THE EFFECT OF GERIATRIC CARE ON HEALTH CARE USE

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ABSTRACT

Laura Paser D'Arcy: The Effect of Geriatric Care on Health Care Use
(Under the direction of Sally C. Stearns)

Health care for older adults with chronic conditions is costly and often of suboptimal quality. The quality of health care for geriatric conditions such as dementia and incontinence may be considerably poorer than for chronic disease such as diabetes and hypertension. Geriatricians have extensive training in and experience with physical, mental, cognitive, and social issues related to aging. Many elders might benefit from geriatric care; however, the current and projected future supply of geriatricians is limited. An understanding of the use and effects of geriatric care will help to ensure that the existing supply of geriatricians is used efficiently and provide information about possible benefits of expending supply. The purpose of this dissertation is to describe the use of geriatric care, to evaluate whether geriatric care reduces emergency department use, and to determine whether geriatric care is typically used in lieu of or in combination with care from other types of physicians.

Using Medicare claims data for a national sample of elders who had a recent hospitalization for acute coronary syndromes and subsequent diagnosis of a geriatric condition, we found that very few patients received geriatric care. Use of geriatric care was closely tied to metropolitan status and nursing home residency. Geriatric care was associated with reduced emergency department use for both community and nursing home residents. Geriatric consultative care was associated with a reduction in emergency

department use that was not statistically different from the reduction associated with geriatric primary care. Geriatric care was associated with fewer visits to family and internal medicine physicians and in some cases with fewer visits to specialists.

Although our results suggest that geriatric care reduces emergency department use, the total clinical impact of geriatric care is likely to be very small because of the low supply of geriatricians. Because of the lack of existing literature on the topic, additional studies are needed to elucidate the use and effects of geriatric care in real-world clinical settings. However, for geriatric medicine to have a population-level impact on the health and health care of older adults, its focus may need to be on teaching, research, and advocacy/policymaking.

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PREFACE

This dissertation is organized in a non-traditional format. The first chapter provides an introduction to the aims of the dissertation and a statement of the significance of the work. Chapter 2 provides the background, literature review and conceptual framework for the dissertation. Chapter 3 describes the data and the methodology used to address the three research questions in this dissertation. Chapters 4, 5 and 6 are manuscripts for the three studies in this dissertation. These three chapters must stand alone as manuscripts to be submitted for publication and have some redundancies with the earlier chapters. The three manuscripts in this dissertation are referred to as Study 1 (Chapter 4), Study 2 (Chapter 5), and Study 3 (Chapter 6). Chapter 7 presents a synthesis of the findings, strengths and limitations, and policy implications of the three studies and provides directions for future research.

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LIST OF ABBREVIATIONS

2SRI – Two-stage residual inclusion

ABMS – American Board of Medical Specialties

ACS – Acute coronary syndromes

AMA – American Medical Association

CGA – Comprehensive geriatric assessment

ED – Emergency department

FE – Fixed effects

FM – Family medicine

GEM – Geriatric evaluation and management

GM – Geriatric medicine

NH – Nursing home

IM – Internal medicine

IV – Instrumental variables

LPM – Linear probability model

MedPAR – Medicare Provider Analysis and Review

NPI – National provider identifier

NP – Nurse practitioner

OLS – Ordinary least squares

PA – Physician Assistant

UPIN – Unique provider identification number

RCT – Randomized controlled trial

SNF – Skilled nursing facility

1. INTRODUCTION

The growth in the number of elderly Americans, especially those aged 85 years or older, is increasing pressure on the health care system in the United States. Health care for older adults with chronic conditions is costly and often of suboptimal quality [1]. Nearly a quarter of elderly Medicare beneficiaries have four or more chronic conditions, and average Medicare expenditures per capita for this group are more than eight times higher than for beneficiaries with three or fewer chronic conditions [2]. The quality of health care for geriatric conditions such as dementia and incontinence may be considerably poorer than for chronic diseases such as diabetes and hypertension [3]. The term "geriatric condition" is defined precisely in Chapter 2; it refers to conditions that increase in prevalence with age (e.g., stroke, hearing impairment) as well as geriatric syndromes, which are clinical conditions that do not fit into distinct clinical categories (e.g., falls, weight loss/malnutrition) [4].

Comprehensive primary care programs may be beneficial for elders with multiple chronic diseases, geriatric conditions, or other complex health care needs, but these programs are not widely available [5]. Most elders receive primary care from family medicine/general practice or general internal medicine (FM/IM) physicians. About 15% of elders replace traditional primary care with health care from specialists [6]. Very few elders receive primary or specialty care from geriatricians. Geriatricians are FM/IM physicians who are certified in geriatric medicine (GM). While geriatrician supply has declined from 8,824 to 6,756 in the last fifteen years, the number of elders is projected to

increase 90% from nearly 37 million to 70 million between 2005 and 2030 [7, 8]. In the literature, the term “geriatric care” is used in two contexts: to refer to care provided to elders by any type of provider, and to refer to care provided by geriatricians. We use the term “geriatric care” to refer to care provided by geriatricians.

Given the small number of board-certified geriatricians and the large number of older patients, health care for elders is a shared responsibility of primary care physicians, specialists and geriatricians. However, training for FM/IM physicians and specialists may be inadequate for several competencies related to elderly patients, including recognition and management of geriatric conditions, transitional care, assessment of caregiver and family needs, and coordination of care [9-12]. Geriatricians’ training targets these and other related skills, and geriatricians often work in collaboration with other disciplines including nursing, pharmacy, physical and occupational therapy, and social work [13].

1.1. Specific aims

This dissertation includes three studies. The aims for the three studies were as follows:

Aim 1: Describe the frequency of geriatric care, patient characteristics associated with geriatric care, and trends in the use of geriatric care.

Study 1 provides novel data on the use of geriatric care by a broad sample of Medicare beneficiaries. Using the beneficiary as the unit of observation, we described the frequency of geriatric care in hospital and non-hospital settings. Bivariate and multivariate models indicated whether demographic characteristics and comorbidities were related to the use of geriatric care. Patterns of the use of geriatric care over time

were assessed.

Aim 2: Analyze the effect of geriatric care on ED use.

Study 2 was based on the hypothesis that the knowledge, skills, and experience of a geriatrician may enable him or her to provide care to a beneficiary that reduces the likelihood of ED use compared to people who receive care from other types of physicians. We examined whether geriatric care provided during a six month period was associated with reduced ED use in the following month. Several measures of geriatric care were used to provide a multi-dimensional picture of the association of geriatric care with ED use. Fixed effects (FE) were used to account for unobservable factors that may have affected both geriatric care and ED use. Separate analyses were conducted for community residents and long-term NH residents, because NH residence is an indicator of frailty and complex health care issues that are difficult to measure in claims data. We also conducted a supplementary analysis examining the association between geriatric care and in-hospital death.

Aim 3: Assess whether geriatric care is associated with the use of FM/IM physicians and specialists.

Geriatricians may function in practice as primary care physicians or as specialists who provide consultative (i.e., intermittent) care. In Study 3, we assessed whether geriatric care acts as a substitute or complement for other types of care by estimating the association of geriatric care in a six month period with visits to FM/IM physicians and visits to specialists in the following six months. As in Study 2, we used FE to account for unobservable factors that may have affected both geriatric care and visits to other physicians, and separate analyses were conducted for community residents and NH

residents.

1.2. Summary of significance

Limitations in the current supply and a projected future shortage of geriatricians in the United States have been well-documented [4, 14]. In light of these supply constraints, understanding to whom, how frequently, and in what settings geriatric care is provided as well as whether geriatric care tends to be a substitute or complement for other types of physician care is critical to ensuring that geriatric care is used efficiently. However, patient-level data on the use of geriatric care are not available in the literature. Further, the effects of geriatric care provided in real-world settings are unknown. A number of interdisciplinary geriatric interventions have been tested in randomized controlled trials in the past two decades. Evidence from these interventions suggests that highly coordinated, comprehensive, ongoing care in outpatient and in-home settings has favorable effects on some measures of health and health care use [15-20]. Evidence demonstrating the efficacy of interventions without ongoing care (i.e., consultative care only) in outpatient and home settings is scarce [21-23]. No studies were found that assessed geriatric interventions in NHs. Drawing conclusions about the effects of geriatric care in real-world settings from trials of geriatric interventions is challenging because of differences among trials and differences between geriatric care provided as part of trials versus outside of these interventions. Whether the favorable outcomes found in trials translate to improvements in outcomes in real-world settings is not known. The effect of geriatric care on ED use is of interest since ED use has increased in recent years, and reductions in ED use are desirable from the perspectives of patients, providers, payers, and society. Reliable evidence about the use and effects of geriatric care is

required in order to help policymakers, health professionals, and researchers develop strategies to distribute this scarce resource more efficiently and to inform broader discussion about effective models of care for elders with geriatric conditions.

2. BACKGROUND

Primary care has been defined as first-contact care that is longitudinal, comprehensive, and coordinated [24]. Adult primary care specialties traditionally include FM, IM, and general practice physicians without further subspecialty training. FM physicians are trained to care for all patients of all ages, while IM physicians typically treat adults only; according to the American Boards of Family Medicine (ABFM, formerly the American Board of Family Practice) and Internal Medicine (ABIM), however, the differences between these specialties are “not sharply defined” [25]. In this paper, we use the term “IM” to refer to general internists (i.e., excluding internal medicine subspecialists such as cardiologists) and the term “specialist” to refer to physicians other than FM/IM generalists and geriatricians.

2.1. Geriatrician training and supply

Three allopathic medicine specialties offer a certification in geriatrics: FM, IM, and psychiatry. Osteopathic physicians can also pursue a certification in geriatrics. The focus of the following discussion about geriatrician training refers to allopathic physicians, since by 2003, less than 5% of certifications in GM had been earned by osteopathic physicians [26]. Several major events related to the training and certification of geriatricians have occurred in the last four decades [26]. Training in GM began in the early 1970s with six fellowship programs. In 1988, the boards established a Certification of Added Qualification in GM; this certification is valid for ten years. Until 1994, physicians could qualify for the exam on the basis of substantial clinical experience

instead of a geriatrics fellowship. Geriatrics fellowships were initially required to last two years; in 1995, the boards changed the requirement for length of fellowships to one year. Although physicians can choose additional years of GM fellowship training, this practice is uncommon. Since 2003-2004, geriatrics fellows in the second year and beyond have accounted for no more than 18% of all geriatrics fellows [27].

Since July 1, 2006, the American Board of Internal Medicine has considered GM to be a subspecialty, while the American Board of Family Medicine continues to recognize GM with a certification [28]. The difference between a certification and a subspecialty is a difference in name only. FM-trained geriatricians are required to maintain their primary certification in FM, whereas IM-trained geriatricians can have their primary certification in IM or GM. The majority of geriatricians are trained in IM; from 1998 to 2008, approximately 80% of GM certifications were awarded to internists [29].

Although nearly all FM/IM residency programs require geriatric clinical experience, most require less than one month of clinical time devoted to geriatric training during the three year residency [11, 12]. This level of training stands in stark contrast to a recommendation from the Institute of Medicine that FM/IM residents receive nine months of geriatric experience [30]. Training requirements typically do not include geriatrics-related foci such as recognition and treatment of geriatric syndromes, transitional care, and use of inappropriate medications [10]. FM/IM residents encounter elderly patients outside of the structured geriatric training period; however, exposure without structured training may be insufficient to prepare residents to address the complex and varied problems commonly faced by elderly patients, including not only

physical and mental health problems but also issues related to independence, caregivers, and social support. Because of their additional training and experience, geriatricians have a number of skills that distinguish them from FM/IM physicians (see Table 2.1). Small-scale studies have provided some limited evidence about the processes of geriatric care. Noting the lack of empirical work examining whether fellowship-trained geriatricians deliver higher-quality care to older adults for geriatric conditions than providers without formal geriatric training, Phelan and colleagues [31] used data on 140 elderly patients receiving primary care at a medical center in the Pacific Northwest to study processes of care. Geriatricians were likely to have fewer instances of potentially inappropriate prescribing and more assessments of geriatrician syndromes than FM/IM physicians. A study at five clinics in Israel suggests that geriatricians may be particularly likely to recommend prescription drug modification and physical or occupational therapy [32]. In general, however, a paucity of data exist on whether the quality of medical care differs between geriatricians and other physicians [33].

Geriatrician supply in the United States has been a concern for years [4, 14]. The number of geriatricians in the US decreased from 9,256 in 1998 to 7,128 in 2007 [27, 34]. Because of the growth of the elderly population, an estimated 36,000 geriatricians will be needed to achieve the same geriatrician to elderly population ratio in 2030 as existed in 2002 [35]. Yet current graduation rates from geriatrics fellowship programs suggest that there will be only 7,750 geriatricians [36]. In recent years, a majority of GM fellows have been international medical graduates. Since the change to the one year fellowship requirement in 1995, the share of GM fellows who are international medical graduates has ranged from 51.6% (2002-2003) to 68.5% (2007-2008) [37].

One factor affecting geriatrician supply is reimbursement for geriatric services, which is the same or lower than reimbursement to FM/IM physicians despite the higher amount of uncompensated care that may be required for a geriatric patient population (e.g., interdisciplinary team care, case management occurring outside of a visit with a patient) [14]. The recent Institute of Medicine report titled "Retooling for an Aging America: Building the Health Care Workforce" made two recommendations applicable to both geriatricians and other health care professionals (e.g., geriatric nurse practitioners): increasing reimbursement for clinical services delivered to elders by practitioners with a certification in geriatrics, and instituting programs for loan forgiveness, scholarships, and direct financial incentives [4]. As a result of the passage of the Patient Protection and Affordable Care Act, steps are being taken to increase reimbursement for geriatric care and support the development of geriatricians as well as non-physician providers of care to the elderly, although the effect of these policy changes on geriatrician supply will not be known for quite some time [38].

2.2. Provision of geriatric care

The proper role of geriatricians in the health care system has been widely debated. Callahan and colleagues [39] discuss three approaches to GM: focus on persons most in need, consultative care, and health system design. In the first approach, geriatricians provide comprehensive primary care for elders who generally have a high need for geriatric care defined by disability, geriatric syndrome, or site of care (e.g., nursing home (NH)). In the second approach, geriatricians provide consultation to a broader range of elders, affecting health care through the care provided by other primary care providers. In

the third approach, geriatricians contribute to health care administration and health system design to improve health care for older adults.

Few data are available which address whether one of these approaches is a more common and/or more effective use of geriatricians' services than the other approaches. About 44% of respondents to a survey of geriatricians whose fellowships occurred in the 1990s reported that the focus of their current position is essentially all geriatrics [40]. Other respondents said their primary focus was geriatrics with a secondary focus in IM (19%), FM (6%), or another specialty (6%). About one-quarter of respondents reported that geriatrics was the secondary focus of their current practice. Unlike FM/IM physicians who typically provide primary care, geriatricians commonly provide both primary and consultative care. Among respondents to a survey of geriatricians whose fellowships occurred in the 1990s, 64% reported that they engage in outpatient primary care, and 60% reported conducting outpatient comprehensive assessment [40].

Site of care differs among specialties. Claims data from 1998 for a nationally representative sample of Medicare beneficiaries show that geriatricians are substantially more likely to provide care in a NH and less likely to provide care in an office than family medicine and general internal medicine (FM/IM) physicians [41]. In that study, nearly 27% of GM claims originated in NHs compared to 7% for FM/IM claims. The reverse was found for office visits: 72% for FM/IM compared to 47% for geriatricians. Although NH care comprises a larger share of geriatricians' practices than it does for FM/IM physicians, the small number of geriatricians compared to FM/IM physicians means that most physicians who provide NH care have no specialized geriatric training [42]. Further, although most NH medical directors serve as attending physicians for at

least some of the residents in their NHs [33], only 30% of NH medical directors are certified in GM [43].

2.3. Evidence on the effect of geriatric care

Interventions that aim to improve health care outcomes for older adults have been implemented in a host of settings. Many interventions have had no geriatrician involvement, and some have no physician involvement (the primary interventionist is typically a nurse practitioner, nurse, or social worker). The following discussion focuses largely on interventions that have included geriatricians. Existing evidence on the effect of geriatric care comes largely from randomized controlled trials (RCTs) of comprehensive geriatric assessment (CGA). CGA is a multidimensional, interdisciplinary process that determines an individual's medical, psychosocial, functional, and environmental resources and problems, aims to improve diagnostic accuracy and optimize drug prescribing, and develops a coordinated plan for treatment and follow-up [44-46]. CGAs that provide continuing care are frequently referred to as geriatric evaluation and management (GEM). In contrast to GEM, other CGAs provide consultative care only (i.e., little or no follow-up after the initial assessment). In this case, an individual's primary care physician, who is usually not directly involved in the CGA, determines to what extent the plan of care developed during the CGA is followed. A literature review on adherence to recommendations of eight outpatient and home-based consultative CGA found that physician adherence ranged from 49% to 79% [47].

The interdisciplinary teams involved in CGA typically include geriatricians, nurse practitioners or nurses, and social workers; less commonly, pharmacists, physical therapists, or occupational therapists are included. The role of geriatricians in these

programs varies and is sometimes unclear. A geriatrician may play the leading role in the intervention team, work closely with the primary interventionist (typically a nurse practitioner or nurse), or participate in a less intensive way.

2.3.1. RCTs: Inpatient

A number of RCTs have examined the effects of GEM and consultative CGA in hospitals. The majority of these studies occurred prior to the year 2000 and were in Veterans Administration medical centers; most hospitals have not adopted or considered adopting inpatient GEM [48, 49]. A meta-analysis of GEM by Stuck et al. found favorable changes in mortality at six months, living at home at six and twelve months (alive and not hospitalized), physical function, and cognitive function [44]. Results for consultative CGA were less positive; cognitive function increased, but there was no effect on mortality, living at home, or physical function.

Ellis and Langhorne used the same meta-analysis methodology as Stuck et al. and concluded that results of more recent GEMs were less favorable than results from earlier interventions [45]. The rate of living at home was substantially higher among GEM participants, but no effect was seen on mortality. Neither recent GEMs nor recent consultative CGAs have provided strong evidence of a favorable effect on physical and cognitive function, although the authors did not conduct a formal meta-analysis of consultative CGA results. In sum, evidence of the effectiveness of hospital-based GEM and consultative CGA programs is weak. No studies were found that assessed the effect of GEM or consultative CGA in NHs.

2.3.2. RCTs: Outpatient and in-home

Because of the high cost of hospital care, many of the more recent CGAs have been implemented in outpatient or home settings [15]. Like inpatient interventions, outpatient and in-home GEMs and consultative CGAs have produced results that are mixed; however, their results are more positive than results from hospital-based programs. Older trials of GEM and consultative CGA did not produce promising results in either setting. A meta-analysis of ten in-home programs (eight GEM and two consultative CGA) and four outpatient programs (three GEM and 1 consultative CGA) found few significant effects of those programs on morality, living at home, and physical and cognitive function [44].

More recent evidence demonstrating the effectiveness of outpatient and in-home consultative CGA is also scarce. One intervention reported no effects on physical or cognitive function, NH admission, ED use, or mortality [21]. Another found improved mental health after twelve months but no effects on mortality or a variety of measures of physical and mental function [17]. Consultative CGA for patients discharged home after an ED visit produced a decrease in NH admissions at thirty and 120 days for high-risk patients [22]. No effects were found for low-risk patients or for subsequent ED use, hospitalization, or costs at thirty or 120 days. No effects were seen for elective hospitalizations, NH admission, or mortality. A more recent trial of outpatient consultative CGA coupled with an intervention to increase adherence to recommendations showed an increase in the prevention of functional decline [23]. A trial of in-home consultative CGA lasting four weeks after discharge from the emergency department (ED) resulted in reductions in the total number of hospitalizations as well as ED use alone; favorable effects were also seen for physical and cognitive function [50].

Compared to hospital-based GEM and consultative CGA in any setting, evidence on the effectiveness of outpatient and in-home GEM is much more favorable. Outpatient GEM has shown favorable effects on physical functioning [15, 16] and mental or cognitive health [15, 17, 18]. Some outpatient GEMs have produced either cost reductions or no increase in costs [15-17, 51]. Yet these programs have failed to reduce NH use and hospitalizations [15, 17, 18]. A meta-analysis of nine outpatient CGAs (six GEM and three consultative) found no effect on survival [20].

In a meta-analysis of eighteen in-home interventions, only two included a geriatrician [52]. One of those two interventions showed a reduction in the risks of NH admission and functional status decline but no effect on mortality; the other intervention produced no significant effects on any of the three measures. Participants in an in-home GEM intervention not included in that meta-analysis had a reduced rate of decline in physical and cognitive function and lower likelihoods of hospital admission and ED use [19]. The Geriatric Resources for Assessment and Care of Elders (GRACE) trial of in-home GEM for low-income elders reported lower ED use and hospital admissions among the subsample at high risk of hospitalization [53]. Among the full sample, no improvements in mortality or physical function were found but other measures including general and mental health improved. This RCT was the only one located which compared process measures in addition to outcome measures. Receipt of information about urinary incontinence and falls for those reporting the condition at baseline, presence of health care representative or living will, and presence of a medication list were higher among intervention participants. In sum, evidence of the effectiveness of outpatient and in-home

GEM, and to a less extent outpatient and in-home consultative CGA, is mixed but promising.

2.3.3. Analyses using observational data

Although GEM has features similar to primary care by geriatricians and consultative CGA has features similar to consultative care by geriatricians, they differ in important ways from primary care and consultative care by geriatricians in the community. The high degree of coordinated, interdisciplinary care found in most GEM and consultative CGA interventions does not represent the experience of most patients seeing geriatricians. Additionally, since the level of geriatrician involvement in interventions varies widely, it is difficult to characterize how the geriatrician impacts outcomes. In order to assess the effects of geriatric care more broadly than studies of CGA, we located a handful of analyses that explicitly measured the effect of geriatric care using observational data. Some observational studies have also examined the effect of geriatric care for particular subpopulations such as hip fracture patients [54, 55], but a review of that literature is outside the scope of this dissertation.

At a clinic in Washington, 146 elders participated in an intervention which consisted of two visits with a geriatrician [56]. One visit was a systematic assessment, screening, and examination, and the other visit was a problem-solving session aimed at reducing threats to functional independence and promoting chronic disease self-management. Participants were matched 1:3 with controls at other clinics based on sex and a propensity score computed using demographic, clinical, and health care utilization data. Hospitalization rate and total health care costs were lower among intervention

participants; no effects were found for mortality, NH admission, outpatient or specialty visits, or high-risk prescriptions.

In a study of 512 patients at five clinics in central Israel who were referred to a geriatrician from June 2003 through October 2006, the only outcome measure examined was the difference in the number of visits to the primary care provider in the six months before and after the geriatrician consultation [32]. No control group was used. The difference was small but statistically significant (mean of 10.9 visits before and 10.2 visits after). Although the authors reported that visit reduction did not differ by group (e.g., age, cognitive function), no multivariable model was estimated.

Another paper examined potentially inappropriate prescribing among elderly VA patients with at least one outpatient clinic visit and one medication during the study period [57]. The study included one individual and one facility measure of geriatric care. Potentially inappropriate prescribing was significantly less likely among patients who had at least one inpatient or outpatient geriatric visit. In contrast, whether the patient was in a facility where the proportion of patients with at least one geriatric visit exceeded the median of all facilities in the sample had no association with potentially inappropriate prescribing.

Each of these three studies offers some information about how geriatricians may have different effects than FM/IM physicians, but their limitations are substantial. The studies had substantially different samples, measures of geriatric care, and outcomes; therefore, a comparison of their results is difficult. The studies had limited external validity. None of the study populations was nationwide; two were restricted to a single geographic location, and the third was restricted to the Veteran's Affairs system. Finally,

an important limitation common to all three studies is that they failed to address unobserved variables that may affect both the use of a geriatrician and the outcome measure. An inability to observe factors such as functional status, longevity expectations, and health-care seeking behavior that could plausibly affect both geriatrician use and health outcomes makes estimating a causal effect of geriatrician visits on outcomes challenging.

2.4. Who should visit a geriatrician?

The published literature does not provide formal evidence or consensus on conditions for which geriatric care is most likely to be beneficial. Information about which groups are expected to benefit can be gathered from two sources: sample selection criteria used in RCTs of CGA and a 2008 survey of directors of geriatrics academic programs which asked to what degree elders would be likely to benefit from geriatric care (Table 2.2) [28]. Most trials have had lengthy sample selection criteria. These include criteria that must be met by every patient (e.g., geographic location, demographic characteristics) and a list of additional criteria of which one or two must be met by each patient (e.g., particular health conditions). The criteria are designed to select individuals who are most likely to respond to intervention.

Health conditions used as sample selection criteria for RCTs of geriatric interventions fall into three categories: physical health, mental and neurological health, and geriatric syndromes. Interventions that use indicators of poor physical health to define the sample typically include chronic diagnoses such as diabetes and heart disease [15, 18, 53, 58]. The most commonly used indicators of mental and neurological health used by RCTs of geriatric interventions are dementia and delirium/confusion [17, 58-60]

as well as depression [58, 59, 61]. Mental and neurological health indicators are used more frequently than physical health indicators. Stroke may be considered a measure of physical health or neurological health [17, 59]. Other conditions used to select samples for trials fall under the broad category of geriatric syndromes, which are health conditions that are strongly associated with advanced chronologic age. Functional status is a strong predictor of health outcomes and is probably the most widely used characteristic for recruitment into RCTs of geriatric interventions [17, 18, 51, 58-64]. Four other conditions are used less frequently than functional status but are still common: (1) bed rest/immobility [17, 59]; (2) falls or impaired gait and balance [17, 58, 59, 61]; (3) incontinence [17, 59-61], and (4) weight loss/malnutrition/failure to thrive [17, 59].

In addition to health conditions, RCT investigators have used demographic factors and measures of health care use as indicators of which elders might benefit from geriatric care. Trials are typically conducted using only patients in a particular setting (e.g., hospital, community). Nearly all studies have a minimum age for sample inclusion; the minimum age is usually 65. Some studies use 70 or 75 as the minimum age [15, 58, 62]. Trials have occasionally targeted populations on the basis of socioeconomic status or social/family problems [53, 59]. Finally, measures of health care use including hospital readmission, number of outpatient visits, and number of medications are used as sample selection criteria in a number of trials [15, 17, 51, 53, 56].

The idea that a multitude of conditions or characteristics may be indicative of the potential to benefit from geriatric care is supported by the results of a 2008 survey of directors of geriatrics academic programs [28]. Respondents were asked whether elders would be likely to benefit from geriatric care greatly, to some extent, to a small extent, or

not at all relative to primary, consultative, and hospital care from FM/IM physicians. Questions were posed about groups of elders by age, functional state, medical complexity, and geriatric syndromes (Table 2.2). The results of the survey are consistent with the sample selection criteria commonly used by RCTs of geriatric interventions. Based on both RCT criteria and the survey, old age alone appears to be an insufficient marker for potential to benefit from geriatric care. Only one-third of survey respondents reported that an individual aged 75 to 85 would greatly benefit from geriatric care. Most survey respondents indicated that elders with moderate to severe functional impairment would greatly benefit from geriatric primary care. This finding mirrors the high frequency with which activity of daily living restrictions appears in sample selection criteria for RCTs.

In addition to agreement on advanced age and functional impairment, three other characteristics that were most often reported to be indicative of greatly benefiting from geriatric care are closely tied to sample selection criteria used in RCTs: complex psychomedical problems (e.g., depression and dementia); complex biomedical problems (e.g., multiple comorbidities and immobility); and geriatric syndromes. In most cases, the share of respondents indicating that consultative or hospital geriatric care would provide a great benefit was similar to but slightly lower than the share indicating that primary geriatric care would provide a great benefit. In general, most of the conditions for which at least 80% of respondents reported the potential for a great benefit from geriatric care have been used frequently in RCT sample selection criteria. One case in which this is not true is frailty/vulnerability. A high proportion of respondents reported that frailty/vulnerability were indicative of the potential to substantially benefit from geriatric

care. These terms are not often used in sample selection for RCTs of geriatric interventions, perhaps because of the lack of clarity about how to measure these complex constructs.

2.5. Conceptual framework

This analysis examines the relationship between physician specialty and selected measures of health care use with a focus on the effects of geriatric care. From an economic perspective, a beneficiary maximizes his or her expected utility by making decisions intended to maintain or increase one's health capital. The choice of physician type may affect a beneficiary's health outcomes. For example, some health crises that lead to ED use may be able to be prevented by care by physicians trained in the spectrum of issues affecting elderly patients. Health status and several other factors internal and external to the beneficiary, described below, affect the specialty of the physician from which the beneficiary seeks care (Figure 2.1). Subsequently, the effect of physician type on health outcomes such as ED use arises via the knowledge, skills and experience of the physician in conjunction with beneficiary compliance with physician recommendations.

