	3	0	3	1	0	65		

*Percentages are calculated on non-missing cases. There are <= 2% of observations with missing values.

72

Supplemental Table 4. Odds of PA Care with Geographical Divisions

			PA		MD	Odds of PA Care	
			N(%)		N(%)	OR (95% CI)	
Geographic Division							
	New England		286(31)		631(69)	0.63(0.54-0.74)	†
	Middle Atlantic		294(22)		1,036(78)	0.40(0.34-0.46)	†
	East North Central Midwest		237(29)		574(71)	0.57(0.48-0.68)	†
	West North Central Midwest		413(47)		475(53)	1.21(1.04-4.41)	†
	South Atlantic		549(39)		875(61)	0.87(0.77-0.99)	†
	East South Central		278(37)		497(63)	0.83(0.70-0.98)	†
	West South Central		207(33)		416(67)	0.69(0.58-0.83)	†
	Mountain		345(42)		486(58)	0.99(0.84-1.15)	
	Pacific		1,149(42)		1,596(58)	Ref	

Geographic Region			PA		MD	Odds of NP Care	
	Northeast		580(26)		1667(74)	0.49(0.43-0.54)	†
	Midwest		650(38)		1,049(62)	0.86(0.77-0.97)	†
	South		1,034(37)		1,758(63)	0.82(0.74-0.91)	†
	West		1,494(42)		2,082(58)	Ref	

Rural vs Urban			PA		MD	Odds of NP Care	
	Urban		3,177(35)		5,950(65)	Ref	
	Rural		587(46)		700(54)	1.57(1.40-1.77)	†

MD = Hematologists, Hematologists/Oncologists, Medical Oncologists, and Gynecological Oncologists

† $p<0.05$

Chapter 5

Summary and Conclusion

Lorinda A. Coombs, PhD(c), FNP-BC, AOCNP

The purpose of this dissertation was to evaluate the provision of cancer care by NPs to older adults with cancer and investigate if they may provide an alternate source of care to help meet the increased need for cancer care in the future. The specific aims of this dissertation were to: 1) measure the NP workforce caring for older adults with cancer, and determine what proportion they make up of the oncology workforce, 2) identify if there are specific types of malignancies which NPs provide a larger proportion of care than other providers, and 3) describe the patient population receiving cancer care from NPs.

Review of Chapter 2

The first manuscript, titled 'A Scoping Review of the Nurse Practitioner Workforce in Oncology', presented the findings of a scoping review of the literature examining what is currently known of NP oncology practice. Scoping reviews summarize research findings when the topic has not been extensively studied.[18] In contrast to systematic reviews that focus on randomized controlled trials, scoping reviews may include a diverse range of study designs and methodologies.[50]

A total of 10 studies were included in the final analysis. The lack of an accurate estimation of NP care in oncology and the small number of NPs represented in the review (only 0.1% of the licensed NP population in the U.S.) were important findings. Additionally, the reliance upon self-report and small sample sizes was also identified. This scoping review offered insight into the limitations of prior research on the NP oncology workforce.

Review of Chapter 3

'The Growing Nurse Practitioner Workforce in Specialty Care' presented an analysis of the findings from the National Sample Survey of Nurse Practitioners conducted by the Health Resources and Service Administration (HRSA) in 2012. While various estimations of the NP workforce exist, this was the first attempt to measure the workforce including their geographic distribution and role in primary or specialty care.

Although the scope was large, the methodology was again reliant upon self-report, with surveys sent to a random sample of NPs identified through state licensing boards. The study findings indicated that one third of the surveyed workforce was currently providing specialty care.[7] The National Center for Health Workforce Analysis concurrently released a report documenting the growth of non-primary care advanced practice nurses, and estimated their growth at 141%.[28] This unprecedented growth may be a result of the success of the NP role in primary care.[27] Simultaneously, the Association of American Medical Colleges anticipated an insufficient supply of specialty physicians[26] with an increased demand due to the doubling in the number of Americans 65 years or older between 2010 and 2010.[34] The role of the NP was initially created out of a need for pediatric primary care providers,[19] and has grown to encompass specialty care. This study highlights the need to better quantify and analyze the role of the NP workforce in specialty care.