A beneficiary chooses the physician(s) whose care leads to the highest expected utility net of costs. Geriatricians are unique, because they are trained as both a primary care physician and a subspecialist. They can participate in a patient's care as the primary care physician or as a consultant. Since geriatric care may have heterogeneous treatment effects, an individual assesses the benefits and costs of geriatric care given their personal characteristics and expectations. The benefits and costs of geriatric care are applicable to both primary and consultative care from a geriatrician. In Study 2, we test whether the benefits are larger for primary geriatric care than for consultative geriatric care.

Health status may be the most important factor that affects whether a person chooses geriatric care. Patients who have poor or declining functional and cognitive status or geriatric syndromes are particularly well-suited to geriatric care; unlike FM/IM physicians and specialists, geriatricians have extensive training and experience caring for people with these conditions. In contrast, elders who are relatively healthy and those whose health conditions are less closely related to the aging process or have little effect on their functional and cognitive status (e.g., hypertension, diabetes) may be less likely to benefit from geriatric care relative to other types of care. Therefore, healthier elders and those with common chronic conditions may be less likely to choose geriatric care.

A beneficiary may be referred to geriatric care by a physician from whom they have previously received inpatient or outpatient care. For a NH resident, nursing home staff or the medical director may recommend geriatric care. In the case of referral, a beneficiary may value the expected benefit from geriatric care in part based on trust in the existing provider. Referral to geriatric care is more likely than self-referral, since anecdotal evidence suggests a general lack of knowledge about geriatric care. The ability of a beneficiary whose health is poor to identify and select alternatives to the existing patient-provider relationship may depend in large part on family and social support. Socioeconomic status (e.g., supplemental health insurance) may also affect the aggressiveness with which the beneficiary seeks options for health care.

Personal preferences such as time preference and longevity expectations may affect whether a person chooses geriatric care. Geriatricians' unique skill set enhances their ability to manage both medical and non-medical aspects of patients' care (e.g., providing support for caregiver and family decision-making, identifying available social

services). These types of non-medical care are likely to improve quality of life, but their impact on longevity is less clear. Therefore, a person who values present quality of life more than longevity may gain more utility from geriatric care than someone who pursues aggressive medical care with the intention of extending longevity at all costs. In other words, the effect of geriatric care on utility for a beneficiary who has a high discount rate may be larger than the effect of geriatric care for a beneficiary with a low discount rate.

The total individual costs of geriatric care are determined in part by socioeconomic status (e.g., supplemental health insurance), health status, physician referral, patient preferences, and geriatrician availability and location. A geriatrician may provide or recommend different types or amounts of care than a FM/IM physician or specialist for a patient with a particular health status. Care recommendations affect the out-of-pocket cost of physician care, since beneficiaries in fee-for-service Medicare have an annual deductible and 20% coinsurance (unless other insurance covers these costs). The nature of geriatric care may be such that more services or more expensive services are incurred initially, but the beneficiary consumes less health care over time than if he or she visited another type of physician. For example, a geriatrician may be more likely than other physicians to refer a patient who has functional status limitations to physical or occupational therapy. Although higher short-term costs would be incurred under geriatric care in this case, physical or occupational therapy may reduce the risk of falls; it follows that there may be a reduced risk of health care use that would be associated with the occurrence of a fall (e.g., ED use). Similarly, the short-term cost of geriatrician visits for medication management may be outweighed by a reduction in the longer-term risk of ED

use for adverse drug events. In either event, the cost of geriatric care over multiple periods may be lower than the cost of care from another type of physician.

In addition to socioeconomic status and health status, several other factors play a role in the non-monetary costs of geriatric care. Search costs are lower for beneficiaries whose provider refers them to geriatric care. Non-monetary costs are also affected by patient preference; some patients incur higher costs as a result of changing providers than other patients. These may include time costs due to filling out paperwork on one's medical history as well as the psychological cost of uncertainty. In most cases, a beneficiary has far less information than a physician about the options and likely outcomes of treatment [65]. Beneficiaries who are especially uncomfortable with this information asymmetry may incur a higher transaction cost from switching to geriatric care than beneficiaries who are less affected by uncertainty. For example, a beneficiary who has received care from the same physician for several years may experience higher transaction costs due to uncertainty than a beneficiary who does not have a long-standing relationship with a physician. Existing data suggest that most Americans prefer to have a long-term relationship with a single primary care provider, which implies that non-monetary costs associated with changing providers may have a substantial impact on whether a patient receives geriatric care [66-68]. Finally, the costs of geriatric care are not determined only by factors such as health status and preferences that are internal to the beneficiary. Physician location and availability are external to the beneficiary but also affect the cost of geriatric care. Conditional on local demand, low geriatrician supply implies more time required to wait for an appointment and to travel to appointments. This corresponds to higher costs for the beneficiary due to deteriorating health and travel.

Once a beneficiary has chosen care from a geriatrician or another type of physician, the physician's knowledge, skills, and experience determine the contribution of the physician to the beneficiary's health care use. In the case of consultative geriatric care, the degree to which the primary care physician complies with recommendations from the geriatrician also plays an important role in whether the geriatric consultation affects subsequent health care use. As described in Table 2.1, the marginal product of GM relative to other specialties is driven by skills such as diagnosis and management of acute and chronic conditions as well as involvement with other providers, social services, and caregivers. These features of geriatric care may allow beneficiaries who receive care from geriatricians to have a lower likelihood of health care services such as ED use and in-hospital death that are typically considered to be undesirable (compared to similarly ill beneficiaries who receive care from other types of physicians). In other words, because geriatricians have knowledge, skills, and experience that distinguish them from other types of physicians, geriatric care plausibly leads to better health outcomes than non-geriatric care for certain patients.

This conceptual framework identified internal and external factors that affect use of geriatric care and the pathways of the effect of geriatric care on health outcomes. The discussion focused on health status as a key factor affecting the benefits and costs of geriatric care. The reason health status is intrinsically linked to the expected utility from geriatric care is that the marginal product of GM is not likely to be the same for all elders. Both the sample selection criteria and the empirical models used in this dissertation reflect these effects of health status and other factors internal and external to the beneficiary on geriatrician use and the effect of geriatric care on health care use.

2.6. New contributions

This is an opportune time to examine the effects of geriatric care; in the short-run, the number of elders in the US will grow substantially, while geriatrician supply is predicted to continue to stagnate due to low recertification rates and failure to fill geriatrics fellowship positions. Using a large, geographically diverse sample of elderly Medicare beneficiaries, we assessed patient-level patterns of geriatrician use and the association of geriatric care with ED use and other physician visits. This study complements the literature on RCTs of multidisciplinary geriatric interventions and makes a substantial contribution to the limited number of existing studies that used observational data to examine the effect of visits to geriatricians. The effects of both the number of visits to a geriatrician as well as geriatric care as a share of the beneficiary's total physician visits were examined. Using multiple measures of geriatric care provided depth to the analysis and expanded the policy implications of the results.

The results of this study are not definitive; additional studies are needed to examine the effect of geriatrician use on other important outcomes (e.g., quality of life, functional status) and to determine whether the results of this study can be replicated using other samples. However, by focusing on physician choice and health care use, this study provides vital information about the effects of geriatric care at a time of marked increase in the elderly population and recent policy changes designed to increase support for geriatric care and education.

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Figure 2.1. Conceptual framework

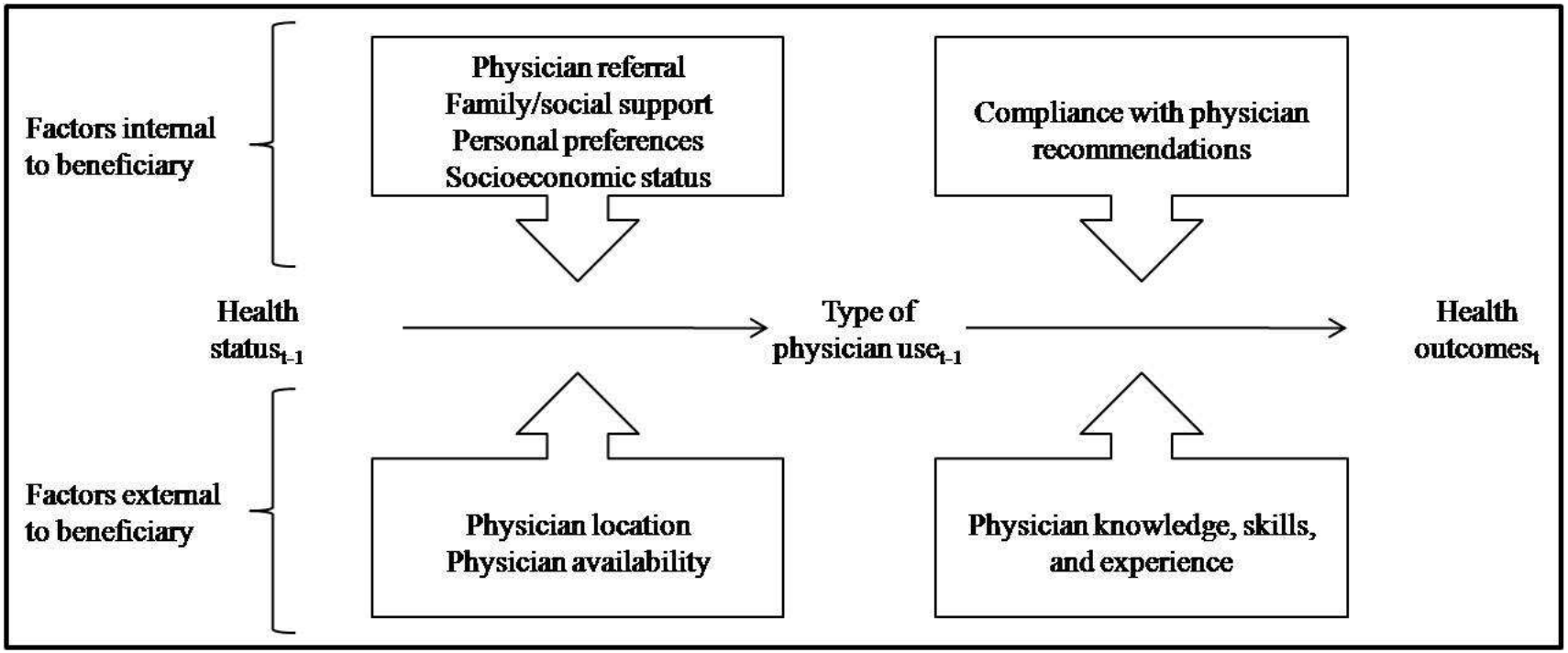

Table 2.1. Key features of geriatric care

- Expertise in managing common conditions that affect older persons including dementia, falls, urinary incontinence, malnutrition, osteoporosis, sensory impairment, and depression
- Understanding the interaction between aging and other conditions and diseases
- Recognizing the effects of aging and other conditions on clinical health, physical and mental function and independence
- Understanding the appropriate use of medications to avoid the potential hazards and unintended consequences of multiple medications
- Coordinating care among other providers to help patients maintain functional independence and improve their overall quality of life
- Evaluating and organizing health care and social services to preserve the independence and productivity of older persons
- Assisting families and other caregivers as they face decisions about declining capacity, independence, availability of support services, and end-of-life decision-making

Source: American Geriatrics Society [13]

Table 2.2. Characteristics/conditions indicative of potential to benefit from geriatric care

Randomized controlled trials		Survey of directors of geriatric academic programs [5]		
Characteristic/condition	**Frequency of use**	**Characteristic/condition**	**% responding greatly benefit^**	**Conditions used in this dissertation**
Physical health				
Diabetes, heart disease, stroke	Moderate	Complex biomedical problems	79%-82%	Stroke
Mental/neurological health				
Dementia, depression	High	Psychomedical complexity	81%-87%	Dementia, depression
Delirium/confusion	Low	Psychomedical complexity	81%-87%	Delirium
Geriatric syndromes				
Functional status, falls/impaired gait and balance	High	Moderate to severe functional impairment	59%-82%	Pressure ulcer, fractures, dislocations, lacerations, osteoporosis, syncope, hearing impairment, vision impairment
Incontinence	Moderate	Geriatric syndromes	75%-82%	Urinary incontinence
Bed rest/immobility, weight loss/malnutrition	Low	Unexplained health decline	68%-73%	Weight loss/malnutrition, failure to thrive, dehydration, pressure ulcer
Advanced age				
65+	High	75-85	33%-40%	66+
70+ or 75+	Moderate	>85	68%-82%	None
Demographic characteristics				
Socioeconomic status, social/family problems	Low	Socioeconomic, family, or ethical problems	67%-69%	ZIP code level income (control only)

Randomized controlled trials		Survey of directors of geriatric academic programs [5]		
Characteristic/condition	**Frequency of use**	**Characteristic/condition**	**% responding greatly benefit^**	**Conditions used in this dissertation**
Measures of health care use				
Hospital readmission, number of outpatient visits, number of medications	Moderate	End-of-life/palliative care	72%-75%	None

^ "Greatly benefit" refers to the percent of respondents who said that someone with a given characteristic/condition would greatly benefit from primary, consultative or hospital care from geriatricians, compared to the benefit of care from FM/IM physicians.

3. METHODS

This chapter provides an overview of the methodologies used for the three studies. Much of the information contained here is in also included in the methods sections for the individual studies. The methodologies for the three studies were the same when possible; in some cases, samples, measures, or estimations varied because of the nature each of the studies.

3.1. Research design

This dissertation used a retrospective cohort design. Data analysis began on the date when the beneficiary was included in the sample on the basis of a diagnosis of a qualifying geriatric syndrome/condition (discussed in more detail below). Beneficiaries were followed from this date until date of death, study end (12/31/2007), or admission to a long-stay hospital. In Study 1, we examined the association of geriatric care with contemporaneous demographic characteristics and comorbidities. In Studies 2 and 3 we used lagged measures of geriatrician visits to examine the relationship between geriatric care and health care use.

3.2. Data sources

The main data source for this dissertation was Medicare claims. Data from Medicare Provider Analysis and Review (MedPAR), Outpatient, Carrier, and Denominator files were available for 2002 through 2007. Medicare claims data were supplemented with ZIP code-level data from the 2000 Census and Rural-Urban

Commuting Areas Codes [69, 70]. Data for the instruments were from an analysis file constructed using aggregated data from the American Medical Association (AMA) Physician Masterfile and the American Board of Medical Specialties (ABMS). Since AMA and ABMS data for 2007 were unavailable, data for 2003-2006 and 2009 were used to interpolate the values of the instrumental variables in 2007.

3.3. Sample

We used 2002-2007 Medicare claims data for beneficiaries who met the following criteria (Figure 3.1): an acute care hospital stay with a diagnosis of acute coronary syndromes (ACS) (ICD-9 codes 410.xx, 411.1x, and 413.9x) from January 2003 through October 2004; age $\geq$ 66 years at the time of the hospital stay; and continuously enrolled in Medicare Parts A and B until death or 12/31/2007 (the last date for which data were available) (n=965,087). The initial sample of nearly one million beneficiaries was identified for a separate study [71].

The data used in this dissertation were advantageous because of the large initial sample size; since geriatric care is rare, having a large sample was critical. Yet the presence of ACS alone is unlikely to suggest a potential to benefit from geriatric care in excess of the benefits that would be expected from FM/IM or specialty care. In order to ensure a sample with the most potential to benefit from geriatric care and sufficient statistical power, we used two additional sample selection criteria: diagnosis of a geriatric syndrome/condition in a setting other than a long-stay hospital at least one year after the hospitalization for ACS and before the date of death or 12/31/2007 (n=452,985), and no diagnosis of the same syndrome/condition in the two prior years (n=340,848).

Requiring a diagnosis of one of the geriatric syndromes/conditions (Table 2.2) created a buffer between measurement of physician visits for this dissertation and use of cardiac care around the time of the hospitalization. Further, in the case of acute conditions such as stroke and fracture, requiring beneficiaries to have a look-back period of two years maximizes the likelihood that the diagnosis represents the onset of the condition. The rationale for this criterion was identification of a point in time at which a beneficiary's health status may have recently changed, since physician care may have particularly important effects on health care use following a health shock. Taken together, requiring a diagnosis of a geriatric syndrome/condition and a look-back period of two years for that diagnosis restricted the sample to beneficiaries who were most likely to benefit from geriatric care. Geriatrician use was substantially higher among beneficiaries in the final sample than among beneficiaries who did not meet these two sample selection criteria relating to diagnosis of the geriatric syndrome/condition, which suggests that the conditions we chose may in fact have indicated a high likelihood of benefiting from geriatric care.

Diagnoses occurring during long-stay hospital records were not used for sample selection, since patterns of health care use are markedly different for long-stay hospital patients. The mean (median) stay in a long-stay hospital in our claims data was 580 (595) days. During that period of time, beneficiaries would not have been at risk for the outcomes in Studies 2 and 3. An additional sample selection criterion was used in Study 1: a minimum of one year of follow-up data after diagnosis of the geriatric condition (n = 214,375). Of the beneficiaries who met all criteria except a minimum of one year of follow-up data after diagnosis of the geriatric condition, 55% died within the first year

following diagnosis. The remaining 45% had less than one year of data available between the date of diagnosis and 12/31/2007. In addition to the full sample, analyses for Study 1 were conducted using subsamples defined by the presence of dementia and congestive heart failure (CHF).

Studies 2 and 3 had the same number of beneficiaries. Both had 287,259 community dwellers and 66,551 NH dwellers. Study 2 used person-month observations. The sample sizes were 5,277,762 (community) and 1,005,122 observations (NH). Some beneficiaries (n=26,875) had observations in both the community and NH samples. Study 2 used person-six month observations. The sample sizes were 1,006,879 (community) and 195,433 observations (NH).

3.4. Measurement

3.4.1. Physician visits

Data in the Carrier files are divided into claims, and each claim can have up to thirteen line items. Each line item has its own “from date” and “to date” as well as its own Unique Physician Identification Number (UPIN). We defined a physician visit as all line items provided to a single beneficiary on a given date by a single physician [6]. We used the line item date rather than the claim date because, in some cases, these two dates differed. For example, 22.9% of claims with two or more line items had at least one line item from date that did not match the claim from date.

A visit in the claims data was included in this analysis if it met one or more of the following criteria: 1) associated with a physician-related performing provider Unique Physician Identification Number (UPIN) [72, 73]; 2) for 2007 claims data only, UPIN was missing but a National Provider Identifier (NPI) was present (unlike UPIN, NPI data

do not have any inherent information about whether the provider is a physician); or 3) the performing provider specialty indicated that the provider was a physician assistant or nurse practitioner. Visits were identified using Berenson-Eggers Type of Service (BETOS) codes for evaluation and management services provided during office, home, and NH visits as well as consultations [72]. All line items with BETOS codes M1A, M1B, M4A, M4B, and M6 were included unless one of the following Healthcare Common Procedure Coding System (HCPCS) codes was present: 99221-99239, 99251-99255, 99261-99263, 99271-99275, 99411-99412, 95115-95117, or G0175.

Physician visits were measured by specialty group, not by individual physician. Three specialty groups were used: geriatricians, FM/IM physicians, and specialists. For example, one visit to each of two geriatricians were treated the same as two visits to a single geriatrician. Visits to general practitioners, preventive medicine physicians, nurse practitioners, and physician assistants were included with FM/IM physicians. NAs and PAs can bill Medicare directly, and in non-hospital settings, they can bill incident to a physician service. They receive 85% of the physician fee schedule when they bill Medicare directly and 100% when they bill incident to physician service (i.e., there is no record of NP or PA involvement) [74]. About 35% of NPs and PAs are in FM, while more NPs than PAs are in IM or GM (17.8% and 5.9% of NPs are in IM and GM respectively, compared to 8.5% and 0.8% of PAs) [75]. Elderly patients are less likely than younger patients to see a NP or PA only [76]. Medicare claims data do not identify PAs and NPs by their specialty, and no data were located on practice patterns of gerontological NPs. Therefore, it is not possible in this dissertation to identify or infer the use of gerontological NPs.

In the specialist group, we included all specialties that could possibly be considered as providing the bulk of care to a beneficiary. The following specialties were included in the specialist group: addiction medicine, allergy and immunology, cardiology, dermatology, endocrinology, gastroenterology, gynecological oncology, hematology, hematology-oncology, infectious diseases, interventional radiology, medical oncology, nephrology, neurology, neuropsychiatry, obstetrics/gynecology, osteopathic manipulative treatment, physical medicine and rehabilitation, psychiatry, pulmonary disease, radiation oncology, rheumatology, surgical oncology, and urology.

Physicians self-designate specialty when they apply to become a Medicare provider; this specialty appears in the Carrier file. Since specialty is self-designated, geriatrician specialty does not necessary imply that a physician has ever been or is currently certified in GM. If a physician lists multiple specialties on their application, they identify the specialty they want listed first in claims data. In some cases the first specialty may not be listed if a claim merits using another specialty on the basis of the services provided (Research Data Assistance Center, personal communication, January 13, 2010). Medicare updates the records only when the physician or his/her institution sends an update to the Centers for Medicare and Medicaid Services.

3.4.2. Geriatric care

Compared to non-geriatricians, a much larger share of geriatricians were listed as having multiple specialties in the claims data for a single year (e.g. a physician whose specialty is listed as GM for some visits and FM for others). Using a dataset with one observation per physician per year, we found that 20.7% of physician-year observations that had at least two GM visits also had non-GM visits. The corresponding figures for

physician-year observations that had at least two FM/IM visits and also had non-FM/IM visits were much smaller: 5.1% (FM) and 9.9% (IM).

Because geriatricians had multiple specialties more often than other physicians, using the specialty listed for a given visit likely would have undercounted geriatrician visits. We assumed that physicians who are trained in GM apply their geriatric knowledge and experience in the care of all older patients regardless of which specialty is listed for a particular visit. We considered physicians with at least two visits in a year coded as GM to be a geriatrician for all visits by all beneficiaries in that year. All visits by all beneficiaries for whom data were available (n = 965,087) were used to identify physicians with at least two GM claims. We used two or more visits to minimize the possibility that the geriatrician designation was an error. Of the visits labeled as GM by the two or more visit measure, 90.2% were labeled as GM by the original claims data (i.e., the two or more visit measure did not substantially over count GM visits). In contrast to measurement of GM visits, FM/IM and specialist visits were classified based on the physician specialty listed on the Carrier claim.

Group practices may bill under a single UPIN. Group UPINs typically have a first digit of W – Z [73]. However, in some cases, multiple providers may bill under a single physician-related UPIN. If this practice was widespread, then assigning GM to all visits for physicians who have two or more visits coded as GM could have introduced substantial measurement error (i.e., GM would have been assigned to visits provided by a non-geriatrician who billed under the same UPIN as a geriatrician). A comparison of UPINs and NPIs in the 2007 data suggested that multiple providers billing under a single physician-related UPIN is not a widespread issue. Of the physician-related UPINs that

appeared on one or more claims in 2007 on which NPI is also listed, 96.3% were associated with only one NPI. Only 0.3% of UPINs were associated with more than two NPIs. Practice-level NPIs also exist and may be listed for the billing provider, but individual NPI is listed for the performing provider.

We used several measures of geriatric care in the three studies (Table 3.1). For Study 1, we measured any geriatric care (≥1 visit) in six months and one year as well as an ordered measure of geriatric care in one year: 0, 1, 2 to 3, 4 to 6, and ≥7 visits. For Study 2, we used three measures of geriatric care in six months. Two measures indicated the dose of geriatric care: any geriatric care and 1, 2, or ≥3 visits. These measures were used for Study 3. A third measure indicated geriatric care as a share of all physician visits [72, 77]. The reference category was beneficiaries for whom FM/IM visits accounted for the largest number of total visits ("FM/IM plurality"). Three groups were compared to FM/IM plurality: (1) beneficiaries for whom geriatrician visits accounted for the largest number of total visits ("GM plurality"); (2) beneficiaries who had at least one geriatrician visit but for whom geriatrician visits was not the largest number ("GM consultation"); and (3) beneficiaries for whom specialist visits was the largest number ("specialist plurality").

Studies 2 and 3 measured geriatric care using a six month lag. We chose to use a lagged measure of visits to ensure that the geriatric care occurred prior to outcomes. The data showed that among those who had any geriatric care, a sizeable share of beneficiaries had a single visit only. We chose to use a six month window because using a shorter measure of geriatric care (e.g., three months) would have failed to capture many

of the beneficiaries who had a single geriatrician visit, while using a longer measure (e.g., nine months) could have hidden a true effect of geriatric care if it diminished over time.

It is possible that six months may be too long or too brief a period of time for geriatric care to affect outcomes. A shorter measure of geriatric care may be more appropriate if one hypothesizes that the effect of physician care diminishes substantially over time. On the other hand, when measuring geriatrician visits as a share of total visits (i.e., GM plurality care and GM consultative care), having a longer time period over which to categorize physician use may provide a truer picture of which physician specialty is really driving the beneficiary's care. We conducted sensitivity analyses for Study 2 regarding the measurement of geriatric care. Using the three month measures, sample sizes were the same as the six month measures. Using the nine month measures, sample sizes decreased because additional data were needed for each observation. The community sample size decreased from 287,259 to 249,486, while the NH sample size decreased from 66,551 to 61,526.

3.4.3. Dependent variables

The dependent variable in Study 2 was ED use. ED use was measured using MedPAR claims for beneficiaries who were admitted to the hospital after the ED visit; for those who were not admitted to the hospital, ED use was measured in from Outpatient claims. In MedPAR claims, a positive ED charge indicated ED use in MedPAR claims, while a claim for revenue centers 0450-0459 or 0981 indicated ED use in Outpatient claims [78]. In Study 3, FM/IM physician visits and specialist visits were measured as the number of visits in six months. These visits were measured the same way as visits to

geriatricians (Chapter 3.4.1) were measured, except specialty for FM/IM visits and specialist visits was taken directly from the line item in the Carrier claim.

3.4.4. Comorbidities

Several options exist for measuring comorbidities in analyses of observational data; comorbidity measures developed by Charlson and Elixhauser are the two most widely used methods [79, 80]. The Elixhauser method creates individual binary indicators for 30 comorbid conditions, while the Charlson method creates a single indicator generated by 17 comorbidities. Several studies have compared the performance of the two methods. Studies which use inpatient data to predict mortality have concluded that the Elixhauser method has better predictive power than the Charlson method [81, 82]. Additional evidence suggests when using outpatient and/or physician claims in addition to inpatient claims, the Elixhauser method may be a superior predictor of mortality, hospitalization, and physician visits [83, 84]. Another comparison of the two methods found that they produce similarly predictions of health care expenditures [85]. Based on the existing evidence, we concluded that the Elixhauser method is at least as good as (and likely better than) the Charlson method for predicting health care use.

MedPAR, Outpatient, and Carrier claims were used to create indicators of the Elixhauser comorbidities and the geriatric comorbidities listed in Chapter 3.3. Indicators for the Elixhauser comorbidities were generated using software from the Healthcare Cost and Utilization Program [86]. This software normally includes only diagnoses that are unrelated to a claim's principal diagnosis; this assumption was relaxed to allow for the inclusion of all comorbidities in order to capture as full a picture as possible about a beneficiary's comorbidity burden. In order to prevent overestimation of geriatric

condition prevalence and to avoid “rule out” diagnoses, comorbidities were identified only if they were found in one MedPAR or two or more Outpatient or Carrier claims occurring more than thirty days apart [87, 88].

Relying only on comorbidities indicated in the claims data in a given month would likely undercount comorbidities that are not likely to be reversible (i.e., likely to still be present even when not indicated in claims data). Our files had only up to five additional diagnosis codes (Medicare claims can have up to ten diagnosis codes in addition to the principal diagnosis), and evidence suggests that diagnoses may be underreported in claims data [89, 90]. In an effort to identify all comorbidities likely to have been present in a given month, we differentiated between comorbidities that may have been reversible and those that were unlikely to be reversible (e.g., depression may be reversible, but dementia is not). We indicated comorbidities that may have been reversible only in the months during which the diagnoses appeared in the claims data. Comorbidities that were not likely to be reversible were indicated in the month of the first diagnosis and for the remainder of the study period. The following comorbidities were treated as non-reversible: stroke, osteoporosis, dementia, urinary incontinence, hearing impairment, vision impairment, hypertension, diabetes, CHF, deficiency anemia, chronic obstructive pulmonary disease, peripheral vascular disease, hypothyroidism, valvular disease, diabetes with complications, tumor without metastasis, renal failure, other neurological disorder, rheumatoid arthritis, obesity, metastatic cancer, paralysis, lymphoma, liver disease, and alcohol abuse. All other comorbidities were treated as reversible (depression, dehydration, syncope, fracture, pressure ulcer, weight loss, failure

to thrive, laceration, delirium, dislocation, hypertension with complications, psychoses, coagulation deficiency, pulmonary circulation disorder, and blood loss anemia).

3.4.5. Control variables

In all three studies, metropolitan status was obtained by linking ZIP code to Rural-Urban Commuting Area Code [69]. Median household income was measured at the ZIP code level using data from the 2000 Census. ZIP code was generally derived from the claims files; for beneficiaries with no physician visits in a year and all beneficiaries in 2007, ZIP code came from the Denominator file. Dual eligibility measured whether the beneficiary had some or all of their Medicare costs paid by the state Medicaid program [91]. In Studies 2 and 3, binary indicators identifying the month (for Study 3, the first month of the six month period) captured seasonal variation in the outcome measures and linear and non-linear time trends captured any changes in the outcome measures that occurred during the study period.

3.4.6. Instrumental variables

The first instrument for geriatric care measured geriatrician supply: a count of the number of geriatricians in the beneficiary's home county per 10,000 residents aged 65 and older. The second instrument measured differential distance to geriatric care: the difference between the distance from the beneficiary's home ZIP code to the ZIP code of the nearest geriatrician and the distance from home ZIP code to the ZIP code nearest FM/IM physician or specialist. Physicians were eligible to be included in the data generating the instruments if they were clinically active, non-resident, and non-federal. Clinically active physicians exclude physicians with one or more of the following characteristics: (1) dead; (2) older than 80 years; (3) major professional activity is listed

as administration, medical teaching, research, inactive, temporary foreign, or other; (4) type of practice is listed as administration, medical teaching, research, retired, other medical activities, temporarily not in practice, or not active for other reasons; or (5) primary present employment is listed as non-patient care. Resident physicians were excluded since they have not finished graduate medical education, and federal physicians were excluded care because from those physicians is not available to the general public. More specifically, although the Department of Veterans Affairs employs a number of geriatricians, we excluded those physicians from the instruments because visits to physicians in a Veterans Affairs facility typically are not billed to Medicare (i.e., do not appear in Medicare claims data).

FM/IM physicians and specialists were identified by primary specialty from the AMA data and the first current certification from the ABMS data. Geriatricians were identified by primary and secondary specialty from the AMA data and up to three current certifications from the ABMS data. We identified geriatricians differently than FM/IM physicians and specialists in order to be consistent with the differences in how we measured geriatrician visits and visits to other physicians in the claims data.

Multiple ZIP codes are reported for most physicians in the AMA data. The ZIP code and corresponding county code we used for each physician were from the address that was most likely to be the place where the physician practices most of the time. If the preferred mailing address was used for all physicians, 55-60% of addresses would be home addresses. The “max office” procedure creates an address that is most likely to be the place where the physician practices most of the time (e.g., screens for cases where the preferred mailing address is a home and an alternate mailing address is an office). Using

this procedure, 86% of addresses for office-based physicians are office addresses. Distance was measured as the number of miles between the centroid of the beneficiary's home ZIP code and the centroid of the physician ZIP code using the zipcitydistance function in SAS 9.1.3.

3.4.7. NH residence

Long-term NH dwellers are likely to have different unobservable characteristics than community dwellers or beneficiaries who have a brief stay in a skilled nursing facility (SNF) (e.g., poorer functional and cognitive status). By separating beneficiaries into two groups based on setting, we hoped to minimize within-group variation in unobserved characteristics. A beneficiary was classified as a long-term NH resident if he or she met the following criteria: (1) three consecutive months with at least one nursing NH claim; and (2) at least one of these months had no skilled nursing NH (SNF) claims. Place of Service codes 31 and 32, HCPCS codes 99301-99318, 99379-99380, and G0066, and BETOS code M4B indicated long-term nursing NH use in Carrier claims. SNF stays were identified using the SNF indicator code in MedPAR claims. A beneficiary was in the community sample until the date of death, end of study, or the first month in which he or she was identified as a NH resident.

We used an alternative, less restrictive measure of NH residence for sensitivity analyses to determine whether the results reported in Studies 2 and 3 were sensitive to changes in how NH use was identified. Under the alternative definition, NH residency was measured on the basis of two consecutive months with at least one NH claim; there was no requirement about whether either or both of these months took place in a SNF or other NH. The number of beneficiaries in the community sample decreased by 15,177

(5.3%), while the number of beneficiaries in the NH sample increased by 28,762 (43.2%). The NH sample increased by more than the community sample decreased because many more beneficiaries had observations in both samples under the alternative measure of NH residence than under the original measure.

3.5. Overview of data analysis

The starting date for the study period of all three studies was the same (Figure 3.2). This date was determined by the setting in which the beneficiary was diagnosed with the qualifying geriatric condition. If the beneficiary was in a hospital, the discharge date from the MedPAR record was used as the starting date. Hospital discharge date was used rather than admission date since the beneficiary was not at risk for the outcomes used in Studies 2 and 3 during the hospitalization. If the beneficiary was in a SNF, the starting date was the admission date in the MedPAR record for the SNF stay. If the beneficiary was in neither a hospital nor a SNF, the starting date was the claim "from date" on the Carrier or Outpatient record. In other words, the date in the Carrier record was used as the starting date only when it did not occur between the admission and discharge dates of any of the beneficiary's MedPAR records.

3.5.1. Use of geriatric care in non-hospital settings

To examine the frequency and location of geriatric care as well as characteristics associated with the use of geriatric care, we used data from the twelve months following the date of diagnosis of the geriatric condition. To examine the use of geriatric care over time, we used data for six month periods beginning with the date of diagnosis of the geriatric condition and ending on the date of death or 12/31/2007. We chose six month periods because we felt that three months was too short a time to infer a pattern of

physician use, while nine months would have substantially reduced our ability to look across time. On average, we followed beneficiaries for four periods of six months (two years); for 23% of the sample, we had data for only two periods of six months (the first year following the geriatric diagnosis). Between diagnosis and date of death or 12/31/2007, the 214,375 beneficiaries had 813,631 complete six month periods of data.

3.5.2. Association of geriatric care and emergency department use

The unit of analysis for this study was the beneficiary-month (30 day period) beginning with the date of diagnosis of the geriatric condition. ED use was estimated as a function of geriatric care during the previous six months. Using a lagged measure ensured that the geriatric care occurred prior to the ED use. As discussed in Chapter 2.5, a host of factors may play a role in whether people choose geriatric care including health status, family support, referral from one's existing provider or NH, and the costs of geriatric care. Since some of these factors may also affect ED use and were unobservable in Medicare claims data, we used linear probability models (LPMs) with individual fixed effects (FE) to control for time-invariant unobserved variables.

When unobservable variables vary at or below the level of the FE, the preferred approach is IV regression if a valid instrument can be identified. We do not present results from IV regression as the preferred approach for either Study 2 or Study 3 because of questions regarding the validity of our instruments and the highly implausible effect sizes estimated by the IV models for some measures of geriatric care in Study 2. Our instruments are described in Chapter 3.4.6, and our IV methodology is described in Chapter 3.6.

Six months may be too long or too brief a period of time for geriatric care to affect outcomes, so we also measured geriatric care over three months and nine months. To test whether our measure of long-term NH use was overly restrictive, we used an alternative measure: two consecutive months with at least one NH claim. We also conducted the analyses for beneficiaries who had a diagnosis of dementia in the first month.

3.5.3. Association between visits to geriatricians and visits to other physicians

In Study 3, we examined visits to FM/IM physicians and specialists as a function of geriatric care in the previous six months. The unit of analysis was beneficiary-six months. We chose six months in order to balance our desire for a long follow-up period with the need to minimize the impact of censoring and maintain a sufficient sample size. We estimated ordinary least squares (OLS) models using individual FE. FE was the preferred specification because of our concerns about bias from self-selection of geriatric care and difficulties locating valid instrumental variables. For all outcomes and both samples, F tests of joint insignificance of the FE were rejected ($p<0.000$), and Hausman tests indicated that estimates from OLS models were inconsistent ($p<0.000$).

Results from Poisson models with FE were very similar to results from OLS models with FE; we chose OLS as the preferred specification for ease of interpretation. Ideally we would have used a negative binomial model with FE, since specification tests suggested the presence of overdispersion ($p<0.000$). However, the FE negative binomial model in Stata did not appear to be analogous to the concept of FE that we used in the OLS models (i.e., FE that that uses only within-individual variation to estimate parameters and then averages the estimates across individuals).

To assess whether the relationship between geriatric care and specialist visits was moderated by FM/IM care, we included FM/IM visits in the previous six months as an explanatory variable in the model estimating specialist visits and vice versa. We measured physician visits during three months as an alternative to six months because of our concerns about censoring due to death or end of study. We used binary dependent variables (any FM/IM visits and any specialist visits in six months) to allow for the possibility that geriatric care may have affected the likelihood of having any physician visits rather than the number of physician visits. To test whether results were sensitive to measurement of geriatric care as 1, 2, or ≥3 visits, we estimated models measuring geriatric care as 1, 2, 3, and ≥4 visits. To test whether our measure of long-term NH use was overly restrictive, we used samples defined by an alternative measure: two consecutive months with at least one NH claim. We explored IV as an alternative to FE since FE do not eliminate bias if time-varying unobserved variables are related to both geriatric care and physician visits. We estimated IV models using two-stage residual inclusion (2SRI).

3.6. Instrumental variables

3.6.1. Rationale

The theoretical justification for using measures of geriatrician supply and location is that geriatrician availability impacts the likelihood of using geriatric care but is uncorrelated with unobservable variables that affect visits to other physicians, ED use, or in-hospital death. Geriatrician supply is likely to be positively associated with use of geriatric care. A beneficiary who lives in an area with a relatively high geriatrician to elderly population ratio is more likely to be aware of the availability of geriatric care than

one who lives in an area with lower geriatrician supply. Further, higher geriatrician supply may lead to reduced costs for waiting to obtain an appointment. Because of their medical history, beneficiaries in our sample may have more physician visits and more problems finding transportation than elders with better health status or younger adults. Since their transportation costs may be higher, differential distance may negatively impact a beneficiary's likelihood of using geriatric care. Having two instruments is helpful in a statistical sense because multiple instruments allow for a test of overidentification. Further, although the differential distance measure is likely to be correlated with geriatrician supply, differential distance is a more flexible measure because it ignores geographic boundaries. This is important in light of existing evidence that, for example, the health benefits of access to medical care in urban counties spillover into rural counties with close proximity to urban counties [92, 93].

The instruments were valid only if there is was no direct effect of geriatrician supply and differential distance to geriatric care on outcomes and the instruments were uncorrelated with unobservable variables that affect those outcomes. Physician supply and differential distance have been used as instruments for the receipt of cardiac care [94, 95]. Some research suggests that primary care provider supply is correlated with area-level health outcomes and that physician density is endogenous in models of area-level health [96-99]. A recent paper found a connection between area-level primary care physician supply and individual-level outcomes [100]. To address concerns about the supply instrument, we used an alternative measure of supply that measured the availability of geriatricians relative to other types of physicians rather than indicating the

actual availability of geriatricians: the ratio of county geriatrician supply to county FM/IM and specialist supply.

Despite using an alternative instrument, geriatrician supply (and therefore distance) is highly correlated with the presence of academic medical centers, and it seemed implausible to us that there would be no unobserved, area-level differences in ED use and physician visits related to the presence of an academic medical center. To explore the validity of excluding the instruments from the equation of ED use, we compared two groups: community dwellers who lived in an area where geriatrician supply was at or above the median for all community dwellers, and those who lived in an area where supply was below the median (we did a similar comparison for the NH sample) [101]. This comparison suggested that the distribution of observable variables was not independent of geriatrician supply. For example, beneficiaries who lived in an area with high geriatrician supply had much higher median ZIP code income and were less likely to be dual eligible than beneficiaries who lived in an area with low geriatrician supply. Differences in observed socioeconomic status are problematic, because unobserved socioeconomic status may be associated with both geriatrician supply and ED use and in-hospital death. In short, differences in observable variables between groups that were defined by values of the instruments suggested that the instruments were not functioning well as a natural experiment for geriatric care.

3.6.2. IV estimation

The description of IV estimation provided in the remainder of this chapter refers to Study 2 (we conducted a similar IV estimation for Study 3). Two-stage least squares is not an ideal IV estimation technique for a binary dependent variable because of well-

known shortcomings in LPMs (e.g., assumption of constant marginal effects and predicted probabilities outside the 0 to 1 interval). Our main IV results for the effect of any GM use were generated using a recursive bivariate probit model [102]. In a recursive bivariate probit model, the dependent variable of one equation appears on the right-hand side of the other equation. The error terms from the two equations are allowed to be correlated. In order to compare IV estimates for the effect of any GM use with other measures of geriatric care, we used two-stage residual inclusion (2SRI) in which both the observed value of the endogenous variable and the predicted residual from the first stage equation are included in the second stage equation. The 2SRI approach has been used for several specific nonlinear models [103-105]. Terza, Basu, and Rathouz [106] show more generally that 2SRI is a theoretically consistent implementation of IV in non-linear models.

The predicted residual was calculated as the difference between the actual value of the dependent variable and the predicted probability. The first stage logit model had one residual, while the first stage ordered logit model had three residuals because there were four levels of geriatric care in the ordered measure. The categorical measure of geriatric care was estimated via a multinomial logit, and three predicted residuals were calculated as differences between mutually exclusive binary variables and predicted probabilities. For example, the residual for GM consultative care was generated by a dummy variable indicating whether a beneficiary was actually in the GM consultative care group minus the predicted probability of being in the GM consultative care group. Evidence from Hausman tests of the assumption of independence of irrelevant alternatives in the multinomial logit model suggested that this assumption was supported

($p<0.05$). Bias-corrected confidence intervals for changes in the predicted probability of the dependent variable were generated by bootstrapping 250 random samples drawn at the beneficiary level with replacement. Bias-corrected confidence intervals for odds ratios were generated using bootstrapping 250 random samples drawn at the beneficiary level with replacement.

Depending on whether the measure of geriatric care was binary, ordered, or categorical, the first stage equation that predicted geriatric care in a six month period was estimated using a logit, ordered logit, or multinomial logit model with standard errors clustered at the beneficiary level. If a comorbidity was present in at least one month during the six month period, then the comorbidity was indicated for the entire six month period. The same procedure was used for state buy-in due to Medicaid eligibility. The values for the instruments and the other control variables reflect the beneficiary's characteristics during the last month of the six month period. In other words, if the beneficiary moved during a six month period, geriatrician supply and distance, income, and metropolitan status would reflect the beneficiary's location in the sixth month. About 11.0% of beneficiaries move at least once, but only 2.6% of observations are affected because most people do not move multiple times.

3.6.3. Specification tests

The first specification test was a Hausman test of the assumption of independence of irrelevant alternatives that is inherent in multinomial logit models. In Study 2, one of the measures of geriatric care was a categorical variable, which means that one of the first stage models for IV was a multinomial logit. The null hypothesis of the Hausman test is that the odds of two outcomes are independent of other alternatives. Hausman tests

results suggested that the independence of irrelevant alternatives assumption was supported for both the community and NH samples. When estimating ED use, the p values for whether each of the three outcome categories can be omitted exceed 0.05 in all cases for both the community and NH samples except one (specialist as the modal visit type, NH sample).

Tests to assess the exogeneity of geriatrician use and the strength of the instrumental variables were conducted in a two-stage least squares model where both stages were estimated using LPMs. The predicted values of any GM use from the first stage was significant when included with the actual value of any GM use in the second stage ($p<0.01$ for both outcomes and both samples) This indicated that the variable any GM use was endogenous [107].

A test statistic greater than 10 from an F-test to determine whether the estimated coefficients for the instruments in a linear model are jointly different from zero is an indicator that the instruments are not weak [108]. Using a LPM for the first stage equation predicting any GM use, the test statistics for the F-test of the two instruments are 116.97 (NH) and 241.58 (community), indicating that these variables are strong instruments. Lagrange multiplier tests of overidentification rejected the null hypothesis that the instruments are validly excluded from the second stage model for both samples, although this test does not provide information about which instrument(s) may be invalidly excluded from the second stage model [109].

3.7. Alternative methodologies

We considered using propensity score methods to estimate the models in Studies 2 and 3. Propensity scores are often used as an alternative to multivariate regression

[110]. Several propensity score methods exist, including many variations of weighting and matching. The main advantage of propensity scores compared to multivariate regression is their non-parametric nature. However, using propensity scores does not address the problem of unobserved heterogeneity. Since we believe strongly that use of geriatric care is related to unobservable variables that also affect outcomes, we could not argue in favor of the assumption of ignorability and thus focused on FE and IV models. Propensity score methods have occasionally been combined with IV, but we did not pursue that route because of the concerns we had with the assumption that our instruments were validly excluded from the outcome models in Studies 2 and 3.

Figure 3.1. Sample selection criteria

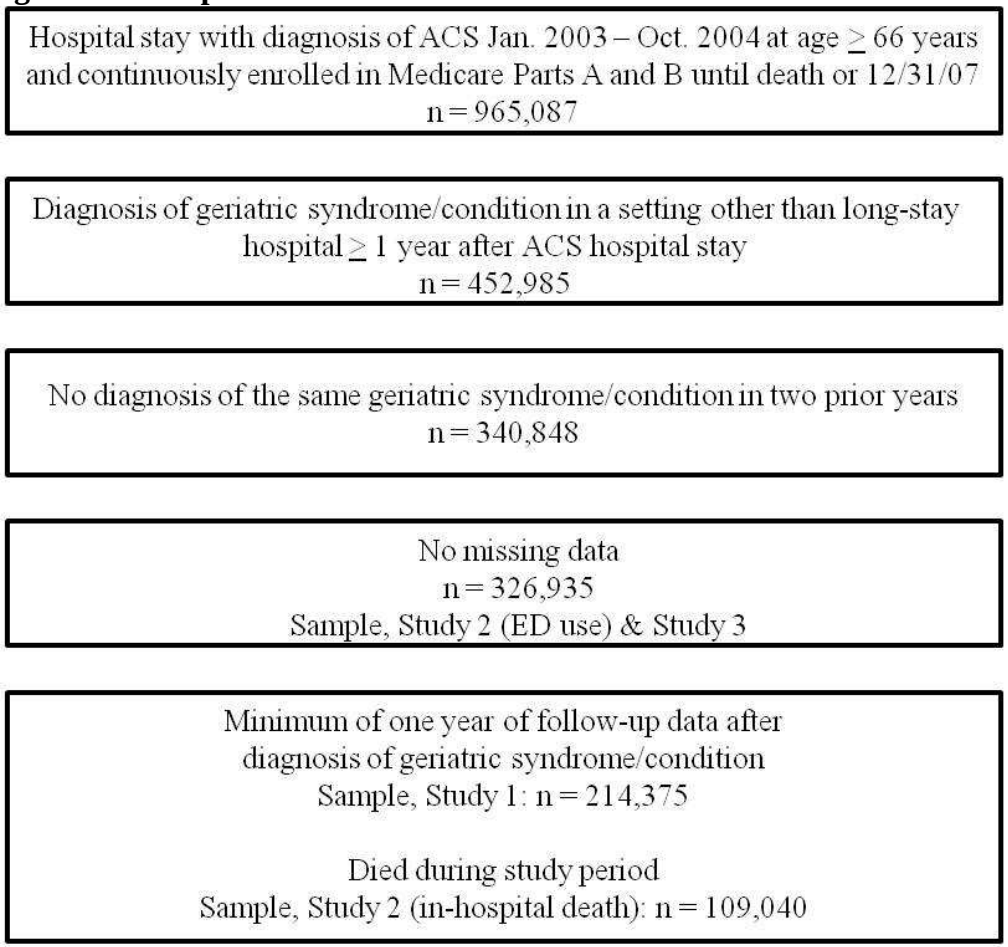

Figure 3.2. Analysis timeline

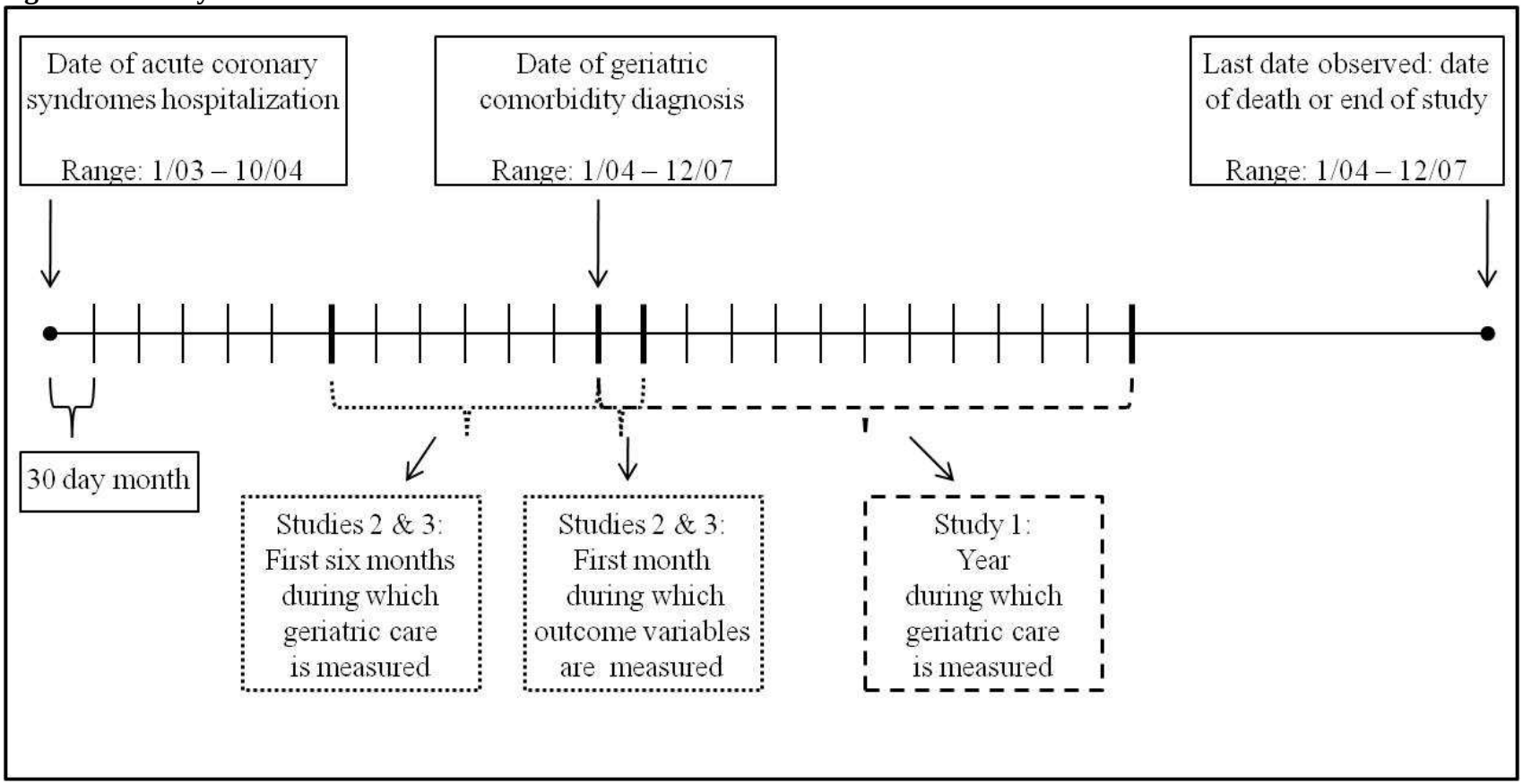

Table 3.1. Study variables

Variable	Time period	Study	Source	Type
Dependent variables				
Any ED use	1 month	2	Claims	Binary
Number of FM/IM visits	6 months	3	Claims	Count
Number of specialist visits	6 months	3	Claims	Count
Geriatric care				
Any geriatric care	1 year, 6 months	1	Claims	Binary
1, 2-3, 4-6, ≥7 geriatrician visits	1 year	1	Claims	Ordered
Any geriatric care	Prior 6 months	2 & 3	Claims	Binary
1, 2, ≥3 geriatrician visits	Prior 6 months	2 & 3	Claims	Ordered
GM plurality care, GM consultative care	Prior 6 months	2	Claims	Categorical
Explanatory/control variables				
Comorbidities	1 year (Study 1), 1 month (Study 2), and 6 months (Study 3)	1, 2, & 3	Claims	Binary
Age	1 month	1, 2, & 3	Claims	Categorical
Gender	1 month	1, 2, & 3	Claims	Binary
Race	1 month	1, 2, & 3	Claims	Binary
Medicaid state buy-in	1 month	1, 2, & 3	Claims	Binary
ZIP code median income	1 month	1, 2, & 3	US Census	Categorical
Metropolitan status	1 month	1, 2, & 3	Claims	Categorical
Calendar month	1 month	2 & 3	Claims	Binary
Linear and non-linear time trends	1 month	2 & 3	Claims	Binary
Instrumental variables				
Geriatrician supply in county	Prior 6 months	2 & 3	AMA/ABMS	Continuous
Differential distance to geriatric care	Prior 6 months	2 & 3	AMA/AMBS	Continuous

4. STUDY 1: USE OF GERIATRIC CARE IN THE UNITED STATES

4.1. Abstract

Objectives: To describe the frequency and location of geriatric care; examine patient characteristics associated with use of geriatric care; and describe trends in the use of geriatric care over time.

Design: Retrospective cohort study.

Setting: Medicare claims data for a national sample of elderly beneficiaries with a history of acute coronary syndromes (ACS).

Participants: 214,375 elderly Medicare beneficiaries who had a diagnosis of a geriatric syndrome or condition at least one year after hospitalization for ACS.

Measurements: Geriatrician visits for evaluation and management services in the first year following diagnosis of the geriatric condition and in all six month periods following diagnosis until date of death or end of study period.

Results: Geriatric care reached only 3.5% of these patients. The use of geriatric care was approximately evenly split between heavy users (4 or more visits in one year) and light users (1 to 3 visits in one year). Beneficiaries living in a metropolitan area, those with dementia or depression, and those who had any nursing home physician visits were substantially more likely to use geriatric care than other beneficiaries. Most beneficiaries with at least one geriatrician visit in a nursing home had the majority of their nursing home physician visits provided by geriatricians.

Conclusion: Few Medicare beneficiaries with geriatric conditions receive geriatric care. The potential for geriatric medicine to have a significant clinical impact on the elderly population is very small. Other avenues including research, teaching, and policymaking may be more effective uses of the limited supply of geriatricians.
Key words: geriatrician visits, geriatric syndromes, nursing home, primary care, geriatric consultation

4.2. Introduction

The growth in the number of elderly Americans, especially those aged 85 years or older, is increasing pressure on the health care system in the United States. Health care for older adults with chronic conditions is costly and often of suboptimal quality [1]. The quality of health care for geriatric conditions may be considerably poorer than for other conditions such as diabetes or hypertension [3]. Several outpatient geriatric evaluation and management programs have shown favorable effects on outcomes including physical functioning and mental or cognitive health [15-18]. In some cases, these interventions have produced either cost reductions or no increase in costs [15-17, 51]. Comprehensive interdisciplinary geriatric care programs may be beneficial for elders with multiple chronic conditions, geriatric conditions, or other complex health care needs, but these programs are not widely available [5]. Although many elders might benefit from geriatric care, the current and projected future supply of geriatricians is limited [4, 35, 36]. In light of these supply constraints, an understanding of to whom, how frequently, and in what settings geriatric specialty care is provided is critical if evidence from these randomized controlled trials is to be translated into population-based geriatric care.

Although the appropriate role of geriatric care has been widely discussed in the literature, little is known about the actual use of geriatric care in the US population [39, 111-115]. Existing evidence uses the geriatrician as the unit of observation; no studies that describe visits to geriatricians using the patient as the unit of observation were located. Claims data from 1998 for a nationally representative sample of Medicare beneficiaries show that geriatricians are substantially more likely to provide care in a nursing home and less likely to provide care in an office than family medicine and general internal medicine (FM/IM) physicians [41]. In that study, nearly 27% of geriatric medicine claims originated in nursing homes compared to 7% for FM/IM claims. The reverse was found for office visits: 72% for FM/IM compared to 47% for geriatricians. Unlike FM/IM physicians, geriatricians commonly provide both primary and consultative care. Among respondents to a survey of geriatricians whose fellowships occurred in the 1990s, 64% reported that they engage in outpatient primary care, and 60% reported conducting outpatient comprehensive assessment [40]. No published study has examined the extent to which geriatric specialty care reaches the older patient population or in what settings the care is provided.

Using a large, longitudinal Medicare dataset of older adults who had a prior hospitalization for acute coronary syndromes (ACS) and subsequent diagnosis of a geriatric condition, our study objectives were to: 1) describe the frequency and location of geriatric care; 2) examine patient characteristics associated with use of geriatric care; and 3) describe trends in the use of geriatric care over time. In addition to the full sample, we conducted the analysis for two disease-specific subsamples. We chose one condition for which geriatricians may have substantially more training and relevant experience

(dementia) and one condition for which geriatric care may not necessarily be expected to be substantially different than care from FM/IM physicians (congestive heart failure (CHF)).