Review of Chapter 4

The third manuscript, 'Nurse Practitioner and Physician Assistant Care for Older Adults with Cancer: A Hidden Workforce' presented the main findings from this dissertation study. The primary goal of the manuscript in this chapter was investigate

and measure the current workforce of NPs providing cancer care to older adults. There is evidence that both NPs and PAs are currently providing oncology care[9,10,54], and the findings from our study confirmed this. Additionally, this study investigated if there were trends for greater proportion of NP or PA care for specific malignancies or types of patients.

A secondary data analysis using the Surveillance, Epidemiology and End Result (SEER) registry linked with 2013 Medicare claims was performed to answer the research questions. The number of patients who received care from a NP was 16,764 patients, or 8.3% of 201,237 patients. The distribution of care by gender revealed an increased number of females than males seen by NPs (56% vs. 48%, p=.0001). The number of patients in high poverty areas who received care from an NP was greater than those who did not receive care from a NP (21% vs. 18%, p=.05).

Of the 15,227 cancer providers in the dataset, 32% (n=4,806) were NPs and 24% (3,767) were PAs; combined they comprised 56.2% of the workforce in our sample. Patients who resided in rural areas were almost twice as likely to receive care from a NP (OR 1.84, 95% CI 1.65-2.05) than from a physician, and one and a half times more likely to receive care from a PA (OR 1.57, 95% CI 1.40-1.77) than from a physician. Research has demonstrated that individuals who live in poorer communities are less likely to receive cancer screening[84] which is one factor in the increased rates of late stage (or metastatic) cancer diagnoses. Patients with metastatic cancer were two-fold compared to those that received no NP care (10% v. 5%, p=<.05).

NPs and PAs provided care for ‘Other’ malignancies compared with physicians. For example, NPs were almost twice as likely (OR 1.85, 95% CI 1.76-1.94) and PAs

were more than five times as likely (OR 5.33, 95% CI 4.99-5.63) to care for patient with 'Other' malignancies compared to physicians. Additionally, NPs and PAs were more likely to care for Genitourinary (OR1.17, 95% CI 1.14-1.20; OR 1.31, 95% CI 1.26-1.37, respectively) and Head and Neck cancers (OR 1.15, 95% CI 1.10-1.19; OR 1.59; 95% CI 1.49-1.69, respectively) compared to physicians.

However, there were differences observed between the NP and PA workforce. NP care was strongly represented in the South compared with physicians (OR1.36, 95% 1.24-1.49) with less representation in the Northeast (0.71, 95% 0.64-0.79). Alternatively, PAs provided a consistent proportion of care across the regions, however, in comparison with physicians, PAs were less likely to provide care in the Northeast (OR 0.49, 95% CI 0.43-0.54).

The main findings of this study are that: 1) a large proportion of ambulatory cancer care for older adults is provided by NPs and PAs, 2) the magnitude of this workforce has previously been unrecognized and underreported, 3) NPs and PAs provide a large proportion of cancer care for rural patients and 4) NPs provide a large proportion of cancer care for poorer older patients. This dissertation highlighted the challenges measuring the NP workforce and identified patterns within malignancy care for older adults.

Implications

These findings have important clinical and policy implications. Clinically, NPs and PAs are already providing cancer care to older adults across the spectrum of malignancies without current recognition for their efforts. Despite the contribution of this research, the complete breadth of their efforts remains unknown because of the known

limitations of ‘incident to’ billing with Medicare data. Similarly, the outcomes of patients who receive care provided by NPs and PAs as well as those who do not, is unknown.

Cancer disparities within the U.S. have resulted in improved outcomes for some populations, and increased rates of metastatic disease for others, specifically lower socio-economic groups. Access to health care is a critical factor, making some areas within the U.S. more vulnerable to cancer physician shortages, especially those patients who reside in rural and poorer areas.[85] According to our findings, NPs and PAs are already in place providing disproportionate amounts of care to older adults who live in rural areas.