4.3. Methods

4.3.1. Sample

We used Medicare claims data for nearly one million fee-for-service beneficiaries who met the following criteria (Figure 4.1): an acute care hospital stay with a diagnosis of ACS (ICD-9-CM codes 410.xx, 411.1x, and 413.9x) from January 2003 through October 2004; age $\geq$ 66 years at the time of the hospital stay; and continuously enrolled in Medicare Parts A and B until death or 12/31/2007 (n=965,087). The initial sample of nearly one million beneficiaries was identified for a separate study [71]. Data from Medicare Provider Analysis and Review (MedPAR) (inpatient), Outpatient, Carrier (physician), and Denominator files were available for 2002 through 2007.

Since geriatric care is rare, the data we used were advantageous because of the large initial sample size. Although ACS is not a condition for which geriatric care would be expected to confer benefits relative to care from other physicians, beneficiaries who have had ACS may have poorer functional status and overall health status than the general elderly population. In combination with the diagnosis of a geriatric condition, these people may have been particularly good candidates for geriatric care. The sample selection criteria were: (1) diagnosis of a geriatric condition in a setting other than a long-stay hospital at least one year after the hospitalization for ACS (n=452,985); (2) no diagnosis of the same geriatric condition in the two prior years (n=340,848); and (3) a minimum of one year of follow-up data after diagnosis of the geriatric condition

(n=223,126). Of the 117,722 patients who met all criteria except a minimum of one year of follow-up data, 55% died within the first year following diagnosis of the geriatric condition. A small number of beneficiaries were lost due to missing data (most had missing income data because their ZIP code did not match a ZIP code tabulation area in the 2000 Census). The final sample size was 214,375. The sample sizes for the disease-specific subsamples were 44,169 (dementia) and 92,955 (CHF).

Geriatric conditions included stroke, dementia, depression, delirium, pressure ulcer, fracture, dislocation, laceration, osteoporosis, syncope, hearing impairment, vision impairment, urinary incontinence, weight loss/failure to thrive, and dehydration (Table 4.1). We created this list of geriatric conditions based on diagnoses used for inclusion in randomized controlled trials of geriatric interventions and a 2008 survey of directors of geriatrics academic programs which asked to what degree elders with a variety of health conditions or other characteristics would be likely to benefit from geriatric care [28].

To examine the frequency and location of geriatric care as well as characteristics associated with the use of geriatric care, we used data from the twelve months following the date of diagnosis of the geriatric condition. To examine the use of geriatric care over time, we used data for six month periods beginning with the date of diagnosis of the geriatric condition and ending on the date of death or 12/31/2007. We chose six month periods because we felt that three months was too short a time to infer a pattern of physician use, while nine months would have substantially reduced our ability to look across time. On average, we followed beneficiaries for four periods of six months (two years); for 23% of the sample, we had data for only two periods of six months (the first

year following the geriatric diagnosis). Between diagnosis and date of death or 12/31/2007, the 214,375 beneficiaries had 813,631 complete six month periods of data.

4.3.2. Measures

We measured a physician visit as all claim line items provided to an individual beneficiary on a given date by a single physician [6]. We used Berenson-Eggers Type of Service (BETOS) codes for evaluation and management services to determine location of the visit (Table 4.2). For evaluation and management visits with a BETOS code indicating a consultation rather than a specific location (M6), we used Healthcare Common Procedure Coding System codes to identify location.

Physician specialty was indicated for each visit in the Carrier claims data. Compared to non-geriatricians, a much larger share of geriatricians were listed as having multiple specialties in the claims data for a single year (e.g. a physician whose specialty was listed as geriatric medicine for some visits and FM for others). As a result, using the specialty listed for a given visit would likely have undercounted geriatrician visits. We assume that physicians who are trained in geriatric medicine apply their knowledge and experience in the care of all older patients regardless of which specialty is listed for a particular visit. We considered physicians with at least two visits in a year coded as geriatric medicine to be a geriatrician for all visits by all beneficiaries in that year. Geriatrician specialty was identified using all available claims data (n = 965,087 persons).

MedPAR, Outpatient, and Carrier claims were used to create two sets of comorbidities: the standard set of comorbidities created by Elixhauser and the geriatric conditions listed above [80]. We included comorbidities diagnosed at any time during the

first year after diagnosis of the geriatric condition. To prevent overestimation of comorbidity prevalence and to avoid "rule out" diagnoses, comorbidities were included only if they were found in one MedPAR claim or two or more Outpatient or Carrier claims more than 30 days apart [87, 88]. Gender, race, dual eligible status, and age were extracted from the Denominator file. Dual eligibility measured whether the beneficiary had some or all of their Medicare costs paid by the state Medicaid program [91]. Income and metropolitan status were measured using the beneficiary's home ZIP code [69, 70]. ZIP codes were derived from the claims files; for beneficiaries with zero physician visits, ZIP code came from the Denominator file.

4.3.3. Analytical approach

To examine frequency of use and location of geriatric care (objective 1), we set the levels of geriatrician visits a priori as 0, 1, 2 to 3, 4 to 6, and 7 or more visits in the year following diagnosis of the geriatric condition. We examined use of geriatric care in any setting as well as separately for hospital and non-hospital settings. We used Kruskal-Wallis tests to examine how often people had geriatric care in more than one setting. We examined the bivariate associations of demographic variables and comorbidities with geriatric care using Chi-square tests for categorical variables and Mann-Whitney (Wilcoxon rank-sum) tests for ordinal and interval variables (objective 2). We also estimated a multivariate logistic regression model. To examine the use of geriatric care over time (objective 3), we examined summary statistics on the number of beneficiaries and number of periods with any geriatric care. To compare and contrast the use of geriatric care over time by location, we examined data beginning with the period in which the initial visit occurred in order to focus on the periods during which the

beneficiary was likely to have knowledge of and access to geriatric care. For example, if a beneficiary had 5 periods of data and the first geriatrician nursing home visit occurred during period 2, we examined geriatrician nursing home visits in periods 2 through 5. All analyses were performed for the full sample as well as dementia and CHF subsamples. All statistical analyses were performed using Stata 11.1 (StataCorp LP, College Station, TX). This study was approved by the institutional review board at the University of North Carolina at Chapel Hill.

4.4. Results

4.4.1. Frequency and location of geriatric care

The vast majority (96.5%) of the 214,375 elderly Medicare enrollees included in the sample had no geriatrician visits in any setting during the year following diagnosis of the geriatric condition (Table 4.3). Approximately as many people had 1-3 geriatrician visits (3,784) as had 4 or more visits (3,631). More people in the study sample received geriatric care in non-hospital settings (2.8%) than in hospital settings (1.2%).

The most common clinical settings of geriatric care were nursing home and office/outpatient. Among the 7,415 of beneficiaries with at least one geriatrician visit in the year, 43.3% had at least 1 visit in a nursing home, 41.2% had at least 1 visit in an office/outpatient setting and 33.4% had at least 1 visit in a hospital. The figures for other settings were substantially smaller: 2.9% (home) and 0.7% (emergency department). Most people (81.1%) received geriatric care in a single setting only.

Nursing home residents (i.e., people who had at least one nursing home visit by any specialty) had substantially higher rates of geriatric care than persons living in community settings. Of the 48,449 beneficiaries who had at least one nursing home visit,

8.2% had geriatric care in any setting. In contrast, of the 165,926 beneficiaries who had zero nursing home visits, only 1.9% had geriatric care in any setting.

People who had at least one geriatrician visit in a nursing home tended to get mostly geriatric care in the nursing home. Among the 3,211 people who had at least one geriatrician visit in a nursing home, 44.5% had geriatric care for all physician visits in the nursing home. An additional 25.3% had geriatric care for at least half of their nursing home visits. In contrast, people who had at least one geriatrician visit in an outpatient or hospital setting tended to get geriatric care for a minority of their physician visits in those settings.

4.4.2. Patient characteristics associated with geriatric care

Bivariate comparisons showed that geriatric care users were likely to be age 86 or older (OR 1.65, CI 1.57 to 1.73) and live in a ZIP code in the highest income quartile (OR 1.64, CI 1.56 to1.72) and less likely to reside in a rural area (OR 0.33, CI 0.28 to 0.38) (Table 4.4). Beneficiaries who received geriatric care had more comorbidities (median of 8 vs. 6, $p<0.01$). Most comorbidities were positively associated with the use of geriatric care, including 12 of the 15 geriatric conditions used for sample selection.

Gender and dual eligibility were no longer significant after adjusting for age and other factors, and the association between geriatric care and living in a ZIP code in the highest income quartile was smaller. After adjustment, all geriatric conditions used for sample selection were positively associated with geriatric care except hearing impairment, vision impairment, and dislocation. With the exception of AIDS (which was very rare in this sample), dementia was the variable that had the largest positive association with geriatric care in both the bivariate and multivariate models.

4.4.3. Use of geriatric care over time

More than half of people who used geriatric care had geriatrician visits in a single six month period only. Using data for all complete 6 month periods after the diagnosis of the geriatric condition (two to eight observations per person), 4.7% (10,076) of the 214,375 beneficiaries had at least one geriatrician visit. Among these 10,076 beneficiaries, close to one quarter (23.0%) had only a single geriatrician visit. An additional 31.5% had multiple geriatrician visits in a single six month period but no geriatric care in any other periods. Still, some people were heavy users of geriatric care. Among the 4,585 beneficiaries who had geriatric care in multiple periods, the median share of periods with at least one geriatrician visit was 80%.

Geriatrician visits played a much larger role in nursing home care than in care delivered in other settings. Among the 4,561 beneficiaries who had at least one geriatrician nursing home visit, the median share of nursing home visits that were geriatrician visits over all periods starting with the first period that had geriatric nursing home care was 78.9%. Among the 3,915 beneficiaries who had at least one geriatrician office/outpatient visit, the median share of office/outpatient visits that were geriatrician visits over all periods starting with the first period that had geriatric office/outpatient care was 33.3%.

4.4.4. Results from dementia and CHF subsamples

Geriatrician use in any setting in the first year following diagnosis of the geriatric condition was higher among the dementia (6.7%) and CHF (4.4%) subsamples than in the full sample (3.5%) (Appendix Table 1). The differences in geriatrician use largely applied to beneficiaries who had zero nursing home visits from any specialty. In general, we

found only minor differences in the frequency and location of geriatric care as well as characteristics of geriatric care users when comparing the dementia and CHF subsamples to the full sample (Appendix Tables 2 and 3).

4.5. Discussion

Using Medicare claims data for a national sample of elderly beneficiaries with a prior hospitalization for ACS, this study described the frequency and location of geriatric care and characteristics of geriatric care users based on visits for evaluation and management services during one year following diagnosis of a geriatric condition. We found that geriatric care reached a very small share (3.5%) of Medicare beneficiaries who had at least one diagnosis that indicated the potential to benefit from geriatric care. The use of geriatric care was relatively evenly split between heavy users (4 or more visits in one year) and light users (1 to 3 visits in one year). More than two-thirds of people who had at least one geriatrician visit in a nursing home had geriatric care for the majority of their nursing home visits in the year. This suggests that geriatricians were largely functioning as primary care providers for nursing home residents while they functioned as both primary care and consultative care providers for patients in community settings. Beneficiaries with either dementia or CHF were more likely to have geriatric care than the full sample. An assessment of trends in the use of geriatric care over time also indicated a split in the use of geriatric care between heavy and light users and concentration of heavy use in nursing homes. Assuming beneficiaries did not have visits to multiple individual geriatricians, this suggests that people who received geriatric care in the nursing home tended to receive most of their care from a single provider while in a nursing home.

Although the use of geriatric care was rare among all people regardless of geographic location, our data indicate that the use of geriatric care was largely restricted to people who had geographic access. The reduction in odds of geriatric care associated with living in a rural area was equivalent to the increase in odds associated with being aged 86 or older. Generally speaking, geriatrician supply is concentrated in areas with academic medical centers which are typically located in metropolitan areas [40]. We repeated the analyses described in this paper to compare beneficiaries who lived in a county with at least one geriatrician with those who lived in a county with zero geriatricians and found that people with geographic access were substantially more likely to receive geriatric care in both hospital and non-hospital settings. Beneficiaries with geographic access had a higher number of geriatrician visits and were more likely to use geriatric care repeatedly over time than those who had at least some geriatric care but lacked geographic access. Policies which encourage the availability of geriatric care in non-metropolitan areas could help to correct this imbalance (e.g., linking academic medical centers that have several geriatricians on staff with physicians in other areas).

Using claims data for elderly fee-for-service Medicare beneficiaries who survived at least one year after a hospitalization for ACS limits the external generalizability of our results. Given the potentially life-threatening nature of ACS, it is possible that cardiac care could have "crowded out" geriatric care. To mitigate this issue, we required a diagnosis of a geriatric condition at least one year after the ACS hospitalization. Further, use of geriatric care in the year following diagnosis of the geriatric condition was more common among people whose condition was diagnosed one to two years after the ACS hospitalization than among those whose condition was diagnosed at least two years later.

Higher use of geriatric care by the group whose diagnosis occurred closer in time to the ACS hospitalization suggests that cardiac care did not crowd out geriatric care in our sample; this improves confidence in the generalizability of our results. A second limitation is that we could not identify visits to gerontological nurse practitioners. Finally, it is possible that some diagnoses may have been correlated with physician specialty. Geriatricians may diagnose conditions such as dementia or depression more often or at an earlier stage than other types of physician; different diagnosis patterns could account for some of the differences in comorbidity prevalence between users and non-users of geriatric care [21].

This investigation used patient-level data to describe the use of geriatric care in the United States. Our findings are consistent with existing knowledge about the limited use of geriatric care in the United States, particularly in non-metropolitan areas. Geriatric care was used by very few beneficiaries, even though everyone in the sample had experienced at least one condition for which geriatricians have advanced knowledge and training. The 96.5% of beneficiaries who had no geriatric care rely on traditional primary care providers and specialists. Although some physicians may have extensive experience dealing with geriatric conditions and other issues related to aging, many physicians do not. Training for FM/IM physicians and specialists may be inadequate for several competencies related to elderly patients, including recognition and management of geriatric conditions, transitional care, assessment of caregiver and family needs, and coordination of care [9-12]. Further, physician residencies often lack exposure to settings of care outside of the hospital, including nursing homes [4].

The rarity of geriatric care is largely due to the low supply of geriatricians, an issue which has been a concern for years [4, 14]. This study did not address the effects of geriatric care, but even if geriatric care does improve health outcomes, our results suggest that the impact of clinical practice at the population level is very minimal. For clinical geriatric care to have a sizeable effect would require an enormous increase in the supply of geriatricians. Recent policy changes such as a provision in the Affordable Care Act that temporarily increases reimbursement for primary care services provided by geriatricians (in addition to other primary care physicians) are unlikely to achieve this goal [38]. The low supply of geriatricians implies that not clinical practice but instead teaching, research, and advocacy/policymaking are the pathways through which geriatric medicine may be able to have a broad impact on the health of older adults. Therefore, despite the fact that the population who can receive geriatric care directly is geographically limited, concentration of geriatricians in academic medical centers may be beneficial for the purposes of advancing the field of geriatric medicine via teaching, research, and advocacy/policymaking.

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Figure 4.1. Sample selection criteria

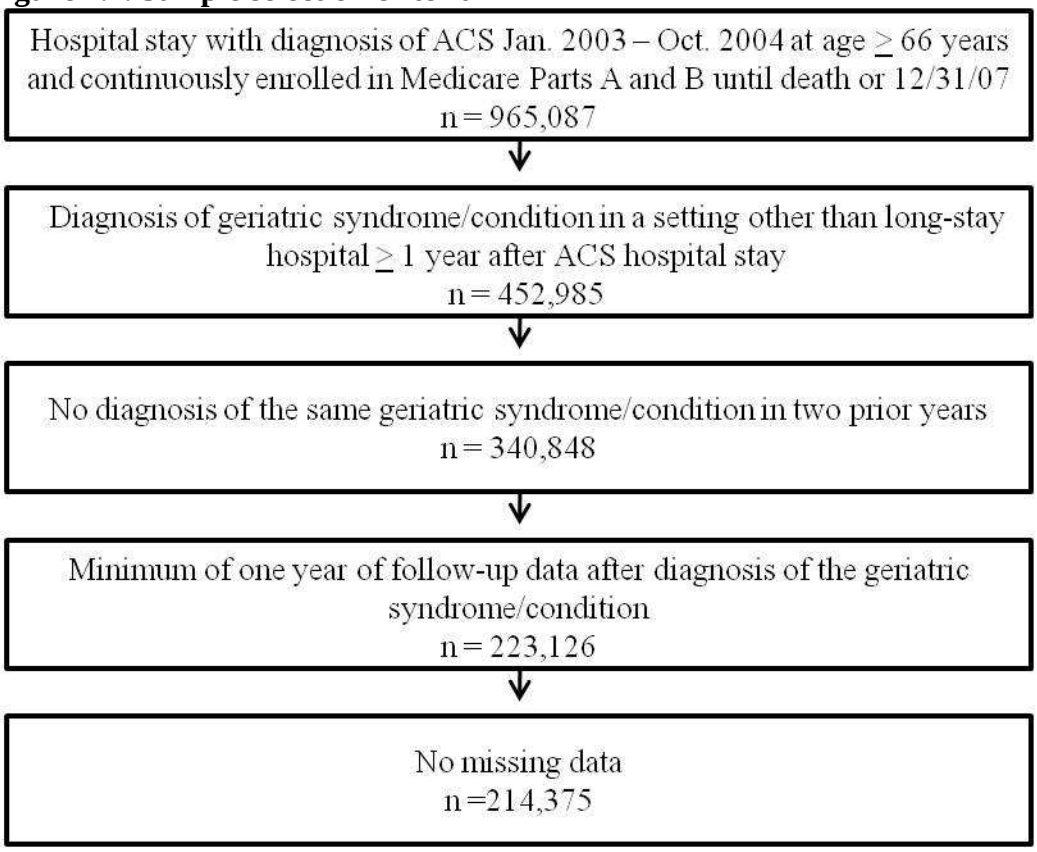

Table 4.1. ICD-9-CM codes used to identify geriatric conditions

Geriatric condition	ICD-9-CM codes
Stroke	430.xx-432.xx, 434.xx-437.1x, 437.3x-438.xx
Dementia	290.0-290.43, 294.0-294.8, 331.0-331.2, 331.7, 797
Depression	300.4, 301.12, 309.0, 309.1, 311
Delirium	293.0x, 293.1x
Pressure ulcer	707.0x, 707.2x-707.9x
Fracture	800.xx--829.xx
Dislocation	830.xx-839.xx
Laceration	870.xx-879.xx, 880.xx-884.xx, 890.xx-894.xx
Osteoporosis	733.0
Syncope	780.2
Hearing impairment	389.xx
Vision impairment	369.xx
Urinary incontinence	596.51-596.52, 596.54-596.59, 599.8x, 625.6x, 788.3, 788.30-788.34, 788.37-788.39
Weight loss/failure to thrive	260-263.9, 783.21-783.22, 783.7x
Dehydration	276.5

Table 4.2. BETOS and HCPCS codes used to identify location of physician visits

Location	BETOS	HCPCS
Office, nursing home, home	M1A, M1B, M4A, M4B, M5A, M5B, M5C, M5D	90652, 99201-99205, 99211-99215, 99241-99245, 99271-99275, 99301-99318, 99341-99350, 99379, 99380, G0066, G0175, G0375, G0376
Hospital, emergency department	M2A, M2B, M2C, M3	99217-99239, 99251-99255, 99261-99263, 99281-99288

BETOS = Berenson-Eggers Type of Service, HCPCS = Healthcare Common Procedure Coding System

Table 4.3. Frequency and location of geriatric care during first year following diagnosis of geriatric condition

Geriatrician visits	People	%
All settings		
0	206,960	96.5
1	1,833	0.9
2-3	1,951	0.9
4-6	1,541	0.7
≥7	2,090	1.0
≥1	7,415	3.5
Office, nursing home, home		
0	208,312	97.2
1	1,464	0.7
2-3	1,640	0.8
4-6	1,372	0.6
≥7	1,587	0.7
≥1	6,063	2.8
Hospital, emergency department		
0	211,850	98.8
1	816	0.4
2-3	724	0.3
4-6	479	0.2
≥7	506	0.2
≥1	2,525	1.2

Table 4.4. Factors associated with geriatric care in first year following diagnosis of geriatric condition

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Sample	206,960	7,415				
Female	64.9	70.2	1.27**	(1.21,1.34)	1.06	(1.00,1.12)
Nonwhite	10.2	13.6	1.39**	(1.30,1.48)	1.27**	(1.18,1.38)
Dual eligible	19.2	21.7	1.16**	(1.10,1.23)	0.95	(0.89,1.01)
Age						
75 or younger	28.8	18.9	Reference		Reference	
76-80	24.4	21.7	0.86**	(0.81,0.91)	1.23**	(1.14,1.32)
81-85	23.7	26.4	1.15**	(1.09,1.21)	1.40**	(1.30,1.51)
86 or older	23.1	33.1	1.65**	(1.57,1.73)	1.65**	(1.53,1.78)
Income						
1st quartile	25.1	18.7	Reference		Reference	
2nd quartile	25.1	19.2	0.71**	(0.67,0.75)	0.98	(0.90,1.06)
3rd quartile	25	27	1.11**	(1.05,1.17)	1.14**	(1.05,1.23)
4th quartile	24.8	35.1	1.64**	(1.56,1.72)	1.32**	(1.22,1.42)
Metropolitan status						
Metropolitan area	69.1	87.1	Reference		Reference	
Micropolitan area	15.1	7.3	0.44**	(0.41,0.48)	0.46**	(0.42,0.51)
Small town	9.1	3.3	0.34**	(0.30,0.39)	0.36**	(0.31,0.41)
Rural area	6.7	2.3	0.33**	(0.28,0.38)	0.35**	(0.29,0.41)
Geriatric conditions						
Stroke	26.2	32.3	1.34**	(1.28,1.41)	1.15**	(1.09,1.21)
Dementia	19.9	39.8	2.66**	(2.53,2.79)	1.95**	(1.85,2.07)
Osteoporosis	22	25.6	1.22**	(1.16,1.29)	1.32**	(1.25,1.40)
Urinary incontinence	10.3	12.8	1.28**	(1.19,1.37)	1.36**	(1.27,1.46)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Depression	19.4	32.3	1.99**	(1.89,2.09)	1.76**	(1.67,1.86)
Dehydration	17.8	22.7	1.36**	(1.28,1.44)	1.11**	(1.05,1.18)
Hearing impairment	7.7	6.8	0.88**	(0.80,0.96)	1.06	(0.96,1.16)
Syncope	16.9	17.6	1.05	(0.99,1.12)	1.10**	(1.03,1.17)
Fracture	17.5	23.6	1.45**	(1.38,1.54)	1.42**	(1.34,1.50)
Pressure	4	8.6	2.26**	(2.08,2.46)	1.51**	(1.38,1.65)
Weight loss/failure to thrive	9.3	15.9	1.84**	(1.73,1.96)	1.56**	(1.45,1.67)
Vision impairment	1.7	2	1.20*	(1.02,1.42)	1.17	(0.99,1.39)
Laceration	5.1	6.7	1.33**	(1.21,1.46)	1.20**	(1.09,1.32)
Delirium	1.6	4.1	2.60**	(2.31,2.93)	1.50**	(1.31,1.70)
Dislocation	2.6	1.6	0.59**	(0.49,0.71)	0.92	(0.77,1.12)
Comorbidities						
Hypertension	89.3	93.1	1.63**	(1.49,1.78)	1.35**	(1.23,1.48)
CHF	42.9	55.1	1.63**	(1.56,1.71)	1.26**	(1.19,1.33)
Diabetes	39.4	41.4	1.09**	(1.04,1.14)	0.97	(0.91,1.03)
Deficiency anemia	39.3	52.6	1.72**	(1.64,1.80)	1.19**	(1.13,1.26)
Chronic obstructive pulmonary disease	34	36.4	1.11**	(1.06,1.17)	1.00	(0.95,1.05)
Peripheral vascular disease	28.8	36.7	1.44**	(1.37,1.51)	1.06*	(1.01,1.12)
Hypothyroidism	26	29.9	1.21**	(1.15,1.28)	1.03	(0.98,1.08)
Valvular disease	22.8	24.7	1.11**	(1.05,1.17)	0.97	(0.92,1.03)
Other neurological	11.4	18.1	1.72**	(1.62,1.83)	1.17**	(1.09,1.25)
Diabetes, with complications	15.7	19.5	1.29**	(1.22,1.37)	1.17**	(1.09,1.26)
Renal failure	14.2	18.5	1.37**	(1.29,1.45)	1.19**	(1.11,1.27)
Tumor, no metastasis	12.4	12.4	1.00	(0.93,1.07)	1.05	(0.98,1.14)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Electrolyte disorder	16.3	23	1.54**	(1.46,1.63)	1.12**	(1.06,1.19)
Hypertension, with complications	20.4	21.7	1.08**	(1.02,1.14)	0.85**	(0.80,0.90)
Paralysis	1.9	3.3	1.77**	(1.56,2.02)	1.33**	(1.16,1.53)
Psychoses	7.9	15.9	2.20**	(2.06,2.34)	1.21**	(1.12,1.30)
Coagulation deficiency	5.4	6.8	1.27**	(1.16,1.39)	1.04	(0.95,1.15)
Rheumatoid arthritis	6.3	7	1.13**	(1.03,1.24)	1.08	(0.98,1.19)
Obesity	3.6	4	1.10	(0.98,1.24)	1.19**	(1.05,1.35)
Pulmonary circulation disorder	3.6	4.6	1.32**	(1.18,1.47)	1.15*	(1.02,1.29)
Blood loss anemia	3.1	4	1.30**	(1.16,1.47)	1.01	(0.90,1.15)
Metastatic cancer	1.5	1.6	1.09	(0.91,1.31)	1.08	(0.89,1.32)
Lymphoma	1.2	1.4	1.19	(0.98,1.45)	1.15	(0.94,1.41)
Liver disease	1.1	1.5	1.31**	(1.08,1.59)	1.21	(1.00,1.48)
Alcohol abuse	0.8	1.1	1.37**	(1.10,1.71)	1.22	(0.97,1.53)
Drug abuse	0.3	0.7	2.29**	(1.71,3.07)	1.73**	(1.28,2.34)
AIDS	0	0.1	3.18**	(1.60,6.34)	2.43*	(1.15,5.13)
Ulcer	0.2	0.2	1.31	(0.78,2.20)	1.08	(0.63,1.84)
Constant					0.01**	(0.01,0.01)

**p<0.01, *p<0.05

5. STUDY 2: THE ASSOCIATION OF GERIATRIC CARE AND EMERGENCY DEPARTMENT USE

5.1. Abstract

Objective: To determine the effect of geriatric care on emergency department (ED) use.

Data Sources: 2002-2007 Medicare claims data for a national sample of elderly beneficiaries with a hospitalization for acute coronary syndromes.

Study Design: Individuals diagnosed with a geriatric condition were followed up to three years. Fixed effects were used to control for unobserved heterogeneity.

Data Collection: We examined the likelihood of ED use each month. Geriatric care was measured with a six month lag as number of visits and share of total visits to geriatricians. Samples were stratified by community and long-term nursing home residence.

Principal Findings: Geriatric care was associated with reductions in monthly ED use of 7.5% to 18.8%. Reductions associated with geriatric consultative care were not statistically different from reductions associated with geriatric primary care. Results for the two samples were similar.

Conclusions: Geriatric care appears to have protective effects on ED use among at-risk elders. Geriatric consultative care may be as effective at reducing ED use as geriatric primary care. Results are evidence of associations; causality is still uncertain. Additional studies are needed to examine the effect of geriatric care on additional outcomes in other samples and to assess whether differences exist in the effects of geriatric primary and

consultative care.

Key words: geriatric care, primary care, nursing home, emergency department

5.2. Introduction

Health care for older adults with chronic conditions is costly and often of suboptimal quality [1, 2]. The quality of health care for geriatric conditions (e.g., dementia, incontinence) may be considerably poorer than for other conditions such as diabetes and hypertension [3]. Geriatricians may be better able to address the complex physical, cognitive, mental, and social issues faced by older adults who have geriatric conditions. Geriatricians are family medicine or general internal medicine (FM/IM) physicians who are certified in geriatric medicine (GM). In this paper, the term "geriatric care" refers to care provided by geriatricians. Processes of geriatric care include prevention and early recognition of acute illness, management of chronic disease and medications, coordination of care among multiple providers, and communication with caregivers [13].