The current anticipated deficit of cancer providers is based upon a model wherein physicians provide the bulk of treatment. While previous studies have revealed a small portion of the NP and PA providers, it appears that this ‘hidden’ workforce may have the capacity to remedy the physician deficit and may already be in position to accommodate the anticipated increased need for cancer care. Although the SEER-Medicare data used in this research is the most recently available, it is over five years old, and given the rapid rise in specialty advanced practice nurses, is almost certain a further underestimates the NP and PA workforce in 2018.

Future Research

There has been an enormous amount of research focused on the future need for cancer care, including projections with complex algorithms to rapidly scale up the physician specialty workforce. These algorithms have missed an important factor; and future workforce projections should include the contributions of the NP and PA oncology workforce. This study provides a baseline for making future comparisons.

No other studies to date have used Medicare claims data linked with the SEER cancer registry to measure NP and PA care, making the findings of this dissertation especially important. Further detailed research is needed to understand the types of care provided NP and PA providers, and whether their care is associated with different outcomes than MD providers. Additionally, given the persistent focus on high value cancer care, further studies are necessary to evaluate the economic impact of NP and PA care. Lastly, this research identified an increased amount of NP care for patients with more than one malignancy and with metastatic cancer a new finding that bears further investigation.

Conclusion

The U.S. health care system is facing a major challenge with the doubling of the older adult population and their increased need for cancer care. Understanding how cancer care is currently delivered is important in order to identify solutions. The results of this dissertation highlight the lack of accurate data on the NP and PA workforce previously available. Full utilization and measurement of the cancer workforce is critical for maximizing value in cancer care. Although mortality from cancer has declined in the past 20 years, the number of cancer survivors has increased, and will continue to increase, putting more pressure on the health care system to recognize the need to

evolve from outdated and inefficient models of cancer care delivery. In order to meet the challenge to deliver high value care to all older adults with cancer, we need to utilize all of our workforce resources.

References

1. Sudhakar A. History of Cancer, Ancient and Modern Treatment Methods. Journal of Cancer Science & Therapy. Dec 1, 2009;1(2):1-4.
2. Siegel R, Miller, K. & Jemal, A. Cancer Statistics, 2016. *CA:* a cancer journal for clinicians. 2016;66:24.
3. Stein CJ, Colditz GA. Modifiable risk factors for cancer. Br J Cancer. Jan 26 2004;90(2):299-303.
4. American Cancer Society. Cancer Facts & Figures 2015. Atlanta: American Cancer Society;2015.
5. American Society of Clinical Oncology. The State of Cancer Care in America, 2016: A Report by the American Society of Clinical Oncology. Journal of oncology practice / American Society of Clinical Oncology. Mar 15 2016.
6. Charlton M, Schlichting, J., Chioreso, C., Ward, M. & Vikas, P. Challenges of Rural Cancer Care in the United States. Oncology Journal, Practice & Policy. 2015. http://www.cancernetwork.com/oncology-journal/challenges-rural-cancer-care-united-states. Accessed March 10, 2016.
7. U.S. Department of Health and Human Services HRSA. Highlights from the 2012 National Sample Survey of Nurse Practitioners. In: U.S. Department of Health and Human Services HRaSA, ed. Rockville, MD2014.