Compared to other physicians, geriatricians' training and experience may enable them to provide higher quality of care for elders who have geriatric conditions. Higher quality of care may lead to reductions in some types of health care use such as emergency department (ED) use. Reductions in ED use are desirable from the perspectives of patients, providers, payers, and society. ED use among elders has increased substantially in recent years [116]. This trend is problematic in part because ED use and hospitalizations are linked to adverse outcomes including inappropriate medication use, hospital-acquired infections, and declines in functional and cognitive status [117-121].

Evidence related to the effects of geriatric care has been generated by randomized controlled trials of comprehensive geriatric assessment (CGA). CGA is a multidimensional, interdisciplinary process that assesses an individual's physical, cognitive, mental, and social problems, aims to improve diagnostic accuracy and optimize drug prescribing, and develops a coordinated plan for treatment and follow-up [44-46]. CGAs that provide ongoing care in outpatient and in-home settings have shown favorable effects on physical functioning, mental, and cognitive health, although they may not reduce nursing home (NH) use and hospitalizations or improve survival [15-20]. Evidence demonstrating the efficacy of CGA without ongoing care (i.e., consultation) in outpatient and home settings is scarce [21-23]. No studies were found that assessed CGA in NHs.

Inferring the effect of geriatric care on health care use in real-world settings is difficult because the level of geriatrician involvement in CGA varies widely and CGA is not commonly available outside of trials. A handful of analyses have tried to explicitly measure the effect of geriatric care using observational data [32, 56, 57]. Those studies used dissimilar measures of geriatric care and had limited external validity. In addition, they failed to control for unobservable factors that may have affected both the use of geriatric care and other types of health care use (e.g., marital status, health-care seeking behavior). When these factors cannot be measured well in secondary data, they have important implications for estimating the effects of geriatric care.

This paper contributes to the literature on the effects of geriatric care by using data from a large national sample to examine whether geriatric care is associated with a reduced likelihood of ED use. We used Medicare claims data for elders who had a prior

hospitalization for acute coronary syndromes (ACS). Because geriatric care is rare, having a sample identified by ACS was advantageous because of the large initial sample size. Since the presence of ACS alone is unlikely to require geriatric care, we used data from beneficiaries with a geriatric condition which suggested that they may have been particularly likely to benefit from geriatric care. We hypothesized that care from geriatricians would lead to a reduced likelihood of ED use compared to care from FM/IM physicians and specialists.

5.3. Methods

5.3.1. Data and sample

We used Medicare claims data for beneficiaries who met the following criteria: an acute care hospital stay with a diagnosis of ACS (ICD-9 codes 410.xx, 411.1x, and 413.9x) from January 2003 through October 2004; age $\geq$ 66 years at the time of the hospital stay; and continuously enrolled in Medicare Parts A and B until death or 12/31/2007 (n=965,087). The initial sample of nearly one million beneficiaries was identified for a separate study [71]. Data from Medicare Provider Analysis and Review (MedPAR), Outpatient, Carrier, and Denominator files were available for 2002 through 2007.

Although ACS is not a condition for which geriatric care would be expected to confer benefits relative to care from other physicians, beneficiaries who have had ACS may have poorer functional status and overall health status than the general elderly population. In combination with the diagnosis of a geriatric condition, these people may have been particularly good candidates for geriatric care. The sample selection criteria were: (1) diagnosis of a geriatric condition in a setting other than a long-stay hospital at

least one year after the hospitalization for ACS (n=452,985), and (2) no diagnosis of the same condition in the two prior years (n=340,848). These criteria created a buffer between measurement of geriatric care and use of cardiac care around the time of the hospitalization and maximized the likelihood that the diagnosis represented the onset of the geriatric condition.

We generated the following list of geriatric conditions from randomized controlled trials of CGA and a survey of directors of geriatrics academic programs which asked to what degree elders would be likely to benefit from geriatric care: stroke, dementia, depression, delirium, pressure ulcer, fractures, dislocations, lacerations, osteoporosis, syncope, hearing impairment, vision impairment, urinary incontinence, weight loss/malnutrition, dehydration, and failure to thrive [28].[1]

5.3.2. Measures

NH Residence

Long-term NH dwellers are likely to have different unobservable characteristics than community dwellers or beneficiaries who have a brief stay in a skilled nursing facility (SNF) (e.g., poorer functional and cognitive status). By separating beneficiaries into two groups based on setting, we hoped to minimize within-group variation in unobserved characteristics. Separate analyses also allowed the effects of geriatric care to differ by setting. NH dwellers were identified by two criteria: three consecutive months with at least one NH claim per month, and at least one of those months had no SNF claims. Once a beneficiary met these two criteria, he/she remained in the NH sample

[1]ICD-9 codes used to identify geriatric comorbidities: 430.xx-432.xx, 434.xx-437.1x, 437.3x-438.xx, 290.0-290.43, 294.0-294.8, 331.0-331.2, 331.7, 797, 300.4, 301.12, 309.0, 309.1, 311, 293.0x, 293.1x, 707.0x, 707.2x-707.9x, 800.xx--829.xx, 830.xx-839.xx, 870.xx-879.xx, 880.xx-884.xx, 890.xx-894.xx, 733.0, 780.2, 389.xx, 369.xx, 596.51-596.52, 596.54-596.59, 599.8x, 625.6x, 788.3, 788.30-788.34, 788.37-788.39, 260-263.9, 783.21-783.22, 783.7x, and 276.5.

permanently. Place of Service codes 31 and 32, Healthcare Common Procedure Coding System (HCPCS) codes 99301-99318, 99379-99380, and G0066, and Berenson-Eggers Type of Service (BETOS) code M4B indicated NH residence in Carrier claims [122]. SNF stays were identified using the SNF indicator code in MedPAR claims.

ED use

We used a binary measure indicating whether the beneficiary had any ED use in a month. We used monthly measures of ED use to minimize bias from censoring. Revenue centers 0450-0459 or 0981 indicated ED use in Outpatient claims [78]. A positive ED charge indicated ED use in MedPAR claims.

Geriatric care

Using Carrier data, a physician visit was defined as all line items provided to a single beneficiary on a given date by a single physician [6]. Visits were identified by BETOS codes for evaluation and management services provided during office, home, and NH visits or during consultations provided in one of those settings [72]. All line items with BETOS codes M1A, M1B, M4A, M4B, and M6 were included unless one of the following HCPCS codes was present: 99221-99239, 99251-99255, 99261-99263, 99271-99275, 99411-99412, 95115-95117, or G0175.

Physicians were identified by a physician-related Unique Provider Identification Number [72, 73]. Three physician specialty groups were used: geriatricians, FM/IM physicians, and specialists. Visits to FM/IM physicians and specialists were classified based on the physician specialty listed on the Carrier claim.[2] Visits to general

[2]The following specialties were included in the specialist group: addiction medicine, allergy and immunology, cardiology, dermatology, endocrinology, gastroenterology, gynecological oncology, hematology, hematology-oncology, infectious diseases, interventional radiology, medical oncology, nephrology, neurology, neuropsychiatry, obstetrics/gynecology, osteopathic manipulative treatment,

practitioners, preventive medicine physicians, nurse practitioners (NPs), and physician assistants (PAs) were included with FM/IM physicians. The data did not indicate NP and PA specialty, whether an NP or PA billed incident to a physician, or whether a NH resident received care from the NH medical director.

A much larger share of geriatricians than non-geriatricians were listed as having multiple specialties in the claims data for a single year (e.g. a physician listed as GM for some visits and IM for others). Therefore, using the specialty listed for a given visit would likely have undercounted geriatrician visits. We considered physicians with at least two visits in a year coded as GM to be a geriatrician for all visits by all beneficiaries in that year. Since physicians self-identify their specialty when they apply to become a Medicare provider, geriatrician specialty does not necessary imply that a physician has ever been or is currently certified in GM.

We measured geriatric care during six month periods. A shorter measure of geriatric care (e.g., three months) would have failed to capture many beneficiaries who used geriatric care very infrequently, while a longer measure (e.g., nine months) may have hidden a true effect of geriatric care if it diminished over time. Two measures indicated the dose of geriatric care: any geriatric care ("any GM") and 1, 2, or ≥3 visits ("number of GM visits"). A third measure indicated geriatric care as a share of all physician visits. The reference category was beneficiaries for whom FM/IM visits accounted for the largest number of total visits ("FM/IM plurality"). Three groups were compared to FM/IM plurality: (1) beneficiaries for whom geriatrician visits accounted for the largest number of total visits ("GM plurality"); (2) beneficiaries who had at least one

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physical medicine and rehabilitation, psychiatry, pulmonary disease, radiation oncology, rheumatology, surgical oncology, and urology.

geriatrician visit but for whom geriatrician visits was not the largest number ("GM consultation"); and (3) beneficiaries for whom specialist visits was the largest number ("specialist plurality").

Control variables

Metropolitan status was obtained by linking ZIP code to Rural-Urban Commuting Area Codes [69]. Median household income was measured at the ZIP code level using data from the 2000 Census [70]. ZIP code was derived from claims files; for beneficiaries with no physician visits in a year and all beneficiaries in 2007, ZIP code came from the Denominator file. Dual eligibility measured whether the beneficiary had some or all of their Medicare costs paid by the state Medicaid program [91]. Dichotomous month variables captured seasonal variation in ED use, and non-linear time trends captured any changes in ED use that occurred during the study period.

MedPAR, Outpatient, and Carrier claims were used to create two sets of comorbidities: the standard set of comorbidities introduced by Elixhauser, and the set of geriatric conditions listed above [80, 86]. Comorbidities were included only if they were found in one MedPAR or two or more Outpatient or Carrier claims occurring more than thirty days apart [87, 88]. Evidence suggests that diagnoses may be underreported in claims data [89, 90]. Therefore, comorbidities that were likely to be present even when not indicated in claims data were indicated in the period of the first diagnosis and for all subsequent periods; these were stroke, osteoporosis, dementia, urinary incontinence, hearing impairment, vision impairment, hypertension, diabetes, congestive heart failure, deficiency anemia, chronic obstructive pulmonary disease, peripheral vascular disease, hypothyroidism, valvular disease, diabetes with complications, tumor without metastasis,

renal failure, other neurological disorder, rheumatoid arthritis, obesity, metastatic cancer, paralysis, lymphoma, liver disease, and alcohol abuse.

5.3.3. Statistical analysis

The unit of analysis for this study was the beneficiary-month (30 day period) beginning with the date of diagnosis of the geriatric condition. ED use was estimated as a function of geriatric care during the previous six months. Using a lagged measure ensured that the geriatric care occurred prior to the ED use. A beneficiary was in the community sample until death, end of study, or the first month he or she was identified as a NH resident. Upon entering a long-stay hospital, a beneficiary was permanently excluded from both samples. Sample sizes were 287,259 community dwellers (5,277,762 observations) and 66,551 NH dwellers (1,005,122 observations). Some beneficiaries (n=26,875) had observations in both samples.

A host of factors may play a role in whether people choose geriatric care including health status, family support, referral from one's existing provider or NH, and the costs of geriatric care. Since some of these factors may also affect ED use and were unobservable in Medicare claims data, we used linear probability models (LPMs) with individual fixed effects (FE) to control for time-invariant unobserved variables. F tests of joint insignificance of the FE were rejected for both samples ($p<0.000$), and Hausman tests indicated that estimates from OLS models were inconsistent ($p<0.000$). We used LPMs rather than logit models because of the issue of perfect prediction. In the naïve (i.e., multivariate regression) models, ED use was estimated with standard errors clustered at the beneficiary level.

5.3.4. Alternative specifications

Six months may be too long or too brief a period of time for geriatric care to affect outcomes, so we also measured geriatric care over three months and nine months. To test whether our measure of long-term NH use was overly restrictive, we used an alternative measure: two consecutive months with at least one NH claim. We also conducted the analyses for beneficiaries who had a diagnosis of dementia in the first month.

We tried instrumental variable (IV) regression, since it is plausible that time-varying unobserved variables may affect both geriatric care and ED use (e.g., functional status).We used a recursive bivariate probit model to estimate the effects of any geriatric care using IV [102]. In a recursive bivariate probit model, the dependent variable of one equation appears on the right-hand side of the other equation. The error terms from the two equations are allowed to be correlated. The instruments were county geriatrician supply and differential distance to geriatric care (distance from beneficiary home ZIP code to nearest geriatrician minus distance from home ZIP to nearest FM/IM physician or specialist). The data for the instruments were from an analytic file created using data from the American Medical Association Physician Masterfile and the American Board of Medical Specialties. Tests of exogeneity suggested that any geriatric care was not exogenous in either sample ($p<0.05$) [107]. F-tests indicated that the instruments were strong (F test statistic>10) [108]. However, we do not present IV results as the preferred approach because of questions regarding the validity of the instruments. Lagrange Multiplier tests of overidentification rejected the null hypothesis that the instruments were jointly validly excluded from models of ED use. Correlation between control

variables and instruments also suggested that the instruments may not have been validly excluded.

5.4. Results

5.4.1. Descriptive statistics

ED use was observed for a median of seventeen months for beneficiaries in the community sample and fourteen months for those in the NH sample. The majorities of both samples were female, white, and at least 80 years old in the first month of observation (Table 5.1). NH dwellers had a median of six comorbidities compared to four for community dwellers. The comorbidity with the largest difference in prevalence between the two samples was dementia: 44.3% (NH) compared to 13.2% (community) (Appendix Table 4).

Geriatric care was uncommon in either sample, although it was much more frequent in the NH sample (5.2% of NH observations vs. 1.4% of community observations). Nearly 60% of observations with geriatric care for NH dwellers were for ≥3 visits compared to 42.9% for community dwellers. GM plurality and GM consultation were approximately equal in both samples. More beneficiaries in the NH sample had any geriatric care during at least one observation in the study period than in the community sample (8.4% vs. 2.7%).

The monthly rate of ED use was somewhat lower among community dwellers (8.0% community vs. 9.6% NH). The majority of each sample had at least one ED visit during the study period (60.2% community vs. 65.8% NH).

5.4.2. Main results

Results from the naïve models showed that geriatric care was associated with reductions in the predicted probability of monthly ED use for both samples (Table 5.2). In naïve models, measures of geriatric care that indicated heavier use (2 visits, ≥3 visits, GM plurality) were generally more often statistically significant than measures that indicated lighter use (any geriatric care, 1 visit, GM consultation).

FE models suggest that geriatric care had a significant negative association with ED use for both samples. The reductions in ED use associated with the various measures of geriatric care were similar across the two samples. Compared to results from the naïve models, FE results showed a larger favorable association for any geriatric care. For community residents, the reduction in ED use of 0.9 percentage points associated with any geriatric care represented an 11.3% decrease from the average monthly ED use of 0.080 (Figure 5.1). The naïve model predicted a 5.0% decrease (0.4 percentage points). For NH residents, the reduction in ED use of 1.1 percentage points associated with any geriatric care represented an 11.5% decrease from the average monthly ED use of 0.096, compared to 8.3% for the naïve model. The largest reduction in the likelihood of ED use was associated with ≥3 visits, but those effects were not significantly different from the effects of 2 visits for either sample.

GM plurality was significantly associated with a reduction in ED use compared to FM/IM plurality. The effect sizes were reductions of 10.0% (0.8 percentage points) for community dwellers and 9.4% (0.9 percentage points) for NH dwellers. The effects of GM consultative care were slightly larger than but not statistically different from GM plurality in both samples.

For both samples, the associations of geriatric care with ED use were at least as large (absolute value) as the coefficient estimates of many of the demographic characteristics such as age and metropolitan status (Appendix Table 5). Several of the comorbidities had larger associations with ED use than did geriatric care.

5.4.3. Alternative specifications

Results from three (nine) month measures of geriatric care suggested slightly smaller (larger) reductions in ED use compared to results from six month measures; interpretation of those results was the same as above. Using samples defined by the alternative measure of NH residence led to estimates that were very similar to the original estimates. Results for beneficiaries with dementia were also very similar in magnitude to the original estimates, although in some cases they were not statistically significant (likely due to a lack of statistical power, since the dementia subsamples were substantially smaller than the full samples).

Reductions in the predicted probability of ED use from any geriatric care estimated by IV models were statistically significant and were several times larger than reductions in ED use estimated by FE models: 7.4 (IV) versus 0.9 (FE) percentage points for community dwellers and 11.7 (IV) versus 1.1 (FE) percentage points for NH dwellers. IV results apply to the marginal subpopulation only (i.e., the local average treatment effect) [123]. This group was beneficiaries who would have received geriatric care solely because it is plentiful in their local area; they may not be generalizable to those who intentionally seek geriatric care. If ED use for the marginal subpopulation was anything close to the rates for the full samples (8.0% community, 9.6% NH), then the estimated effects of 7.4 (community) and 11.7 percentage points (NH) would be implausibly large.

IV and FE models estimated using data for beneficiaries who were living in county with at least one geriatrician produced results that were very similar to those from the full sample. Because we found evidence that the instruments were not validly excluded from the model of ED use, we chose FE as the preferred specification.

5.5. Discussion

Using claims data for elderly Medicare beneficiaries who had a history of ACS and a subsequent diagnosis of a geriatric condition, we found that geriatric care was used rarely but occurred much more often among NH dwellers than community dwellers. Reductions in ED use were seen for a variety of measures of geriatric care for both samples. Predicted reductions in monthly ED use were small in an absolute sense (0.6 to 1.8 percentage points) but large in a relative sense (7.5% to 18.8%). GM consultation was found to be as effective as GM plurality for both samples.

Particular contributions of this study to the literature on the effects of geriatric care are threefold: (1) a large, geographically diverse sample; (2) a variety of measures of geriatric care in community and NH settings; and (3) reduction in bias from unobservable variables that may have affected both ED use and selection into geriatric care. However, the present study has some limitations. The results of this analysis cannot be generalized to beneficiaries without a history of ACS and geriatric conditions nor to those enrolled in Medicare managed care. The claims data lacked a number of variables that would have been useful (e.g., family support, detailed measures of functional and cognitive status). It is possible that time-varying unobserved variables were related to the use of geriatric care as well as ED use, so our results must be interpreted as evidence of an association rather than evidence of a causal link.

Measurement of physician specialty is a key issue in this analysis. Physician specialty was self-designated, and we considered physicians with at least two visits in a year coded as GM to be a geriatrician for all visits in that year. As a result, we many have misclassified some visits to non-geriatricians as geriatric care and vice versa. In addition, some FM/IM physicians have extensive experience working with elders with geriatric conditions. If we could compare only geriatricians with active certification in GM to physicians without extensive experience working with patients with geriatric conditions, we might find an even larger reduction in ED use associated with geriatric care (i.e., the results we present may be a lower bound of the association of geriatric care with ED use). More generally, the mechanisms by which geriatric care may reduce ED use are not clear. Existing evidence on the processes of geriatric care is very limited [32, 53]. We could not discern which aspect(s) of geriatric care were responsible for the negative association with ED use.

Differences in estimates between naïve and FE models suggested the presence of unobserved variables affecting both the use of geriatric care and ED use. One key variable is health status. If declining health status leads to use of geriatric care, then patients who use geriatric care may be less healthy in ways that are unobservable in claims data than patients who do not (e.g., difficulty with activities of daily living). On the other hand, geriatricians may be more likely than other physicians to diagnose geriatric conditions such as dementia [21]. If geriatricians make a diagnosis at an earlier stage in the progression of a condition than non-geriatricians, patients who use geriatric care may be healthier in unobservable ways than those who do not. Therefore, the expected direction of the bias from unobservable variables in the estimation of the effect

of geriatric care on ED use was unclear. We found that decreases in ED use associated with geriatric care were generally substantially larger when estimated by FE models than when estimated by naïve models. In other words, the naïve estimates were biased upward (toward zero) by time-invariant unobservable variables. It may be that the FE effects were larger in part because beneficiaries who visited geriatricians had poorer unmeasured health status than other beneficiaries (assuming that poorer unmeasured health status was also related to higher ED use). Although FE could not control for changes in health status during the study period, FE accounted for unmeasured health status at baseline.

In this study, we found that although geriatric care is rarely used, it may be effective in reducing ED use. This suggests that increasing the supply of geriatricians may lead to improved health outcomes for elderly Medicare beneficiaries with geriatric conditions. Low geriatrician supply in the United States has been a concern for years [4, 14]. An estimated 36,000 geriatricians will be needed to maintain the current geriatrician to elderly population ratio in 2030, yet current graduation rates from geriatrics fellowship programs suggest that there will be 7,750 geriatricians in 2030 [35, 36]. One factor affecting geriatrician supply is remuneration. Geriatricians train at least one additional year but are typically paid less than FM/IM physicians [124, 125].

In the Patient Protection and Affordable Care Act, geriatricians were included in the list of primary care providers who are eligible for a 10% incentive payment from Medicare for primary care services provided from 2011 to 2015 [38]. However, this short-term change in reimbursement is not likely to have a meaningful effect on the supply of geriatricians. Further, Medicare reimbursement for physician visits is based on the time and effort it takes to see an “average” patient, yet geriatricians’ patients tend to

face disproportionately complex physical, cognitive, mental, and social health issues [4, 126]. Permanently increasing reimbursement for visits by patients with complex issues could induce more FM/IM physicians to pursue a certification in GM. Specific options might include expanding reimbursement for case management and coordination of care outside of the face-to-face visit. Expanding the role of midlevel providers (e.g., gerontological NPs) may help to address the shortage of geriatricians [4]. Incentive payments could be broadened to include NPs and PAs specializing in geriatrics and primary care.

Effects of policy changes on the supply of geriatricians are not likely to occur in the short-term (if they occur at all). Therefore, the leading policy implication of this study may not be increasing the number of geriatricians but rather impacting the use of the existing supply of geriatricians. Results from naïve models suggested that compared to FM/IM plurality, GM plurality reduced the predicted probability of ED use by both samples, while GM consultation had no effect. These findings support conclusions from existing literature which suggest that geriatric interventions that provide primary care are substantially more effective than those that provide consultative care. FE results did not support the same conclusions. The reduction in ED use associated with GM consultation was not different from the reduction in ED use associated with GM plurality (which in some cases may suggest the provision of primary care by geriatricians).

Approximately half of observations in both of our samples had geriatric care for a plurality of visits and half had geriatric consultative care. Most geriatricians report regularly providing both primary and consultative care [40]. If geriatric care is as effective in a consultative role as in a primary care role, then more patients could benefit

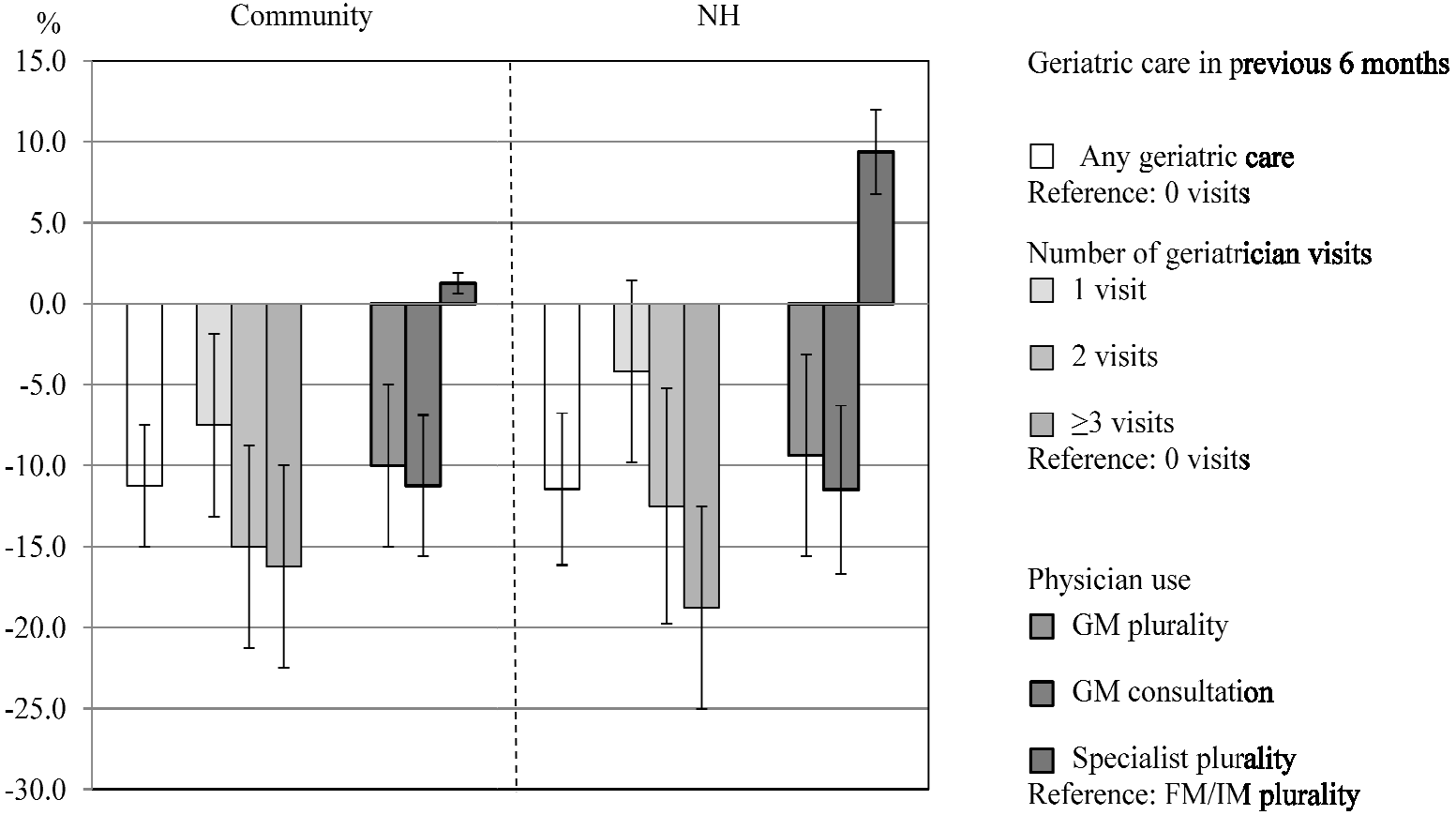
from the existing supply of geriatricians by increasing the amount of geriatric care provided on a consultative basis. Increasing reimbursement for consultations, for interdisciplinary teams, or for activities related to consultations (e.g., communication between the geriatrician providing the consultation and the primary care physician) might encourage geriatricians to increase their role as consultative care providers. Among the list of payment and delivery reform models to be given priority by the Center for Medicare and Medicaid Innovation at the Centers for Medicare and Medicaid Services is the use of geriatric assessments [127].

In our study, geriatric care was provided much more commonly to NH residents than to community residents. Most FM/IM physicians provide little or no NH care, while geriatricians often provide NH care [40, 41, 128]. FM/IM physicians who provide care to NH patients may have more experience treating patients with geriatric conditions and related issues than other FM/IM physicians. Therefore, one might expect that any differences in outcomes as a function of FM/IM physician care versus geriatric care in the community sample would be larger than differences in outcomes between FM/IM physician care and geriatric care in the NH sample. Yet our results suggest that the reduction in ED use associated with geriatric care was very similar for the two samples (after taking into account the slightly higher rate of ED use in the NH sample). Further examination of whether outcomes differ for NH residents on the basis of physician specialty is warranted, especially because the issue has not been addressed by randomized controlled trials. Low reimbursement may play a role in the difficulty of attracting FM/IM physicians to NH care [129]. Increases in reimbursement for NH care may induce more FM/IM physicians to “follow” their patients into NHs (a practice which

is uncommon now) [33]. The provision of NH care by more FM/IM physicians might allow geriatricians more time to provide consultative care for both NH and community residents.

This paper complements the literature on geriatric interventions by assessing the effect of geriatric care on ED use among community and NH residents. The results of this analysis offer an important contribution to a larger assessment of the role of geriatricians and effective models of care for elders with geriatric conditions and suggest directions for future research. Studies should continue to examine whether differences exist in the effects of geriatric primary and consultative care as well as whether the effects of geriatric care vary based on setting of care. More generally, researchers need to analyze the effect of geriatric care in other samples and on other outcomes such as quality of life, functional status, and health care expenditures. Given the increased constraints on geriatrician supply in the near term as the elderly population continues to grow, additional research is needed to ensure that elders with geriatric conditions receive high quality care.

Figure 5.1. Percent change in likelihood of ED use in one month associated with geriatric care



95% confidence intervals shown.
Percent change calculated as change in predicted probability of ED use (Table 5.2) divided by the sample mean of ED use (Table 5.1) multiplied by 100 (e.g., for the community sample, 11.3% for any geriatric care reflects a decrease of 0.9 percentage points relative to the sample average of 0.080).

Table 5.1. Descriptive statistics

	Comm. First month	NH** First month		Comm. All months	NH** All months
Observations	287,259	66,551	*Observations*	5,277,762	1,005,122
Demographic characteristics			*Geriatric care during previous 6 months*		
Age			Any geriatric care	0.014	0.052
66-74	0.231	0.108			
75-79	0.235	0.156	Number of geriatrician visits		
80-84	0.245	0.242	0 visits	0.986	0.948
85-89	0.178	0.255	1 visit	0.005	0.012
90+	0.111	0.238	2 visits	0.003	0.009
Male	0.378	0.286	≥3 visits	0.006	0.031
Nonwhite	0.103	0.116			
Dual eligible	0.171	0.350	Physician use		
ZIP median income	$42,704	$43,987	GM plurality	0.007	0.025
Metropolitan status			GM consultation	0.007	0.027
Metropolitan area	0.686	0.731	Specialist plurality	0.304	0.100
Micropolitan area	0.153	0.130	FM/IM plurality	0.682	0.848
Small town	0.092	0.083			
Rural area	0.069	0.056	*Dependent variable*		
Comorbidities, median	4	6	Any ED use in 1 month	0.080	0.096

**Differences between samples are statistically significant at $p<0.01$ for all variables.
Month indicators, time trends, and comorbidities omitted.

Table 5.2. Change in predicted probability of ED use in one month

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Geriatric care in previous 6 months				
Any geriatric care (reference: 0 visits)	-0.004** (-0.006, -0.001)	-0.009** (-0.012,-0.006)	-0.008** (-0.011, -0.004)	-0.011** (-0.016,-0.007)
Number of geriatrician visits (reference: 0 visits)				
1 visit	0.000 (-0.004, 0.004)	-0.006** (-0.010,-0.001)	0.002 (-0.005, 0.008)	-0.004 (-0.010,0.003)
2 visits	-0.008** (-0.013, -0.004)	-0.012** (-0.017,-0.007)	-0.004 (-0.011, 0.003)	-0.012** (-0.019,-0.005)
≥3 visits	-0.004** (-0.008, -0.001)	-0.013** (-0.018,-0.008)	-0.012** (-0.016, -0.009)	-0.018** (-0.024,-0.012)
Physician use (reference: FM/IM plurality)				
GM plurality	-0.009** (-0.012, -0.005)	-0.008** (-0.012,-0.003)	-0.011** (-0.015, -0.007)	-0.009** (-0.015, -0.002)
GM consultation	-0.001 (-0.004, 0.002)	-0.009** (-0.013,-0.006)	-0.003 (-0.008, 0.001)	-0.009** (-0.006, -0.011)
Specialist plurality	-0.003** (-0.004, -0.002)	0.001 (-0.000,0.001)	0.007** (0.005, 0.009)	-0.010** (-0.015, -0.005)

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Control variables				
Age (omitted: 66-74)				
75-79	-0.001*	-0.001	-0.006**	-0.003
	(-0.001, -0.000)	(-0.003,0.000)	(-0.008, -0.003)	(-0.010,0.003)
80-84	0.002**	0.000	-0.008**	-0.006
	(0.001, 0.003)	(-0.003,0.002)	(-0.009, -0.004)	(-0.014,0.002)
85-89	0.005**	0.001	-0.009**	-0.004
	(0.004, 0.006)	(-0.002,0.004)	(-0.010, -0.007)	(-0.013,0.006)
90+	0.010**	0.007**	-0.010**	0.002
	(0.008, 0.011)	(0.003,0.011)	(-0.011, -0.006)	(-0.009,0.013)
Male	-0.002**	N/A	0.008**	N/A
	(-0.003, -0.002)		(0.007, 0.010)	
Nonwhite	0.003**	N/A	-0.004*	N/A
	(0.002, 0.004)		(-0.007, -0.002)	
Dual eligible	0.016**	-0.003*	-0.005**	-0.010**
	(0.014, 0.016)	(-0.006,-0.001)	(-0.006, -0.004)	(-0.014,-0.007)
ZIP income quartile (omitted: First quartile)				
Second	0.001	-0.007**	-0.003	-0.014**
	(0.000, 0.001)	(-0.011,-0.003)	(-0.005, -0.001)	(-0.022,-0.006)
Third	-0.001	-0.011**	-0.006**	-0.019**
	(-0.002, -0.000)	(-0.015,-0.007)	(-0.007, -0.005)	(-0.027,-0.011)
Fourth	-0.005**	-0.020**	-0.010**	-0.039**
	(-0.006, -0.005)	(-0.024,-0.015)	(-0.012, -0.009)	(-0.048,-0.030)

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Metropolitan status (omitted: Metropolitan area)				
Micropolitan area	0.014**	0.001	0.010**	-0.003
	(0.014, 0.015)	(-0.003,0.006)	(0.009, 0.012)	(-0.015,0.009)
Small town	0.022**	0.007*	0.022**	-0.001
	(0.021, 0.024)	(0.001,0.012)	(0.019, 0.023)	(-0.014,0.013)
Rural area	0.018**	0.008*	0.019**	0.002
	(0.017, 0.019)	(0.001,0.014)	(0.017, 0.023)	(-0.014,0.017)
Observations	5,277,762	5,277,762	1,005,122	1,005,122

** p<0.01, * p<0.05
95% confidence intervals in parentheses.
Month indicators, time trends, and comorbidities omitted.

6. STUDY 3: IS GERIATRIC CARE A SUBSTITUTE OR COMPLEMENT FOR OTHER PHYSICIAN CARE?

6.1. Abstract

Background: Whether geriatric care is typically used in conjunction with or in lieu of visits to family medicine/general internal medicine (FM/IM) physicians or specialists is unknown.

Objectives: Using data on physician visits for evaluation and management services provided in non-hospital settings, we examined the relationship between visits to geriatricians and visits to FM/IM physicians or specialists.

Research Design: We conducted a retrospective cohort analysis using 2002-2007 Medicare claims data for elderly beneficiaries who had a hospitalization for acute coronary syndromes and subsequent diagnosis of a geriatric condition. Analyses were stratified by community and long-term nursing home (NH) residence.

Measures: We measured any geriatric care and number of geriatrician visits during six month periods and FM/IM and specialist visits in the following six months.

Results: Measures of geriatric care were associated with reductions in FM/IM care of 8.8% to 19.4%. The relative magnitude of the reduction in specialist visits associated with geriatric care was smaller than the reduction in FM/IM visits. Relative reductions in specialist visits were larger at lower levels of geriatric care for community dwellers and at higher levels of geriatric care for NH dwellers.

Conclusions: Geriatric care was associated with reduced FM/IM care and in some cases

with reduced specialty care. Results are evidence of associations; causality is still uncertain. In light of increased constraints on geriatrician supply in the near term due to the substantial increase in the elderly population, future studies should determine the circumstances under which substitution of geriatric care for FM/IM care or specialty care is most effective.

Key words: geriatric care, primary care, specialty care

6.2. Introduction

In a traditional arrangement, a family medicine/general practice or general internal medicine (FM/IM) physician provides the majority of a patient's care, and specialists play a complementary role. About 15% of older adults replace traditional primary care with care from specialists [6]. People who develop geriatric syndromes (e.g., dementia, falls), functional limitations, or other geriatric conditions that reduce their quality of life may seek geriatric care or may be referred to geriatric care by an existing provider. Geriatricians are FM/IM physicians who are certified in geriatric medicine.

Geriatricians have extensive training in and experience with physical, mental, and social issues related to aging [13]. FM/IM and other physicians (e.g., geriatric psychiatrists and neurologists) may have extensive experience working with elders. However, these physicians are not likely to be equipped to assess and address the full range of issues related to aging that elders with geriatric conditions may face. Geriatricians can replace a traditional primary care provider, or they can provide consultation for a host of specific issues (e.g., cognitive impairment) that are complementary to primary care from FM/IM physicians. Some evidence suggests that primary care and specialty care are substitutes [130, 131]. However, because most

geriatricians regularly provide both primary and consultative care, geriatric medicine is unique [40]. The relationship between geriatric care and visits to FM/IM physicians and specialists has not been addressed in the literature. In light of the substantial increase in the elderly population in the near-term combined with stagnant geriatrician supply, understanding how geriatric care is presently being used is important [4]. We hypothesized that geriatric care is a substitute for FM/IM care but had no a priori hypothesis about the relationship between visits to geriatricians and specialists.

We used Medicare claims data for elders who had a hospitalization for acute coronary syndromes (ACS). Because geriatric care is rare, having a sample identified by ACS was advantageous because of the large initial sample size. Yet since the presence of ACS alone is unlikely to require geriatric care, we selected a sample that had a geriatric condition. We conducted separate analyses for community and long-term nursing home (NH) dwellers. NH residence is a signal of functional dependence and other complex issues that cannot be measured well using claims data. Patterns of physician use may be different in the two settings because of physician visit regulations for NH residents. The Centers for Medicare and Medicare Services (CMS) requires a physician visit for an initial assessment followed by routine evaluations for every 30 days for the first 90 days and every 60 days thereafter; every other visit can be provided by a physician extender (e.g., nurse practitioner) [33]. Reassessments are required promptly after a significant change in the resident's condition.

Limited existing data describe physician care for NH residents. A majority of NH residents are treated by a physician other than the physician who provided their primary care prior to NH entry; in some cases, this physician is the NH medical director [33, 129,

132]. No existing data describe the use of specialty or consultative care in NHs. Based on the assumption that NH residents and their families prefer to have a single physician provide as much of the patient's care as possible, we hypothesized that geriatric care is negatively associated with both FM/IM care and specialist care for NH residents.

6.3. Methods

6.3.1. Data and sample

We used Medicare claims data for beneficiaries who met the following criteria: (1) an acute care hospital stay with a diagnosis of ACS from January 2003 through October 2004 (Table 6.1); (2) age $\geq$ 66 years at the time of the hospital stay; and (3) continuously enrolled in Medicare Parts A and B until death or 12/31/2007 (n=965,087) [71]. Data from Medicare Provider Analysis and Review (MedPAR), Outpatient, Carrier, and Denominator files were available for 2002 through 2007.

Since the presence of ACS alone is unlikely to suggest a potential to benefit from geriatric care, we used two additional sample selection criteria: (4) diagnosis of a geriatric condition in a setting other than a long-stay hospital at least one year after the hospitalization for ACS (n=452,985), and (5) no diagnosis of the same condition in the two prior years (n=340,848). These criteria created a buffer between measurement of geriatric care and use of cardiac care around the time of the hospitalization and maximized the likelihood that the diagnosis represented the onset of the condition.

Geriatric conditions included stroke, dementia, depression, delirium, pressure ulcer, fracture, dislocation, laceration, osteoporosis, syncope, hearing impairment, vision impairment, urinary incontinence, weight loss/failure to thrive, and dehydration. We created this list of geriatric conditions based on diagnoses used for inclusion in

randomized controlled trials of geriatric interventions and a 2008 survey of directors of geriatrics academic programs which asked to what degree elders with a variety of health conditions or other characteristics would be likely to benefit from geriatric care [28].

6.3.2. Measures

NH residence

We measured long-term NH residence by two criteria: (1) three consecutive months with at least one nursing NH claim; and (2) at least one of these months had no skilled nursing NH (SNF) claims. Once a beneficiary met these two criteria, he/she remained in the NH sample permanently.

Physician visits

Using data from the Carrier files, a physician visit was defined as all line items provided to a single beneficiary on a given date by a single physician [6]. Physicians were identified using the Unique Provider Identification Number. Visits were identified using Berenson-Eggers Type of Service codes for evaluation and management services provided during office, home, and NH visits as well as consultations [72]. Three specialty groups were used: geriatricians, FM/IM physicians, and specialists.

FM/IM and specialist visits

The dependent variables in this study were visits to FM/IM physicians and specialists in six months (we refer to the two dependent variables jointly as “physician visits”). Physician visits were categorized based on the physician specialty listed on the Carrier claim.

Geriatric care

We used two measures of geriatrician visits during a six month period: any geriatric care and 1, 2, or ≥3 visits. A much larger share of geriatricians than non-geriatricians were listed as having multiple specialties in the claims data for a single year (e.g. a physician listed as geriatric medicine for some visits and FM for others). As a result, using the specialty listed for a given visit would likely have undercounted geriatrician visits. We considered physicians with at least two visits in a year coded as geriatric medicine to be a geriatrician for all visits by all beneficiaries in that year.

Control variables

Metropolitan status was obtained by linking ZIP code to Rural-Urban Commuting Areas [69]. Median household income was measured at the ZIP code level using data from the 2000 Census [70]. ZIP code was derived from claims files; for beneficiaries with no physician visits in a year and all beneficiaries in 2007, ZIP code came from the Denominator file. Dual eligibility measured whether the beneficiary had some or all of their Medicare costs paid by the state Medicaid program [91]. Dichotomous month variables captured seasonal variation in physician use, and non-linear time trends captured any changes in physician use that occurred during the study period.

We created two sets of comorbidities: comorbidities defined by Elixhauser, and geriatric conditions listed above [80, 86-88]. Diagnoses may be underreported in claims data [89, 90]. Therefore, comorbidities that were likely to be present even when not indicated in claims data were indicated in the period of the first diagnosis and for all subsequent periods; these were stroke, osteoporosis, dementia, urinary incontinence, hearing impairment, vision impairment, hypertension, diabetes, congestive heart failure, deficiency anemia, chronic obstructive pulmonary disease, peripheral vascular disease,

hypothyroidism, valvular disease, diabetes with complications, tumor without metastasis, renal failure, other neurological disorder, rheumatoid arthritis, obesity, metastatic cancer, paralysis, lymphoma, liver disease, and alcohol abuse.

6.3.3. Statistical analysis

The unit of analysis for this study was beneficiary-six months beginning with the date of diagnosis of the geriatric condition. We chose six months in order to balance our desire for a long follow-up period with the need to minimize the impact of censoring and maintain a sufficient sample size. Physician visits were estimated as a function of geriatric care during the previous six months. Using a lagged measure ensured that the geriatric care occurred prior to the physician visits. A beneficiary was in the community sample until the date of death, end of study, or the first month in which he or she was identified as a NH resident. Upon entering a long-stay hospital, a beneficiary was excluded from both samples for the remainder of the study. The sample sizes were 287,259 community dwellers (1,006,879 observations) and 66,551 NH dwellers (195,433 observations).

We estimated ordinary least squares (OLS) models using fixed effects (FE) at the individual level and compare those results to results from multivariate logistic regression models. We chose FE because unobserved variables may affect both use of geriatric care and other physician care (e.g., social support), and we had difficulties locating valid instrumental variables (IVs). We found evidence in favor of FE for both outcomes and both samples: F tests of joint insignificance of the FE were rejected ($p<0.000$), and Hausman tests indicated that estimates from OLS models were inconsistent ($p<0.000$) [133]. Since results from Poisson models with FE were very similar to results from OLS

models with FE, we chose OLS as the preferred specification for ease of interpretation (Appendix Tables 10 and 11).

6.3.4. Alternative specifications

To assess whether the relationship between geriatric care and specialist visits was moderated by FM/IM care, we included FM/IM visits in the previous six months as an explanatory variable in the model estimating specialist visits and vice versa. We measured physician visits during six months because of our concerns about censoring due to death or end of study. We used binary dependent variables (any FM/IM visits and any specialist visits in six months) to allow for the possibility that geriatric care may have affected the likelihood of having any physician visits rather than the number of physician visits. To test whether results were sensitive to measurement of geriatric care as 1, 2, or ≥3 visits, we estimated models measuring geriatric care as 1, 2, 3, and ≥4 visits. To test whether our measure of long-term NH use was overly restrictive, we used samples defined by an alternative measure: two consecutive months with at least one NH claim.

We explored IV as an alternative to FE since FE do not eliminate bias if time-varying unobserved variables are related to both geriatric care and physician visits. We estimated IV models using two-stage residual inclusion (2SRI) [106]. In 2SRI, both the observed value of any geriatric care and the predicted residual from logit model of any geriatric care were included in the OLS model of physician visits. Instruments were county geriatrician supply and differential distance to geriatric care (distance from beneficiary home ZIP code to nearest geriatrician minus distance from home ZIP to nearest FM/IM physician or specialist). Data for the instruments came from an analytic file created using data from the American Medical Association Physician Masterfile and

the American Board of Medical Specialties. Tests of exogeneity suggested that any geriatric care was not exogenous in either sample ($p<0.05$) [107]. F-tests indicated that the instruments were strong (F test statistic>10) [108]. However, we do not present IV results as the preferred approach because of questions regarding the validity of the instruments. Lagrange Multiplier tests of overidentification rejected the null hypothesis that the instruments were jointly validly excluded from models of ED use. Correlation between control variables and instruments also suggested that the instruments may not have been validly excluded.

6.4. Results

6.4.1. Descriptive statistics

Both samples had a high proportion of females, whites, beneficiaries aged 80 or older, and metropolitan area residents (Table 6.2). NH dwellers had a median of six comorbidities compared to four for community dwellers. NH residents had more FM/IM visits and fewer specialist visits than community residents.

A very small share of beneficiaries in either sample used geriatric care during the study period. Geriatrician use was much higher in the NH sample than in the community sample, and use of geriatric care was heavier in the NH setting. Among all NH observations with geriatric care during the study period, 59.6% had ≥3 visits in six months (2.8% of 4.7%). In contrast, 38.5% of community observations with geriatric care had ≥3 visits (0.5% of 1.3%).

6.4.2. Main results

Results for the community sample from multivariate logistic regression showed that both the binary and ordered measures of geriatric care a six month period were

negatively related to FM/IM visits in the following six months (Table 6.3). The associations of geriatric care with specialist visits were also negative but were smaller than the associations with FM/IM visits. For both dependent variables, FE results were smaller than multivariate logistic regression results. Any geriatric care was associated with a 13.7% reduction in FM/IM visits (decrease of 0.396 visits compared to sample average of 2.9 visits) (Figure 6.1.a). The effect of ≥3 geriatrician visits was statistically different from the effect of 1 visit but not 2 visits. Any geriatric care was associated with a much smaller reduction in the predicted number of specialist visits than FM/IM visits (3.3% versus 13.7%). The association of geriatric care with reduced specialist visits by community residents was found for people with 1 or 2 geriatrician visits but not ≥3 geriatrician visits.

For the NH sample, multivariate logistic regression suggested negative associations between geriatric care and FM/IM visits as well as geriatric care and specialist visits (Table 6.4). FE results were smaller than multivariate logistic regression results. Any geriatric care was associated with a 13.8% reduction in FM/IM visits (Figure 6.1.b). The association of ≥3 geriatrician visits with FM/IM visits was not statistically different from the association of 1 or 2 visits. Any geriatric care was associated with a 10.8% reduction in specialist visits. The reduction in specialist visits associated with geriatric care was concentrated among NH residents with ≥3 geriatrician visits. Estimates from control variables provided additional evidence that geriatric care was more important in predicting FM/IM visits than in predicting specialist visits for both samples (Appendix Tables 12 and 13).

6.4.3. Alternative estimations

Estimations using alternative dependent variables, measures of geriatric care, and samples supported our main conclusions. Specialist visits had no meaningful effect on the relationship between geriatric care and FM/IM visits for either sample, but FM/IM visits impacted the relationship between geriatric care and specialty care. For community dwellers, the reduction in specialist visits associated with geriatric care was small and insignificant for beneficiaries with zero FM/IM visits; beneficiaries who had three FM/IM visits (approximately the sample mean) had a 3.2% reduction in specialist visits. For NH dwellers, the reduction in specialist visits associated with geriatric care was larger for beneficiaries with zero FM/IM visits than those with six FM/IM visits, which was approximately the sample mean (16.5% compared to 10.6%).

IV results were implausible, suggesting that having any geriatric care led to *increases* in the number of FM/IM visits for both samples and specialist visits for the community sample (Appendix Table 14). The IV estimates are relative to mean FM/IM and specialist visits for the marginal subgroup of beneficiaries (i.e., those who would have received geriatric care because of an increase in geriatrician availability as measured by the supply and distance instruments). Even though those means were unknown because the marginal subgroup could not be identified, the results were highly questionable. Compared to the means for the entire samples, IV results suggested a 150% (NH) to 240% (community) increase in FM/IM visits and a 110% increase in specialist visits for the community sample. Because we found evidence that the instruments were not validly excluded from the models of FM/IM and specialty visits, we chose FE as the preferred specification.

6.5. Discussion

In this study, we used Medicare claims data for elderly beneficiaries with a hospitalization for ACS and subsequent diagnosis of a geriatric condition to examine the relationships between geriatric care and other physician visits. For both samples, geriatric care appeared to substitute for FM/IM visits, and the magnitude of the association of geriatric care with specialist visits was smaller than for FM/IM visits. The association of geriatric care with specialist visits was larger at lower levels of geriatric care for community dwellers and at higher levels of geriatric care for NH dwellers.

We found support for our hypothesis that geriatric care is a substitute for FM/IM care from both samples. For community residents, the negative association of geriatric care with FM/IM care was larger at higher levels of geriatric care. For NH residents, reductions in FM/IM visits were statistically equivalent for all levels of geriatric care. Taken together, these results indicate that geriatric care tended to eliminate the need for FM/IM care rather than to identify previously unmet health care needs that were subsequently addressed by an FM/IM physician. The gradient in the geriatric care-FM/IM care relationship for community residents and lack thereof for NH residents suggests that permanent replacement of FM/IM care with geriatric care was more common among NH residents than community residents. In other words, geriatric primary care was more common among NH residents than geriatric consultative care, while community residents tended to receive both consultative and primary care from geriatricians.

For both samples, the relationship between geriatric care and specialty care depended on the dose of geriatric care and the number of FM/IM visits received in the same period as the geriatric care. Geriatric care was associated with a small reduction in specialist visits by community dwellers, but this reduction was statistically significant

only for beneficiaries who had few (1 or 2) geriatrician visits or who had FM/IM visits in conjunction with geriatric care. The small degree of substitution between geriatric and specialty care likely occurs when FM/IM physicians refer patients to geriatric care for problems that might have other otherwise lead to referral to a specialist (e.g., referral to a geriatrician for cognitive impairment in lieu of referral to a neurologist). Geriatric care was neither a substitute for nor complementary to specialty care when a community resident had several (≥3) geriatrician visits. For that group, a reduced need for specialist visits due to geriatricians' specialized experience may have been offset by demand for specialty care induced by geriatric care (e.g., geriatricians may be more likely than FM/IM physicians to perceive aging-related conditions as being treatable problems instead of inevitable consequences of aging).

Results supported our hypothesis that geriatric care is negatively associated with specialist care for NH residents. Compared to NH residents who had no geriatric care, the largest reduction in specialist visits was associated with having several (≥3) geriatrician visits or having geriatric care but no FM/IM care; a smaller reduction was associated with consuming both geriatric care and FM/IM care. In other words, the larger the role of a geriatrician in a NH resident's health care, the larger the decrease in specialty care. Overall, results for both dependent variables suggest that NH residents and their families prefer to have a single physician provide as much of the patient's care as possible.

Effects of geriatric care estimated by FE models were substantially smaller than effects estimated by multivariate logistic regression models. Smaller FE estimates suggest that unobserved, time-invariant individual-level variables caused upward bias in the multivariate estimates. For example, beneficiaries who visited geriatricians may have

had more extensive family and social support than other beneficiaries; if greater support was positively related to both geriatrician visits and other physician visits, this could be one reason why FE estimates were smaller.

Randomized controlled trials have generally found geriatric interventions that provide ongoing care to be more effective than those that provide consultative care [15-23]. This suggests that substitution of geriatric care for FM/IM care, and in particular the focus on geriatric primary care in the NH setting, is appropriate. However, the provision of geriatric primary care limits the clinical impact of geriatric care; the more geriatric primary care that is provided, the fewer number of elders who will receive any level of geriatric care. The relative use of primary and consultative geriatric care is of interest because low geriatrician supply in the United States has been a concern for years [4, 14]. An estimated 36,000 geriatricians will be needed to maintain the current geriatrician to elderly population ratio in 2030, yet current graduation rates from geriatrics fellowship programs suggest that there will be 7,750 geriatricians in 2030 [35, 36]. Data from the present samples suggest that very few elders who may be particularly likely to benefit from geriatric care receive it. Only 2.4% of community residents and 7.4% of NH residents ever had a geriatrician visit during the study period. These figures indicate that geriatricians' ability to affect health care use and outcomes for elders via clinical practice is very limited. The reach of geriatric care is further limited by the practice patterns we found for beneficiaries who used geriatric care (some geriatric primary care for community residents and more widespread geriatric primary care for NH residents).

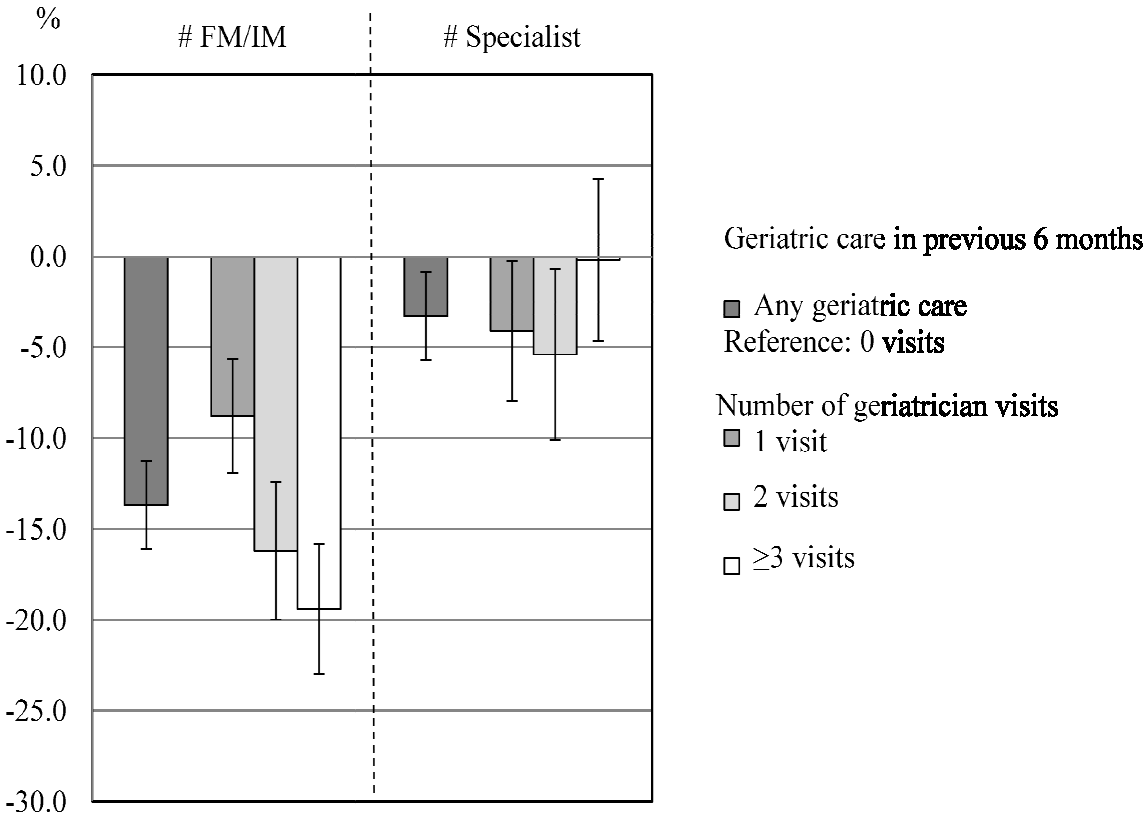
This study has some limitations. Since unobserved variables that varied over time at the individual level were not accounted for by the FE, our results must be interpreted

as evidence of an association between geriatric care and other physician visits rather than evidence of a causal link. Because our dataset is an unbalanced panel, we assumed that attrition in any period was unrelated to unobserved, time-varying variables. This issue is most relevant in the first period, as the 22% of the community sample and 27% of the NH sample that had only one observation did not contribute information toward the FE estimates. Results from multivariate logistic regression models estimated using only beneficiaries who had two or more observations were nearly identical to results estimated using the full samples; this provides some confidence that having an unbalanced panel does not pose major concerns.

The claims data lacked some useful details (e.g., whether a gerontological nurse practitioner billed incident to a physician). Since physicians self-identify their specialty when they apply to become a Medicare provider, geriatrician specialty does not necessary imply that a physician has ever been or is currently certified in geriatric medicine. The results of this analysis cannot be generalized to beneficiaries without a history of ACS and geriatric conditions nor to Medicare managed care enrollees. ACS is not likely to be particularly relevant when considering tradeoffs between geriatric care and FM/IM care. However, because beneficiaries in our study were likely to need at least some cardiac care, we may have estimated a lower bound on the degree of substitution between geriatric care and specialty care. Finally, geriatricians may be more likely than other physicians to diagnose some geriatric conditions [21]. If beneficiaries who received their diagnosis from a geriatrician were systematically healthier in unobserved ways, the negative associations of geriatric care with other types of physician visits could be overestimated.