8. American Academy of Nurse Practitioners. American Academy of Nurse Practitioners National NP Database. 2014.
9. Nevidjon B, Rieger P, Miller Murphy C, Rosenzweig MQ, McCorkle MR, Baileys K. Filling the gap: development of the oncology nurse practitioner workforce. Journal of oncology practice / American Society of Clinical Oncology. Jan 2010;6(1):2-6.
10. Ruegg T. A Nurse Practitioner-Led Urgent Care Center: Meeting the Needs of the Patient With Cancer. Clinical Journal of Oncology Nursing. 2013;17(4).
11. Moote M, Krsek C, Kleinpell R, Todd B. Physician assistant and nurse practitioner utilization in academic medical centers. American Journal of Medical Quality : the official journal of the American College of Medical Quality. Nov-Dec 2011;26(6):452-460.
12. Hinkel JM, Vandergrift JL, Perkel SJ, Waldinger MB, Levy W, Stewart FM. Practice and productivity of physician assistants and nurse practitioners in outpatient oncology clinics at national comprehensive cancer network institutions. Journal of Oncology Practice / American Society of Clinical Oncology. Jul 2010;6(4):182-187.
13. Buswell L, Reid Ponte, P., & Shulman, L. Provider Practice Models in Ambulatory Oncology Practice: Analysis of Productivity, Revenue, and Provider and Patient Satisfaction. Journal of Oncology Practice. 2009;5(4):188-192.
14. Institute of Medicine. Addressing the Challenges of an Aging Population. In: Levit L BE, Nass S, et al, ed. Delivering High-Quality Cancer Care: Charting a New

Course for a System in Crisis. Washington (DC): National Academies Press, 2013.

15. American Medical Association. AMA Physician Masterfile. 2016; http://www.ama-assn.org/ama/pub/about-ama/physician-data-resources/physician-masterfile.page. Accessed March 22, 2016.

16. Institute of Medicine. Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis. Washington, DC: National Academy of Sciences; 2013.

17. Brownlee S, Colucci, J. & Walsh, T. Productivity and the Health Care Workforce. Washington, DC: New America Foundation;2013.

18. Pham MT, Rajic A, Greig JD, Sargeant JM, Papadopoulos A, McEwen SA. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. Res Synth Methods. Dec 2014;5(4):371-385.

19. Wilson K. The evolution of the role of nurses: the history of nurse practitioners in pediatric oncology. Journal of pediatric oncology nursing : official journal of the Association of Pediatric Oncology Nurses. Sep-Oct 2005;22(5):250-253.

20. AANP. Discussion Paper: Doctor of Nursing Practice. 2015; http://www.aanp.org/images/documents/publications/doctorofnursingpractice.pdf. Accessed June 10, 2015, 2015.

21. Chattopadhyay A, Zangaro GA, White KM. Practice Patterns and Characteristics of Nurse Practitioners in the United States: Results From the 2012 National Sample Survey of Nurse Practitioners. The Journal for Nurse Practitioners. 2015;11(2):170-177.

22. Mundinger M, Kane, R., Lenz, E., Tsai, W., Cleary, P., Friedwald, W., Siu, A., Shelanski, M. . Primary Care Outcomes in Patients Treated by Nurse Practitioners or Physicians. Journal of the American Medical Association. 2000;283(1):59-68.

23. Laurant M, Reeves, D., Hermens, R., Braspenning, J., Grol, R., & Sibbald, B. Substitution of doctors by nurses in primary care. Cochrane Database of Systematic Reviews. 2004(4).

24. Fletcher C, Baker, J., Copeland, L., Reeves, P. & Lowry, J. Nurse Practitioners' and Physicians' Views of NPs as Providers of Primary Care to Veterans. Journal of Nursing Scholarship. 2007;39(4):358-362.

25. Everett C, Schumacher, J., Wright, A. & Smith, M. . Physician Assistants and Nurse Practitioners as a Usual Source of Care. Journal of Rural Health. 2009;25(4):8.

26. Salsberg EG, A. . Physician Workforce Shortages: Implications and Issues for Academic Health Centers and Policymakers. Academic medicine : journal of the Association of American Medical Colleges. 2006;81(9):6.

27. Naylor MD, Kurtzman ET. The role of nurse practitioners in reinventing primary care. Health Affairs. May 2010;29(5):893-899.

28. Health Resources and Service Administration (HRSA). Non primary care Specialty and Subspecialty Clinician Supply Projections to 2025. In: HRSA, ed. Rockville, Maryland: U.S. Department of Health and Human Services; 2014.

29. Efron B, Stein C. The Jackknife Estimate of Variance. The Annals of Statistics. 1981;9(3):586-596.

30. Scheffler RM. Is There A Doctor in the House?: Market Signals and Today's Supply of Doctors. Stanford, CA: Stanford Univeristy; 2008.
31. Hamblin J. What Doctors Make. 2015; http://www.theatlantic.com/health/archive/2015/01/physician-salaries/384846/. Accessed June 10, 2015.
32. American Academy of Nurse Practitioners. 2015 Nurse Practitioner Compensation Survey. 2015.
33. Dall T, West, T., Chakrabarti, R. & Iacobucci, W. . The Complexities of Physician Supply and Demand: Projections from 2013 to 2025. Washington, DC: Association of American Medical Colleges;2015.
34. Vincent GV, V. The Next Four Decades The Older Population in the United States: 2010 to 2050. In: U.S. Census, ed. Washington, DC: U.S. Census Bureau; 2010.
35. Dall T, et al. Physician Supply and Demand: Projections to 2020. In: U.S. Department of Health and Human Services Health Resources and Service Administration, ed 2006.
36. Bernstein AB, Hing, E., Moss, A.J., Allen, K., Siller, A. & Tiggle, R. . Healthcare in America: Trends in Utilization. Hyattsville, MD: National Center for Health Statistics;2003.
37. Fairman J, Rowe, J., Hassmiller, S. & Shalala, D. Broadening the Scope of Nursing Practice. New England Journal of Medicine. 2011;364:193-196.
38. Auerbach D. Will the NP Workforce Grow in the Future? Medical Care. 2012;50(7):5.

39. Stange K. How does provider supply and regulation influence health care markets? Evidence from nurse practitioners and physician assistants. Journal of Health Economics. Jan 2014;33:1-27.

40. Wiltse Nicely KL, Fairman J. Postgraduate nurse practitioner residency programs: supporting transition to practice. Academic Medicine : Journal of the Association of American Medical Colleges. Jun 2015;90(6):707-709.

41. American Cancer Society. Cancer Facts & Figures 2014. Atlanta: American Cancer Society;2014.

42. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2012. CA: A cancer journal for clinicians. Jan-Feb 2012;62(1):10-29.

43. Xu Z, Taylor JA. Genome-wide age-related DNA methylation changes in blood and other tissues relate to histone modification, expression and cancer. Carcinogenesis. Feb 2014;35(2):356-364.

44. American Socity of Clinical Oncology. The State of Cancer Care in America, 2014: A Report by the American Society of Clinical Oncology. Journal of Oncology Practice. 2014;10(2):25.

45. Yang W, Williams, J. H., Hogan, P. F., Bruinooge, S. S., Rodriguez, G. I., Kosty, M. P., Bajorin, D. F., Hanley, A., Muchow, A., McMillan, N. & Goldstein, M. Projected supply of and demand for oncologists and radiation oncologists through 2025: an aging, better-insured population will result in shortage. Journal of Oncology Practice / American Society of Clinical Oncology. Jan 2014;10(1):39-45.

46. Towle E, Barr, T., Hanley, A., Kosty, M., Williams, S., Goldstein, M. . Results of the ASCO Study of Collaborative Practice Arrangements. Journal of Oncology Practice. 2011;7(5):278-282.

47. American Academy of Nurse Practitioers (AANP). Nurse Practitioner State Practice Environment. 2015.

48. U.S. Department of Health and Human Services Health Resources and Service Administration BHP. The Physician Workforce: Projections and Research into Current Issues Affecting Supply and Demand. In: Professions US Department of HRSA BHP, ed. Rockville, MD2008.

49. Cooper JM, Loeb SJ, Smith CA. The primary care nurse practitioner and cancer survivorship care. Journal of the American Academy of Nurse Practitioners. Aug 2010;22(8):394-402.

50. Colquhoun HL, Levac D, O'Brien KK, et al. Scoping reviews: time for clarity in definition, methods, and reporting. J Clin Epidemiol. Dec 2014;67(12):1291-1294.