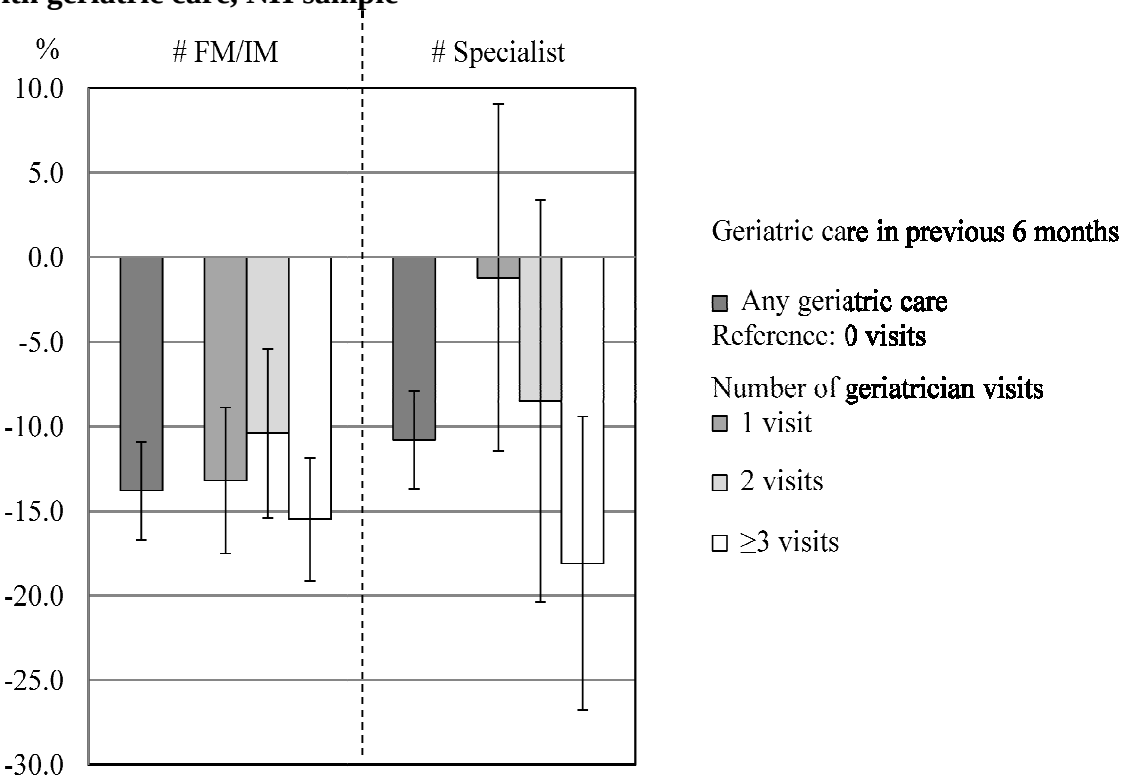
This analysis was the first to use data for a large, national sample of elders to examine whether geriatric care is typically used in conjunction with or in lieu of other types of physician care in non-hospital settings. We found that geriatric care was a substitute for FM/IM care, and permanent replacement of FM/IM care with geriatric care appeared to be more common among NH residents than community residents. Geriatric care was associated with a sizeable reduction in specialty care for NH dwellers that had a high dose of geriatric care and with a small reduction in specialty care for community dwellers that had a low dose of geriatric care. Given the lack of existing evidence on this topic, future studies should determine whether the results of this analysis are found for other samples. Since geriatric care is a substitute for FM/IM care, research is needed to examine the effect of geriatric care compared to FM/IM care on a variety of outcomes including quality of life and health care use, particularly among NH residents who have largely been ignored by trials of geriatric interventions. In light of increased constraints on geriatrician supply in the near term due to the substantial increase in the elderly population, future studies should determine the circumstances under which substitution of geriatric care for FM/IM care or specialty care is most effective. For example, given the very low supply of geriatric psychiatrists, are outcomes for patients who receive geriatric care more favorable than for those who receive psychiatric care from a traditional psychiatrist? If so, is the favorable effect of geriatric care for psychiatry patients larger or smaller than any difference in outcomes for patients with dementia who receive geriatric care compared to those who receive neurological care?

Figure 6.1.a. Percent change in number of physician visits in six months associated with geriatric care, community sample



95% confidence intervals shown.
Percent change calculated as change in number of physician visits (Table 6.2) divided by the sample mean of physician visits (Table 6.1) multiplied by 100
(e.g., for FM/IM visits, 13.7% for any geriatric care reflects a decrease of 0.396 visits relative to the sample average of 2.9 visits).

Figure 6.1.b. Percent change in number of physician visits in six months associated with geriatric care, NH sample



95% confidence intervals shown.
Percent change calculated as change in number of physician visits (Table 6.3) divided by the sample mean of physician visits (Table 6.1) multiplied by 100
(e.g., for FM/IM visits, 13.8% for any geriatric care reflects a decrease of 0.799 FM/IM visits relative to the sample average of 5.8 FM/IM visits).

Table 6.1. Codes used to measure diagnoses, NH residence, physician visits, and physician specialty

Item	Data source	Codes
Diagnoses		
ACS	MedPAR	ICD-9-CM codes 410.xx, 411.1x, and 413.9x
Geriatric conditions	MedPAR, Outpatient, Carrier	ICD-9-CM codes 430.xx-432.xx, 434.xx-437.1x, 437.3x-438.xx, 290.0-290.43, 294.0-294.8, 331.0-331.2, 331.7, 797, 300.4, 301.12, 309.0, 309.1, 311, 293.0x, 293.1x, 707.0x, 788.3, 788.30-788.34, 788.37-788.39, 260-263.9, 783.21-783.22, 783.7x, and 276.5.707.2x-707.9x, 800.xx--829.xx, 830.xx-839.xx, 870.xx-879.xx, 880.xx-884.xx, 890.xx-894.xx, 733.0, 780.2, 389.xx, 369.xx, 596.51-596.52, 596.54-596.59, 599.8x, 625.6x, 788.3, 788.30-788.34, 788.37-788.39, 260-263.9, 783.21-783.22, 783.7x, and 276.5
NH residence		
NH claim	Carrier	Place of service codes 31 and 32, HCPCS codes 99301-99318, 99379-99380, and G0066, BETOS code M4B
SNF claim	MedPAR	SNF indicator code
Physician visits	Carrier	BETOS codes M1A, M1B, M4A, M4B, and M6 (unless one of the following HCPCS codes was present: 99221-99239, 99251-99255, 99261-99263, 99271-99275, 99411-99412, 95115-95117, or G0175)
Physician specialty		
FM/IM physicians	Carrier	Specialty codes 01, 08, 11, 50, 84, 97
Specialists	Carrier	Specialty codes 03, 06, 07, 10, 12, 13, 16, 25, 26, 29, 34, 39, 44, 46, 66, 79, 82, 83, 86, 90-92, 94, 98
Geriatricians	Carrier	Specialty code 38

ACS: Acute coronary syndromes
MedPAR: Medicare Provider Analysis and Review
ICD-9-CM: International Statistical Classification of Diseases and Related Health Problems, Version 9, Clinical Modification
HCPCS: Healthcare Common Procedure Coding System
BETOS: Berenson-Eggers Type of Service

Table 6.2. Descriptive statistics

	Comm. First period	NH** First period		Comm. All periods	NH** All periods
Observations	287,259	66,551	*Observations*	1,006,879	195,433
Demographic characteristics			*Geriatric care in previous 6 months*		
Age			Any geriatric care	0.013	0.047
66-74	0.231	0.108			
75-79	0.235	0.156	Number of geriatrician visits		
80-84	0.245	0.242	0 visits	0.987	0.953
85-89	0.178	0.255	1 visit	0.005	0.011
90+	0.111	0.238	2 visits	0.003	0.008
Male	0.378	0.286	≥3 visits	0.005	0.028
Nonwhite	0.103	0.116			
Dual eligible	0.171	0.350	*FM/IM visits*		
Median income	$42,704	$43,987	#, 6 months, mean	2.9	5.8
Metropolitan status			#, 6 months, median	2.0	5.0
Metropolitan area	0.686	0.731			
Micropolitan area	0.153	0.130	*Specialist visits*		
Small town	0.092	0.083	#, 6 months, mean	2.1	1.3
Rural area	0.069	0.056	#, 6 months, median	1.0	0.0

**Differences between samples are statistically significant at $p<0.01$ for all variables

Table 6.3. OLS results for change in physician visits in six months, community sample

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
Fixed effects?	**No**	**Yes**	**No**	**Yes**
Geriatric care in previous 6 months				
Any geriatric care	-1.075**	-0.396**	-0.229**	-0.070*
(reference: 0 visits)	(-1.142,-1.009)	(-0.467,-0.326)	(-0.298,-0.160)	(-0.133,-0.007)
Number of geriatrician visits				
(reference: 0 visits)				
1 visit	-0.542**	-0.256**	-0.305**	-0.087*
	(-0.645,-0.439)	(-0.346,-0.165)	(-0.389,-0.221)	(-0.168,-0.007)
2 visits	-1.151**	-0.471**	-0.356**	-0.113*
	(-1.263,-1.040)	(-0.581,-0.361)	(-0.456,-0.255)	(-0.211,-0.014)
≥3 visits	-1.486**	-0.562**	-0.087	-0.005
	(-1.583,-1.389)	(-0.667,-0.458)	(-0.206,0.032)	(-0.099,0.088)
Control variables				
Age (omitted: 66-74)				
75-79	-0.006	-0.010	-0.071**	-0.043*
	(-0.033,0.020)	(-0.047,0.027)	(-0.098,-0.044)	(-0.076,-0.010)
80-84	0.012	-0.002	-0.251**	-0.109**
	(-0.016,0.040)	(-0.055,0.050)	(-0.278,-0.223)	(-0.156,-0.062)
85-89	-0.023	-0.042	-0.543**	-0.142**
	(-0.053,0.007)	(-0.110,0.025)	(-0.573,-0.514)	(-0.202,-0.082)
90+	-0.226**	-0.070	-0.994**	-0.065
	(-0.261,-0.192)	(-0.157,0.017)	(-1.026,-0.962)	(-0.143,0.012)
Male	-0.191**	N/A	0.376**	N/A

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
Fixed effects?	**No**	**Yes**	**No**	**Yes**
	(-0.213,-0.170)		(0.355,0.398)	
Nonwhite	0.035	N/A	-0.114**	N/A
	(-0.000,0.070)		(-0.147,-0.081)	
Dual eligible	-0.219**	-0.592**	-0.517**	-0.463**
	(-0.244,-0.193)	(-0.624,-0.559)	(-0.538,-0.495)	(-0.491,-0.434)
ZIP income quartile (omitted: First quartile)				
Second	0.070**	-0.006	0.066**	0.059
	(0.042,0.098)	(-0.088,0.076)	(0.042,0.090)	(-0.014,0.133)
Third	0.120**	0.070	0.126**	0.073
	(0.090,0.149)	(-0.015,0.156)	(0.099,0.153)	(-0.003,0.149)
Fourth	0.062**	0.218**	0.461**	0.097*
	(0.031,0.093)	(0.125,0.310)	(0.430,0.492)	(0.014,0.179)
Metropolitan status (omitted: Metropolitan area)				
Micropolitan area	-0.017	0.116*	-0.513**	-0.169**
	(-0.045,0.011)	(0.012,0.219)	(-0.538,-0.489)	(-0.261,-0.077)
Small town	-0.265**	-0.019	-0.722**	-0.217**
	(-0.301,-0.228)	(-0.144,0.106)	(-0.749,-0.696)	(-0.328,-0.106)
Rural area	-0.382**	-0.007	-0.816**	-0.238**
	(-0.428,-0.336)	(-0.148,0.133)	(-0.845,-0.787)	(-0.363,-0.113)
Observations	1,006,879	1,006,879	1,006,879	1,006,879

** p<0.01, * p<0.05
95% confidence intervals in parentheses.
Month indicators, time trends, and comorbidities omitted.

Table 6.4. OLS results for change in physician visits in six months, NH sample

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
Fixed effects?	**No**	**Yes**	**No**	**Yes**
Geriatric care in previous 6 months				
Any geriatric care	-1.938**	-0.799**	-0.316**	-0.140**
(reference: 0 visits)	(-2.098,-1.778)	(-0.968,-0.631)	(-0.380,-0.253)	(-0.230,-0.051)
Number of geriatrician visits				
(reference: 0 visits)				
1 visit	-0.849**	-0.767**	-0.188**	-0.016
	(-1.110,-0.589)	(-1.017,-0.516)	(-0.322,-0.054)	(-0.150,0.117)
2 visits	-1.145**	-0.605**	-0.339**	-0.111
	(-1.440,-0.850)	(-0.895,-0.315)	(-0.459,-0.220)	(-0.265,0.044)
≥3 visits	-2.612**	-0.898**	-0.361**	-0.235**
	(-2.816,-2.408)	(-1.110,-0.687)	(-0.436,-0.286)	(-0.348,-0.122)
Control variables				
Age (omitted: 66-74)				
75-79	-0.132	-0.289*	-0.124**	-0.266**
	(-0.284,0.020)	(-0.527,-0.050)	(-0.214,-0.033)	(-0.393,-0.139)
80-84	-0.247**	-0.466**	-0.230**	-0.372**
	(-0.392,-0.101)	(-0.772,-0.159)	(-0.322,-0.139)	(-0.535,-0.209)
85-89	-0.270**	-0.565**	-0.396**	-0.393**
	(-0.415,-0.124)	(-0.922,-0.209)	(-0.483,-0.309)	(-0.583,-0.204)
90+	-0.503**	-0.674**	-0.589**	-0.391**
	(-0.650,-0.355)	(-1.084,-0.264)	(-0.676,-0.502)	(-0.609,-0.173)
Male	-0.192**		0.154**	

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
Fixed effects?	**No**	**Yes**	**No**	**Yes**
	(-0.280,-0.104)		(0.104,0.205)	
Nonwhite	0.156*		0.148**	
	(0.023,0.290)		(0.068,0.227)	
Dual eligible	-0.242**	-0.793**	-0.245**	-0.332**
	(-0.319,-0.165)	(-0.922,-0.664)	(-0.284,-0.206)	(-0.401,-0.263)
ZIP income quartile (omitted: First quartile)				
Second	0.088	0.200	-0.008	0.092
	(-0.012,0.188)	(-0.075,0.474)	(-0.061,0.044)	(-0.054,0.239)
Third	0.265**	0.301*	-0.039	0.019
	(0.155,0.374)	(0.017,0.586)	(-0.097,0.018)	(-0.133,0.170)
Fourth	0.453**	0.212	0.243**	0.043
	(0.334,0.572)	(-0.101,0.525)	(0.174,0.313)	(-0.123,0.210)
Metropolitan status (omitted: Metropolitan area)				
Micropolitan area	-1.130**	-0.057	-0.490**	-0.164
	(-1.230,-1.031)	(-0.466,0.353)	(-0.540,-0.441)	(-0.382,0.054)
Small town	-1.298**	0.062	-0.578**	0.095
	(-1.421,-1.175)	(-0.410,0.534)	(-0.639,-0.518)	(-0.156,0.346)
Rural area	-1.407**	0.371	-0.678**	-0.022
	(-1.549,-1.265)	(-0.170,0.912)	(-0.736,-0.620)	(-0.310,0.266)
Observations	195,433	195,433	195,433	195,433

** p<0.01, * p<0.05
95% confidence intervals in parentheses.
Month indicators, time trends, and comorbidities omitted.

7. DISCUSSION

7.1. Summary of findings

7.1.1. Study 1: Use of geriatric care in the United States

In Study 1, we sought to determine the frequency and location of geriatric care, examine patient characteristics associated with use of geriatric care, and describe the use of geriatric care over time. We conducted several bivariate analyses in order to characterize those issues. We found that only 3.5% of the sample had any geriatrician visits in one year. The use of geriatric care was approximately evenly split between heavy users (4 or more visits in one year) and light users (1 to 3 visits in one year). Beneficiaries living in a metropolitan area, those with dementia or depression, and those who had any nursing home physician visits were substantially more likely to use geriatric care than other beneficiaries. Most beneficiaries with at least one geriatrician visit in a nursing home had the majority of their nursing home physician visits provided by geriatricians. Use of geriatric care by patients with dementia and congestive heart failure was higher; other results for subsamples defined by those diagnoses were similar to the full sample. We concluded that an enormous increase in the supply of geriatricians would be required for clinical geriatric care to have a sizeable effect. Because such a large increase in supply is unlikely, teaching, research, and advocacy/policymaking are the pathways through which geriatric medicine may be able to have a broad impact on the health of older adults.

7.1.2. Study 2: The association of geriatric care and emergency department use

In Study 2, we assessed whether geriatric care was associated with ED use. We

examined whether community and long-term nursing home residents who used geriatric care in a six month period were less likely to have ED use in the following month than those who did not use geriatric care. We used individual FE to account for unobserved heterogeneity and measured geriatric care was measured as number of visits and share of total visits to geriatricians. Geriatric care was associated with reductions in ED use of 7.5% to 18.8%. Reductions associated with geriatric consultative care were equivalent to reductions associated with geriatric primary care. Results for the two samples were similar. We concluded that studies should continue to examine whether differences exist in the effects of geriatric primary and consultative care as well as whether the effects of geriatric care vary based on setting of care. More generally, researchers need to analyze the effect of geriatric care in other samples and on other outcomes such as quality of life, functional status, and health care expenditures.

7.1.3. Study 3: Is geriatric care a substitute or complement for other physician care?

In Study 3, we sought to determine whether geriatric care was used more often in combination with or in lieu of FM/IM care and specialty care. We estimated the association of geriatric care received during a six month period on the number of FM/IM and specialist visits in the following six months. We found that geriatric care was associated with reductions in FM/IM care of 8.8% to 19.4%. The magnitude of the reduction in specialist visits associated with geriatric care was smaller than the reduction in FM/IM visits. Reduction in specialist visits was larger at lower levels of geriatric care for community dwellers and at higher levels of geriatric care for NH dwellers. We concluded that geriatric care appears to be used in place of care from FM/IM physicians and in certain instances, geriatric care may also reduce subsequent use of specialty care. Since geriatric care seems to

substitute for FM/IM care, future studies should determine the circumstances under which substitution of geriatric care for FM/IM care or specialty care is most effective.

7.2. Limitations

7.2.1. Claims data

This dissertation has several limitations. The claims data lack some variables that would be useful as outcome measures and control variables, including detailed measures of cognitive and functional status, socioeconomic status, and family and social support. The claims data do not indicate nurse practitioner and physician assistant specialty, whether a gerontological nurse practitioner or other mid-level provider bills incident to a physician, or whether a long-term nursing home resident receives care from the facility's medical director. More generally, using claims data, we cannot capture any services that were provided but were not billed. For example, if a FM/IM physician is in a group practice with a geriatrician, the FM/IM physician may have informal communication with the geriatrician which affects the care the physician provides.

Physician specialty was self-designated, and we considered physicians with at least two visits in a year coded as GM to be a geriatrician for all visits in that year. As a result, we many have misclassified some visits to non-geriatricians as geriatric care and vice versa. In addition, some FM/IM physicians have extensive experience working with elders with geriatric conditions. If we could compare only geriatricians with active certification in GM to physicians without extensive experience working with patients with geriatric conditions, we might find an even larger reduction in ED use associated with geriatric care (i.e., the results we present may be a lower bound of the association of geriatric care with ED use). More

generally, the mechanisms by which geriatric care may reduce ED use are not clear. We could not distinguish between a training effect and an experience effect.

7.2.2. Selection

Geriatricians may be more likely than other physicians to diagnose some geriatric comorbidities such as dementia, depression, and incontinence [21]. If beneficiaries who receive their diagnosis from a geriatrician have less severe comorbidities (i.e., are systematically healthier in unobserved ways), this could lead to overestimates of the favorable effects of geriatric care on outcomes. Although estimating models with individual FE controls for differences in unobserved variables at baseline (including health status), any changes over time that were unobserved are not accounted for. It is possible that time-varying unobserved variables were related to the use of geriatric care as well as ED use and other physician visits, so our results must be interpreted as evidence of associations rather than evidence of causal links. Additionally, because we used FE on an unbalanced panel, we assumed that attrition in any period was unrelated to unobserved, time-varying variables. We used IV methods to try to address the issue of time-varying unobserved variables but were not confident that our instruments were valid.

7.2.3. External generalizability

Finally, the results of this analysis cannot be generalized to beneficiaries without a history of ACS and geriatric comorbidities nor to those who enrolled in Medicare managed care. Since geriatric care is rare, the data we used were advantageous because of the large initial sample size. Although ACS is not a condition for which geriatric care would be expected to confer benefits relative to care from other physicians, beneficiaries who have had ACS may have poorer functional status and overall health status than the general elderly

population. In combination with the diagnosis of a geriatric condition, these people may have been particularly good candidates for geriatric care. Geriatric care was more common among beneficiaries whose geriatric condition was diagnosed closer in time to the ACS hospitalization, which suggests that cardiac care was not "crowding out" geriatric care.

7.3. Contributions of this study

This dissertation contributes to the literature in a number of ways. Using data from a large, geographically diverse sample of elderly Medicare beneficiaries with a history of ACS and subsequent diagnosis of a geriatric condition, we investigated a number of issues that had not been previously explored. We found no existing studies that examined patient-level trends in the use of geriatric care (Study 1) or considered whether geriatric care is more often positively or negatively associated with other types of physician care (Study 3). Although the relationship between geriatric care and ED use by older adults has been studied in RCTs, we did not find any studies that attempted to replicate these findings using real-world data. Further, we did not find any studies that compared the effect of geriatric care for long-term NH residents to the effect for community residents (Study 2).

7.4. Policy implications and future research

Information about the use and effects of geriatric care by this important patient population should aid policymakers, health professionals, and researchers as they seek to determine the most effective ways to use the existing supply of geriatricians and whether additional resources for geriatric training may be worthwhile. More generally, this research has implications for the role of geriatricians in models of care for elders with geriatric conditions. Our results showed that geriatric care is used by very few elders who are likely benefit from such care. Among those who receive geriatric care, geriatric care tends to

substitute for care from FM/IM physicians. Primary care was the dominant model of geriatric care for users of geriatric care residing in NHs. RCTs have generally shown that geriatric interventions that provide ongoing care are more effective than those that provide consultative care. This suggests that substitution of geriatric care for FM/IM care, and in particular the focus on geriatric primary care in the NH setting, is appropriate. However, the provision of geriatric primary care limits the clinical impact of geriatric care; the more geriatric primary care that is provided, the fewer the number of elders who receive any level of geriatric care. The results of Study 2 suggest that geriatric consultative care may be no less effective than geriatric primary care in preventing ED use by both community and NH residents. If geriatric care can be effectively provided in communities and nursing homes as consultative care, then the existing supply of geriatricians could be more broadly spread across the elderly population. More generally, Study 2 suggests that increasing the supply of geriatricians may lead to improved health outcomes for elderly Medicare beneficiaries with geriatric conditions.

Because of the lack of existing literature on the topic, additional studies are needed to further elucidate the use and effects of geriatric care in real-world clinical settings. Researchers should examine additional outcomes and other samples. This is particularly true for the nursing home population which has not been addressed by the literature on geriatric interventions. The specific mechanisms by which geriatric care may reduce ED use are unknown. Researchers should continue to assess whether differences exist in the effects of geriatric primary and consultative care. Future studies should determine the circumstances under which substitution of geriatric care for FM/IM care or specialty care is most effective. For example, in light of the very low supply of geriatric psychiatrists, a comparison of

outcomes for patients with conditions such as depression who receive geriatric care to those who receive care from a traditional psychiatrist would be useful [134]. If an effect of geriatric care exists in that context, it could be compared to other situations in which geriatric care substitutes for specialty care (e.g., patients with dementia who receive geriatric care compared to those who receive neurological care). Also, beyond examining which processes of geriatric care play the largest role in improving outcomes (e.g., medication management versus coordination of care), research should examine whether quality of care differs between FM/IM physicians who are in group practices or other organizations that include a geriatrician and FM/IM physicians who do not have ready access to a geriatrician. In addition, little is known about care from gerontological nurse practitioners and circumstances under which gerontological nurse practitioners may be effective substitutes for geriatricians.

The efficient use of the existing supply of geriatricians is a goal worth pursuing, and much still needs to be understood about the use and effects of geriatric care. However, regardless of the effects of geriatric care on health outcomes, our results suggest that the impact of clinical practice at the population level is very minimal. An enormous increase in the supply of geriatricians would be required for geriatric care to have a sizeable effect through clinical practice. Effects of a recent change in Medicare reimbursement for geriatric care on the supply of geriatricians are not likely to occur in the short-term (if any effects occur at all). For geriatric medicine to have a population-level impact on the health and health care of older adults, its focus needs to be on teaching, research, and advocacy/policymaking. The Patient Protection and Affordable Care Act opens some new avenues for this type of work. It authorizes geriatric education center grants (e.g., for practitioners to increase their knowledge about geriatrics), and the use of geriatric

assessments and comprehensive plans to coordinate care are among the payment and delivery reform models to be given priority by the Center for Medicare and Medicaid Innovation [127]. As the number of elderly Americans increases, funding for Medicare as well as Medicaid and Veterans Affairs will put enormous pressure on the federal budget. Finding ways to improve the quality of care for elders with geriatric conditions and also reduce health care expenditures per beneficiary is critical to ensuring the financial health of the federal government.

APPENDIX 1: DETAILS ON IV ESTIMATION

Data for the instruments came from an analytic file which had data from the American Medical Association (AMA) Physician Masterfile and the American Board of Medical Specialties (ABMS). The first instrument measured geriatrician supply: a count of the number of geriatricians in the beneficiary's home county per 10,000 residents aged 65 and older. The second instrument measured differential distance to geriatric care: the difference between the distance from the beneficiary's home ZIP code to the ZIP code of the nearest geriatrician and the distance from home ZIP code to the ZIP code nearest FM/IM physician or specialist. Distance was measured as the number of miles between the centroid of the beneficiary's home ZIP code and the centroid of the physician ZIP code using the zipcitydistance function in SAS 9.1.3. We hypothesized that supply would be positively associated with use of geriatric care since awareness of geriatric care is likely to be higher among beneficiaries who live in an area with higher supply. We hypothesized that differential distance would be negatively related to use of geriatric care since it is an indicator of transportation costs.

The instruments were valid only if there is was no direct effect of geriatrician supply and differential distance to geriatric care on outcomes and the instruments were uncorrelated with unobservable variables that affect those outcomes. Physician supply and differential distance have been used as instruments for the receipt of cardiac care [94, 95]. Some research suggests that primary care provider supply is correlated with area-level health outcomes and that physician density is endogenous in models of area-level health [96-99]. A recent paper found a connection between area-level primary care physician supply and individual-level outcomes [100]. To address concerns about the supply instrument, we used an alternative

measure of supply that measured the availability of geriatricians relative to other types of physicians rather than indicating the actual availability of geriatricians: the ratio of county geriatrician supply to county FM/IM and specialist supply.

If the marginal subpopulations had rates of ED use similar to the full samples, then the effects estimated by IV models suggest decreases of 92.5% (community, 7.4 percentage points compared to 8.0) and 122.9% (NH, 11.7 percentage points compared to 9.6) (Appendix Table 6). IV results using an alternative supply instrument (GM supply relative to FM/IM and specialist supply) in lieu of actual GM supply as an instrument were similar. However, we did not present results from IV regression as the preferred approach for either model because of questions regarding the validity of our instruments. To try to discern whether the instruments were validly excluded from the ED use model, we compared two groups: beneficiaries who lived in an area where geriatrician supply was at or above the median for all beneficiaries, and those who lived in an area where supply was below the median [101]. This comparison suggested that the distribution of observable variables was not independent of geriatrician supply (i.e., the instruments did not appear to mimic a natural experiment for geriatric care). For example, geriatrician supply was positively correlated with ZIP code median income and negatively correlated with dual eligibility. Since unobserved socioeconomic status is likely to be associated with both geriatric care and ED use, differences in income and dual eligibility are problematic.

APPENDIX 2: ADDITIONAL DETAILS ON IV ESTIMATION

In addition to using a bivariate probit model to estimate IV regression for any geriatric care, we estimated the effects of all three measures of geriatric care with IV regression. Depending on whether the measure of geriatric care was binary, ordered, or categorical, the first stage equation that predicted geriatric care was estimated using a logit, ordered logit, or multinomial logit model with standard errors clustered at the beneficiary level. Since geriatric care was measured using a six month lag in the second stage equation, the unit of observation in the first stage equation was a six month period.