51. Daudt H, van Mossel, C. & Scott, S. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. BMC Medical Research Methodology. 2013;13:9.

52. Alberani V, De Castro Pietrangeli P, Mazza AM. The use of grey literature in health sciences: a preliminary survey. Bulletin of the Medical Library Association. Oct 1990;78(4):358-363.

53. Erikson C, Salsberg, E. & Yamagata, H. . Oncology Workforce Report. AAMC Center for Workforce Studies;2005.

54. Friese C, Hawley, S., Griggs, J., Jagsi, R., Graff, J., Hamilton, A. et al. . Employment of Nurse Practitioners and Physician Assistants in Breast Cancer Care. Journal of Oncology Practice. 2010;6(6):5.

55. Britell JC. Role of advanced nurse practitioners and physician assistants in washington state. Journal of oncology practice / American Society of Clinical Oncology. Jan 2010;6(1):37-38.

56. McCorkle R, Engelking, C., Lazenby, M., Davies, M., Ercolano, E. & Lyons, C. Perceptions of Roles, Practice Patterns and Professional Growth Opportunities: Boradening the Scope of Advanced Practice in Oncology. Clinical Journal of Oncology Nursing. 2012;16(4):5.

57. Vichare A, Washington R, Patton C, et al. An assessment of the current US radiation oncology workforce: methodology and global results of the American Society for Radiation Oncology 2012 Workforce Study. International Journal of Radiation Oncology, Biology, Physics. Dec 1 2013;87(5):1129-1134.

58. Chandak A, Loberiza, F., ,Deras, M., Armitage, J., Vose, J. & Stimpson, J. Estimating the State-Level Supply of Cancer Care Providers: Preparing to Meet Workforce Needs in the Wake of Health Care Reform. *Journal of Oncology Practice.* 2014;11(1):6.

59. Dyar S, Lesperance M, Shannon R, Sloan J, Colon-Otero G. A nurse practitioner directed intervention improves the quality of life of patients with metastatic cancer: results of a randomized pilot study. Journal of palliative medicine. Aug 2012;15(8):890-895.

60. Bakitas M, Doyle Lyons, K., Hegel, M., Balan, S., Brokaw, F., Seville, J., Hull, J. et al. Effects of a Palliative Care Intervention on Clinical Outcomes in Patients with Advanced Cancer. JAMA 2009;302(7):9.

61. American College of Graduate Medical Education. The ACGME 2011 Duty Hour Standards: Enhancing Quality of Care, Supervision, and Resident Professional Development. The 2003 Common Standards and Their Effect Chicago, IL: ACGME; 2011.

62. Siegel R, Miller, K. & Jemal, A. Cancer Statistics, 2017. CA: A Cancer Journal for Clinicians. 2017;67(1):23.

63. Smith BD, Smith GL, Hurria A, Hortobagyi GN, Buchholz TA. Future of cancer incidence in the United States: burdens upon an aging, changing nation. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. Jun 10 2009;27(17):2758-2765.

64. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2015. CA: A Cancer Journal for Clinicians. Jan-Feb 2015;65(1):5-29.

65. Institute NC. SEER: Surveillance, Epidemiology, and End Results. 2018; https://seer.cancer.gov/about/factsheets/SEER_brochure.pdf. Accessed March 4, 2018.

66. Institute NC. SEER-Medicare: About the Data Files. 2016. Accessed August 28, 2016.

67. U.S. Department of HEalth and Human Services. 2013 Poverty Guidelines. 2013; https://aspe.hhs.gov/2013-poverty-guidelines. Accessed February 20, 2018.

68. American Cancer Society: Facts and Figures 2017. 2017; https://http://www.cancer.org/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2017.

69. Office of the Secretary HIPPA Administrative Simplification: Standard Unique Health Identifier for Health Care Providers. In: U.S. Department of Health and Human Services, ed. Vol Vol. 69: Federal Register; 2004.

70. Centers for Medicaid and Medicare Services CMS. Taxonomy. 2016; https://http://www.cms.gov/medicare/provider-enrollment-and-certification/medicareprovidersupenroll/taxonomy.html. Accessed April 29, 2016.

71. Bindman AB. Using the National Provider Identifier for health care workforce evaluation. Medicare & medicaid research review. 2013;3(3).

72. Perloff J, DesRoches CM, Buerhaus P. Comparing the Cost of Care Provided to Medicare Beneficiaries Assigned to Primary Care Nurse Practitioners and Physicians. Health Services Research. Dec 27 2015.

73. American Society of Clinical Oncology (ASCO). The State of Cancer Care in America. *Journal of Oncology Practice.* 2015;11(5):37.

74. Loresto FLJ, Jupiter, D. & Kuo, Y.F. Examining differences in characteristics between patients receiving primary care from nurse practitioners or physicians using Medicare Current Beneficiary Survey data and Medicare claims data. . Journal of the American Association of Nurse Practitioners. 2017;29:8.

75. DesRoches CM, Gaudet J, Perloff J, Donelan K, Iezzoni LI, Buerhaus P. Using Medicare data to assess nurse practitioner-provided care. Nursing Outlook. Nov-Dec 2013;61(6):400-407.

76. Buerhaus PI, DesRoches CM, Dittus R, Donelan K. Practice characteristics of primary care nurse practitioners and physicians. Nursing Outlook. Mar-Apr 2015;63(2):144-153.

77. Bishaw A. Areas with Concentrated Poverty: 2006-2010. United States Census Bureau; 2011.

78. Lyon J. U.S. to Increase Efforts to Reduce Rural Cancer Toll. Journal of American Medical Association. 2017;318(12).

79. Singh RG, L.J. Rural Disparities in Cancer Care: A Review of Its Implications and Possible Interventions. West Virginia Journal. 2016;112(3):7.

80. Ricci S, Tergas, A., Long Roche, K., Gerardi Fairburn, M., Levinson, K.L. et al. . Geographic disparities in the distribution of the U.S. gynecologic oncology workforce: A Society of Gynecologic Oncology study. Gynecologic Oncology Reports. 2017;22:5.

81. Gamm LD, Hutchinson, L.L., Dabney, B.J. & Dorsey, A.M., Ed. Rural healthy people 2010, a companion document to Healthy People 2010 volume 1. College Station, TX: The Texas A & M University System Health Science Scenter; 2003; No. 1.

82. Boscoe FP, Henry, K.A., Sherman, R.L. & Johnson, C.J. The relationship between cancer incidence, stage, and poverty in the United States. International Journal of Cancer. Aug 1 2016;139(3):6.

83. Marken S. U.S. uninsured rate 11.9% in fourth quarter in 2015. *Gallup* 2016; http://www.gallup.com/188045/uninsured-rate-fourth-quarter-2015.aspx. Accessed April 8, 2016, 2016.

84. Schootman M, Jeffe, D.B., Baker, E.A. & Walker, M.S. Effect of area poverty reate on cancer screening across US communities. Journal of Epidemiology and Community Health. 2006;60(3).

85. Meilleur A, SUbramanian, S.V., Plascak, J.J., FIsher, J.L., Paskett, E.D. & Lamont, E.B. Rural Residence and Cancer Outcomes in the U.S.: Issues and Challenges. Cancer Epidemiol Biomarkers Prevention: A Publication of the American Association for Cancer Research. 2013;22(10):10.

Publishing Agreement

It is the policy of the University to encourage the distribution of all theses, dissertations, and manuscripts. Copies of all UCSF theses, dissertations, and manuscripts will be routed to the library via the Graduate Division. The library will make all theses, dissertations, and manuscripts accessible to the public and will preserve these to the best of their abilities, in perpetuity.

Please sign the following statement:

I hereby grant permission to the Graduate Division of the University of California, San Francisco to release copies of my thesis, dissertation, or manuscript to the Campus Library to provide access and preservation, in whole or in part, in perpetuity.

Author Signature

May 18, 2018

Date