We used two-stage residual inclusion (2SRI) in which both the observed value of the endogenous variable and the predicted residual from the first stage equation are included in the second stage equation [106]. Bias-corrected confidence intervals for changes in the predicted probability of the dependent variable were generated by bootstrapping 250 random samples drawn at the beneficiary level with replacement. Further details of the 2SRI estimation are provided in Chapter 3.6.2.

The IV results for the binary measures of geriatric care estimated by 2SRI were larger than but still somewhat similar to results estimated by bivariate probit (Appendix Tables 6 and 7). Results from both 2SRI and bivariate probit were extremely large relative to the means of ED use for the entire sample. This could have been because the marginal subsamples had much higher rates of ED use than the full samples, although there is no reason to expect this. The very rare nature of geriatric care could have presented problems in the estimation. Another explanation is that perhaps the instruments were not validly excluded from the outcome models.

Even more puzzling is that 2SRI estimates for the effect of the ordered and categorical measures of geriatric care on ED use were completely unlike the 2SRI effects estimated for the binary measures; the signs of the effects were opposite, and the magnitudes different substantially. This may have been because there was a problem with the way the instruments were operating in 2SRI when the first stage was an ordered or multinomial logit. For both samples, the estimated effect of GM plurality had the opposite sign and a substantially different size in terms of absolute value compared to the estimated effect of GM consultation. In contrast, in the FE models for ED use, the effects estimated for GM plurality and GM consultation were very similar. In sum, it is not clear what was going on in the IV models that produced such wild estimates, but most of the IV results are implausible (both from bivariate probit and 2SRI).

APPENDIX 3: ASSOCIATION OF GERIATRIC CARE WITH IN-HOSPITAL DEATH

Methods

An analysis of in-hospital death was conducted using data from the month in which death occurred. MedPAR and Outpatient claims identified in-hospital death (including death in an ED) [135]. Sample sizes for in-hospital death were 36,796 (NH) and 72,244 (community). We used three-digit ZIP code FE to control for area-level factors that may have affected the likelihood of in-hospital death (e.g., norms for aggressiveness of end of life care, socioeconomic status). FE models were estimated with LPMs because of perfect prediction. F tests of joint insignificance of the FE were rejected for both samples ($p<0.000$), and Hausman tests indicated that estimates from OLS models were inconsistent ($p<0.000$).

Results

The rate of any geriatric care was very low for both samples, although it was nearly three times higher for the NH sample than for the community sample. In-hospital death was substantially higher among community dwellers (42.0% community vs. 27.7% NH) (Appendix Table 8). In the naïve models, geriatric care was associated with a reduced likelihood of in-hospital death (Appendix Table 9). Compared to in-hospital death rates of 42.0% and 27.7%, the effects of 5.7 and 2.3 percentage points reflected reductions in the predicted probability of in-hospital death of 13.6% (community) and 8.3% (NH). In general, the FE results showed larger effects of geriatric care on in-hospital death for community dwellers than for NH dwellers, and effects for community dwellers were more often statistically significant (Appendix Figure 1). In the FE model for community dwellers, GM plurality and GM consultation were associated with reductions of 10.0% and 11.7% in the predicted probability of in-hospital death compared to FM/IM plurality. For NH dwellers,

neither of those two measures had statistically significant effects. For both samples, specialist plurality was associated with a substantial increase in the likelihood of in-hospital death (9.3% community, 9.7% NH) compared to FM/IM plurality. The associations of geriatric care with in-hospital death were smaller (in absolute value) than many of the demographic characteristics (e.g., advanced age).

Effects of geriatric care estimated by IV models of in-hospital death were substantially larger in absolute value than effects estimated by FE, and the signs of the effects estimated by IV were different from the signs estimated by FE. IV models indicated that geriatric care may *increase* the likelihood of in-hospital death. The effects of 29.3 (community) and 32.3 percentage points (NH) suggested increases of 69.8% (community) and 116.6% (NH) compared to the prevalence of in-hospital death in the full sample.

Results from three and nine month measures of geriatric care produced slightly different results from six month measures, but the differences were small enough that the interpretation would not have differed. Using the alternative measure of NH residence led to estimates that were very similar to the original estimates.

Discussion

The effects of geriatric care on in-hospital death were larger and more often statistically significant for community dwellers than NH dwellers. The largest effects on in-hospital death were found for beneficiaries who had a single visit. Geriatric consultation was found to be as effective as GM plurality in both samples. Most measures of geriatric care had very similar effect sizes in FE models compared to naive models. This may have been because area FE did not control for unobserved person- or facility-level factors. In other words, unobserved person- or facility-level heterogeneity affecting both geriatric care and in-

hospital death was likely to have been a big problem. For example, NHs may have a particular protocol for palliative and end of life care that affected whether their residents are likely to die in a hospital.

The association of a single geriatrician visit with in-hospital death was statistically significant for both samples. Although the effect of 1 visit was not statistically different from the effect of ≥3 visits, the estimated coefficient for 1 visit was larger than all other measures of geriatric care in the in-hospital death models. Unobserved individual-level variables could explain the link between 1 visit and a sizeable reduction in the predicted probability of in-hospital death. For example, beneficiaries who visited geriatricians near the end of life may have been less likely to seek aggressive medical care than otherwise similar beneficiaries in their geographic area. This result suggests that a geriatrician visit may be beneficial even if a person is near death.

Appendix Table 1. Frequency and location of physician visits during first year following initial geriatric diagnosis, by frequency of geriatrician visits
(For inclusion in an online appendix)

Geriatrician visits	People, Dementia	%, Dementia	Geriatrician visits	People, CHF	%, CHF
All settings					
0	41,218	93.3	0	88,867	95.6
1	696	1.6	1	951	1.0
2-3	752	1.7	2-3	1,059	1.1
4-6	598	1.4	4-6	794	0.9
≥7	905	2.1	≥7	1,284	1.4
≥1	2,951	6.7	≥1	4,088	4.4
Office, nursing home, home					
0	41,704	94.4	0	89,706	96.5
1	583	1.3	1	749	0.8
2-3	653	1.5	2-3	848	0.9
4-6	528	1.2	4-6	680	0.7
≥7	701	1.6	≥7	972	1.1
≥1	2,465	5.6	≥1	3,249	3.5
Hospital, emergency department					
0	43,196	97.8	0	91,354	98.3
1	298	0.7	1	480	0.5
2-3	265	1.0	2-3	463	0.5
4-6	190	0.4	4-6	293	0.3
≥7	220	0.5	≥7	365	0.4
≥1	973	2.2	≥1	1,601	1.7

Appendix Table 2. Characteristics and comorbidities associated with geriatric care in first year following initial geriatric diagnosis, dementia subsample
(For inclusion in an online appendix)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Sample	41,218	2,951				
Female	67.3	71.3	1.21**	(1.11,1.31)	1.05	(0.96,1.15)
Nonwhite	13.0	15.1	1.19**	(1.07,1.32)	1.25**	(1.12,1.41)
Dual eligible	27.2	25.6	0.92*	(0.84,1.00)	0.89*	(0.81,0.98)
Age						
75 or younger	14.9	12.1				
76-80	20.8	19.7	0.93	(0.85,1.03)	1.13	(0.99,1.30)
81-85	27.8	28.1	1.01	(0.93,1.10)	1.17*	(1.02,1.33)
86 or older	36.5	40.0	1.16**	(1.08,1.25)	1.25**	(1.09,1.42)
Income						
1st quartile	25.6	17.3				
2nd quartile	25.4	19.7	0.72**	(0.66,0.79)	1.05	(0.93,1.20)
3rd quartile	24.8	27.5	1.15**	(1.06,1.25)	1.23**	(1.08,1.39)
4th quartile	24.2	35.6	1.73**	(1.60,1.87)	1.47**	(1.30,1.66)
Metropolitan status						
Metropolitan area	70.1	88.0				
Micropolitan area	14.3	6.9	0.44**	(0.38,0.51)	0.47**	(0.40,0.55)
Small town	9.1	3.3	0.34**	(0.27,0.41)	0.36**	(0.29,0.45)
Rural area	6.5	1.9	0.27**	(0.21,0.36)	0.30**	(0.23,0.40)
Geriatric conditions						
Stroke	34.5	37.9	1.16**	(1.07,1.25)	1.08	(1.00,1.17)
Dementia	100.0	100.0	1.00	(1.00,1.00)	1.00	(1.00,1.00)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Osteoporosis	16.2	22.5	1.50**	(1.37,1.64)	1.37**	(1.24,1.51)
Urinary incontinence	9.6	13.1	1.42**	(1.27,1.59)	1.41**	(1.26,1.58)
Depression	26.7	37.6	1.65**	(1.53,1.79)	1.55**	(1.43,1.68)
Dehydration	20.9	23.7	1.18**	(1.08,1.29)	1.02	(0.93,1.12)
Hearing impairment	4.9	5.1	1.05	(0.88,1.24)	1.02	(0.86,1.21)
Syncope	15.1	17.0	1.16**	(1.05,1.28)	1.10	(0.99,1.22)
Fracture	16.2	21.0	1.38**	(1.26,1.51)	1.23**	(1.12,1.35)
Pressure	6.3	10.1	1.68**	(1.48,1.90)	1.41**	(1.23,1.61)
Weight loss/failure to thrive	11.5	19.3	1.84**	(1.67,2.02)	1.62**	(1.46,1.79)
Vision impairment	1.6	2.0	1.26	(0.96,1.64)	1.22	(0.93,1.59)
Laceration	4.7	6.5	1.40**	(1.20,1.63)	1.21*	(1.03,1.41)
Delirium	4.3	6.8	1.65**	(1.42,1.91)	1.47**	(1.26,1.72)
Dislocation	0.8	1.0	1.23	(0.84,1.81)	1.21	(0.82,1.79)
Comorbidities						
Hypertension	89.3	92.4	1.45**	(1.26,1.66)	1.27**	(1.10,1.47)
CHF	50.3	54.6	1.19**	(1.10,1.28)	1.11*	(1.02,1.21)
Diabetes	38.7	39.1	1.02	(0.94,1.10)	0.95	(0.86,1.04)
Deficiency anemia	45.3	55.2	1.49**	(1.38,1.60)	1.23**	(1.13,1.33)
Chronic obstructive pulmonary disease	33.2	32.7	0.98	(0.90,1.06)	0.94	(0.86,1.02)
Peripheral vascular disease	34.3	37.9	1.17**	(1.08,1.26)	0.95	(0.88,1.03)
Hypothyroidism	27.4	30.6	1.17**	(1.08,1.27)	1.04	(0.95,1.13)
Valvular disease	19.8	20.8	1.06	(0.97,1.17)	0.98	(0.89,1.07)
Other neurological	21.9	24.9	1.18**	(1.08,1.29)	1.06	(0.96,1.16)
Diabetes, with complications	15.2	17.3	1.16**	(1.05,1.28)	1.14*	(1.01,1.29)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Renal failure	13.9	16.0	1.18**	(1.06,1.31)	1.16*	(1.03,1.30)
Tumor, no metastasis	9.5	9.6	1.01	(0.89,1.15)	0.98	(0.85,1.12)
Electrolyte disorder	19.4	22.2	1.19**	(1.08,1.30)	0.99	(0.90,1.09)
Hypertension, with complications	19.4	18.8	0.96	(0.88,1.06)	0.80**	(0.72,0.89)
Paralysis	2.6	3.5	1.36**	(1.11,1.68)	1.20	(0.97,1.49)
Psychoses	19.3	23.3	1.27**	(1.16,1.39)	1.05	(0.95,1.15)
Coagulation deficiency	5.2	5.6	1.09	(0.92,1.28)	0.95	(0.80,1.12)
Rheumatoid arthritis	4.2	4.7	1.14	(0.95,1.36)	1.00	(0.84,1.20)
Obesity	2.2	2.2	1.01	(0.79,1.30)	0.99	(0.76,1.28)
Pulmonary circulation disorder	3.1	3.3	1.09	(0.88,1.34)	1.01	(0.81,1.25)
Blood loss anemia	3.3	3.6	1.11	(0.91,1.36)	0.93	(0.76,1.14)
Metastatic cancer	0.9	1.2	1.29	(0.91,1.82)	1.24	(0.86,1.80)
Lymphoma	0.8	0.9	1.21	(0.81,1.79)	1.02	(0.68,1.53)
Liver disease	0.9	1.3	1.47*	(1.06,2.05)	1.43*	(1.02,2.02)
Alcohol abuse	1.1	1.1	1.03	(0.72,1.48)	0.98	(0.68,1.42)
Drug abuse	0.4	0.6	1.55	(0.95,2.52)	1.40	(0.86,2.29)
AIDS	0.0	0.1	3.99*	(1.31,12.14)	4.39*	(1.19,16.10)
Ulcer	0.2	0.2	1.11	(0.45,2.76)	0.94	(0.37,2.39)
Constant					0.026**	(0.02,0.03)

**p<0.01, *p<0.05

Appendix Table 3. Characteristics and comorbidities associated with geriatric care in first year following initial geriatric diagnosis, CHF subsample
(For inclusion in an online appendix)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Sample	88,867	4,088				
Female	34.0	29.6	1.22**	(1.14,1.31)	1.06	(0.99,1.15)
Nonwhite	11.7	14.7	1.30**	(1.19,1.42)	1.28**	(1.16,1.42)
Dual eligible	24.4	24.1	0.98	(0.91,1.06)	0.91*	(0.84,0.99)
Age						
75 or younger	23.8	17.8				
76-80	22.5	20.7	0.90**	(0.83,0.97)	1.17**	(1.05,1.30)
81-85	24.7	25.9	1.07	(0.99,1.14)	1.27**	(1.15,1.41)
86 or older	29.0	35.6	1.35**	(1.26,1.44)	1.44**	(1.30,1.59)
Income						
1st quartile	25.3	18.2				
2nd quartile	25.3	18.8	0.69**	(0.63,0.74)	0.97	(0.87,1.07)
3rd quartile	24.9	26.9	1.11**	(1.04,1.19)	1.14*	(1.02,1.26)
4th quartile	24.5	36.1	1.74**	(1.63,1.86)	1.33**	(1.20,1.48)
Metropolitan status						
Metropolitan area	68.2	87.2				
Micropolitan area	15.5	7.5	0.44**	(0.39,0.49)	0.47**	(0.41,0.53)
Small town	9.4	3.1	0.31**	(0.26,0.37)	0.33**	(0.27,0.39)
Rural area	6.9	2.2	0.30**	(0.25,0.37)	0.32**	(0.26,0.40)
Geriatric conditions						
Stroke	29.5	34.5	1.26**	(1.18,1.35)	1.13**	(1.06,1.22)
Dementia	23.3	39.4	2.13**	(2.00,2.28)	1.69**	(1.57,1.82)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Osteoporosis	19.4	23.3	1.26**	(1.17,1.35)	1.29**	(1.19,1.40)
Urinary incontinence	9.6	12.0	1.29**	(1.17,1.42)	1.31**	(1.18,1.44)
Depression	20.9	33.0	1.87**	(1.74,2.00)	1.69**	(1.58,1.82)
Dehydration	23.8	26.9	1.18**	(1.10,1.26)	1.08*	(1.01,1.17)
Hearing impairment	6.5	6.2	0.94	(0.82,1.07)	1.01	(0.88,1.15)
Syncope	18.6	19.0	1.02	(0.94,1.11)	1.09*	(1.01,1.19)
Fracture	19.0	24.2	1.36**	(1.27,1.47)	1.35**	(1.25,1.46)
Pressure	6.0	11.2	1.96**	(1.77,2.17)	1.55**	(1.39,1.73)
Weight loss/failure to thrive	10.3	16.1	1.68**	(1.54,1.83)	1.47**	(1.35,1.61)
Vision impairment	1.9	2.0	1.07	(0.86,1.34)	1.08	(0.86,1.36)
Laceration	6.0	7.4	1.24**	(1.10,1.40)	1.16*	(1.03,1.32)
Delirium	2.2	4.8	2.22**	(1.91,2.58)	1.49**	(1.27,1.75)
Dislocation	1.7	1.1	0.67**	(0.50,0.90)	0.84	(0.62,1.14)
Comorbidities						
Hypertension	91.7	94.5	1.56**	(1.36,1.79)	1.34**	(1.16,1.54)
CHF	100.0	100.0	1.00	(1.00,1.00)	1.00	(1.00,1.00)
Diabetes	48.5	48.4	0.99	(0.93,1.06)	0.95	(0.88,1.03)
Deficiency anemia	50.8	61.2	1.53**	(1.43,1.63)	1.20**	(1.12,1.28)
Chronic obstructive pulmonary disease	45.8	44.8	0.96	(0.90,1.03)	0.98	(0.92,1.05)
Peripheral vascular disease	35.8	42.0	1.30**	(1.22,1.39)	1.06	(1.00,1.14)
Hypothyroidism	28.9	33.0	1.21**	(1.13,1.30)	1.08*	(1.01,1.16)
Valvular disease	32.2	32.6	1.02	(0.95,1.09)	0.99	(0.92,1.06)
Other neurological	13.3	19.2	1.55**	(1.43,1.68)	1.15**	(1.06,1.26)
Diabetes, with complications	22.1	24.7	1.16**	(1.07,1.24)	1.16**	(1.06,1.27)

	0 visits, %	≥1 visits, %	Unadjusted OR	95% CI	Adjusted OR	95% CI
Renal failure	23.1	26.1	1.17**	(1.09,1.26)	1.18**	(1.09,1.28)
Tumor, no metastasis	11.7	11.7	1.00	(0.91,1.11)	1.03	(0.93,1.15)
Electrolyte disorder	23.1	28.6	1.33**	(1.24,1.43)	1.11**	(1.03,1.20)
Hypertension, with complications	28.0	27.7	0.99	(0.92,1.06)	0.86**	(0.79,0.93)
Paralysis	2.2	3.0	1.37**	(1.14,1.65)	1.10	(0.90,1.33)
Psychoses	9.6	17.5	2.00**	(1.84,2.18)	1.24**	(1.13,1.36)
Coagulation deficiency	7.6	9.6	1.30**	(1.16,1.44)	1.18**	(1.06,1.32)
Rheumatoid arthritis	6.3	7.3	1.18**	(1.04,1.33)	1.10	(0.97,1.25)
Obesity	4.8	4.9	1.01	(0.87,1.17)	1.12	(0.96,1.30)
Pulmonary circulation disorder	5.7	6.5	1.16*	(1.02,1.31)	1.15*	(1.00,1.31)
Blood loss anemia	4.4	4.8	1.10	(0.95,1.27)	0.95	(0.82,1.11)
Metastatic cancer	1.5	1.5	0.98	(0.75,1.27)	0.97	(0.74,1.28)
Lymphoma	1.2	1.5	1.22	(0.94,1.58)	1.16	(0.89,1.52)
Liver disease	1.4	1.8	1.28*	(1.01,1.63)	1.19	(0.93,1.53)
Alcohol abuse	0.9	1.3	1.50**	(1.13,1.98)	1.41*	(1.05,1.89)
Drug abuse	0.4	0.7	1.93**	(1.31,2.84)	1.60*	(1.07,2.40)
AIDS	0.0	0.1	3.53**	(1.49,8.37)	2.70*	(1.05,6.90)
Ulcer	0.2	0.1	0.71	(0.29,1.72)	0.64	(0.26,1.60)
Constant					0.01**	(0.01,0.01)

**p<0.01, *p<0.05

Appendix Table 4. Comorbidity prevalence, first month of study period

	Comm.	NH**		Comm.	NH**
Stroke	0.204	0.332	Peripheral vascular	0.180	0.347
Osteoporosis	0.162	0.159	Hypothyroidism	0.180	0.249
Dehydration	0.152	0.143	Valvular disease	0.156	0.193
Dementia	0.132	0.443	Complicated diabetes	0.109	0.167
Fracture	0.127	0.165	Tumor, no metastasis	0.106	0.091
Syncope	0.125	0.063	Renal failure	0.105	0.170
Depression	0.116	0.163	Complicated hypertension	0.090	0.091
Urinary incontinence	0.071	0.078	Electrolyte disorder	0.082	0.107
Weight loss	0.069	0.062	Other neurological	0.073	0.185
Hearing impairment	0.055	0.039	Rheumatoid arthritis	0.044	0.046
Laceration	0.035	0.031	Coagulation deficiency	0.025	0.024
Pressure ulcer	0.027	0.071	Psychoses	0.022	0.092
Dislocation	0.019	0.004	Obesity	0.020	0.029
Vision impairment	0.012	0.018	Metastatic cancer	0.020	0.017
Delirium	0.010	0.022	Pulmonary circ. disorder	0.015	0.018
Failure to thrive	0.007	0.018	Paralysis	0.013	0.035
Hypertension	0.767	0.844	Blood loss anemia	0.013	0.014
Diabetes	0.344	0.429	Lymphoma	0.011	0.010
Congestive heart failure	0.341	0.602	Liver disease	0.008	0.010
Deficiency anemia	0.267	0.471	Alcohol abuse	0.006	0.009
Chronic obstructive pulmonary disease	0.267	0.367			

**Differences between samples are statistically significant at $p<0.01$ for all comorbidities

Appendix Table 5. Change in predicted probability of ED use in one month associated with month, time, and comorbidities

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Month (omitted: December)				
January	0.002**	0.000	0.005**	0.005**
	(0.001, 0.002)	(-0.001,0.001)	(0.003, 0.006)	(0.002,0.007)
February	0.002**	0.001	-0.002**	-0.003
	(0.001, 0.003)	(-0.000,0.002)	(-0.004, -0.001)	(-0.005,0.000)
March	-0.001	-0.002**	-0.006**	-0.006**
	(-0.001, -0.000)	(-0.003,-0.000)	(-0.008, -0.004)	(-0.008,-0.003)
April	-0.003**	-0.004**	-0.010**	-0.010**
	(-0.004, -0.002)	(-0.005,-0.003)	(-0.012, -0.009)	(-0.013,-0.008)
May	-0.003**	-0.004**	-0.009**	-0.009**
	(-0.004, -0.003)	(-0.005,-0.003)	(-0.011, -0.008)	(-0.012,-0.006)
June	-0.004**	-0.004**	-0.013**	-0.013**
	(-0.004, -0.003)	(-0.006,-0.003)	(-0.014, -0.012)	(-0.016,-0.010)
July	-0.006**	-0.007**	-0.014**	-0.015**
	(-0.006, -0.005)	(-0.008,-0.006)	(-0.016, -0.014)	(-0.018,-0.012)
August	-0.005**	-0.007**	-0.014**	-0.014**
	(-0.006, -0.005)	(-0.008,-0.005)	(-0.016, -0.013)	(-0.017,-0.012)
September	-0.005**	-0.006**	-0.010**	-0.011**
	(-0.005, -0.004)	(-0.007,-0.005)	(-0.012, -0.009)	(-0.013,-0.008)
October	-0.006**	-0.007**	-0.012**	-0.013**
	(-0.007, -0.005)	(-0.008,-0.006)	(-0.014, -0.011)	(-0.015,-0.010)
November	-0.005**	-0.005**	-0.012**	-0.013**
	(-0.005, -0.005)	(-0.006,-0.004)	(-0.012, -0.010)	(-0.015,-0.010)

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Month in study	0.001**	0.002**	-0.002**	-0.001**
	(0.001, 0.001)	(0.002,0.002)	(-0.002, -0.002)	(-0.001,-0.001)
Month in study squared	-0.000**	-0.000**	0.000**	0.000**
	(-0.000, -0.000)	(-0.000,-0.000)	(0.000, 0.000)	(-0.000,0.000)
Stroke	0.015**	0.035**	0.010**	0.033**
	(0.014, 0.015)	(0.033,0.037)	(0.009, 0.011)	(0.028,0.037)
Dementia	0.020**	0.031**	0.007**	0.027**
	(0.019, 0.021)	(0.029,0.033)	(0.007, 0.009)	(0.023,0.031)
Osteoporosis	0.004**	0.019**	0.010**	0.022**
	(0.003, 0.005)	(0.017,0.021)	(0.008, 0.011)	(0.017,0.027)
Urinary incontinence	0.009**	0.005**	0.008**	0.003
	(0.008, 0.010)	(0.002,0.008)	(0.005, 0.011)	(-0.003,0.009)
Depression	0.091**	0.095**	0.042**	0.057**
	(0.090, 0.092)	(0.094,0.097)	(0.039, 0.044)	(0.055,0.059)
Dehydration	0.153**	0.208**	0.173**	0.231**
	(0.149, 0.156)	(0.206,0.210)	(0.169, 0.176)	(0.228,0.235)
Hearing impairment	0.004**	0.009**	0.001	0.008*
	(0.003, 0.005)	(0.005,0.012)	(-0.001, 0.002)	(0.000,0.016)
Syncope	0.158**	0.175**	0.123**	0.158**
	(0.157, 0.160)	(0.173,0.176)	(0.121, 0.128)	(0.154,0.163)
Fracture	0.091**	0.097**	0.076**	0.091**
	(0.090, 0.093)	(0.096,0.099)	(0.075, 0.079)	(0.088,0.094)
Pressure	0.025**	0.050**	0.023**	0.046**
	(0.023, 0.027)	(0.047,0.054)	(0.021, 0.026)	(0.042,0.050)

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Weight loss	0.037**	0.043**	0.025**	0.041**
	(0.035, 0.038)	(0.041,0.046)	(0.024, 0.029)	(0.036,0.045)
Vision impairment	0.013**	0.032**	0.007*	0.032**
	(0.011, 0.015)	(0.026,0.039)	(0.002, 0.012)	(0.020,0.045)
Failure to thrive	0.059**	0.112**	0.031**	0.050**
	(0.054, 0.069)	(0.104,0.120)	(0.023, 0.035)	(0.042,0.059)
Laceration	0.129**	0.144**	0.104**	0.130**
	(0.126, 0.133)	(0.141,0.147)	(0.096, 0.113)	(0.125,0.136)
Delirium	0.109**	0.161**	0.136**	0.177**
	(0.102, 0.111)	(0.154,0.168)	(0.130, 0.142)	(0.169,0.185)
Dislocation	0.037**	0.036**	0.078**	0.097**
	(0.034, 0.042)	(0.032,0.039)	(0.075, 0.088)	(0.080,0.113)
Hypertension	0.022**	0.041**	0.022**	0.046**
	(0.022, 0.023)	(0.039,0.042)	(0.020, 0.024)	(0.041,0.052)
Congestive heart failure	0.018**	0.037**	0.013**	0.035**
	(0.018, 0.019)	(0.035,0.038)	(0.011, 0.014)	(0.031,0.039)
Diabetes	0.002**	0.008**	0.003**	0.012**
	(0.002, 0.004)	(0.006,0.010)	(0.002, 0.004)	(0.007,0.018)
Deficiency anemia	0.003**	0.009**	0.000	0.006**
	(0.003, 0.004)	(0.007,0.010)	(-0.001, 0.001)	(0.003,0.010)
COPD	0.021**	0.031**	0.019**	0.038**
	(0.020, 0.022)	(0.030,0.033)	(0.018, 0.020)	(0.033,0.042)
Peripheral vascular disease	0.004**	0.012**	-0.004**	0.001
	(0.004, 0.005)	(0.010,0.013)	(-0.005, -0.003)	(-0.002,0.004)

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Hypothyroidism	0.002**	0.012**	0.003**	0.017**
	(0.001, 0.003)	(0.010,0.014)	(0.002, 0.005)	(0.012,0.022)
Valvular disease	0.008**	0.026**	0.015**	0.047**
	(0.007, 0.008)	(0.024,0.027)	(0.014, 0.017)	(0.042,0.052)
Other neurological	0.021**	0.036**	0.019**	0.042**
	(0.020, 0.021)	(0.034,0.039)	(0.018, 0.022)	(0.037,0.046)
Diabetes w/complications	0.006**	0.015**	0.007**	0.008**
	(0.005, 0.006)	(0.013,0.017)	(0.006, 0.008)	(0.003,0.013)
Renal failure	0.003**	0.028**	0.009**	0.045**
	(0.002, 0.004)	(0.027,0.030)	(0.007, 0.010)	(0.041,0.048)
Tumor, no metastasis	0.003**	0.009**	0.006**	0.014**
	(0.002, 0.004)	(0.007,0.012)	(0.004, 0.008)	(0.007,0.022)
Electrolyte disorder	0.116**	0.181**	0.099**	0.148**
	(0.114, 0.117)	(0.179,0.183)	(0.096, 0.101)	(0.145,0.151)
Hypertension w/complications	0.062**	0.099**	0.084**	0.140**
	(0.060, 0.064)	(0.098,0.101)	(0.081, 0.088)	(0.136,0.143)
Paralysis	0.008**	0.042**	0.007**	0.032**
	(0.007, 0.009)	(0.037,0.047)	(0.005, 0.008)	(0.023,0.042)
Psychoses	0.048**	0.069**	0.036**	0.059**
	(0.046, 0.050)	(0.066,0.071)	(0.034, 0.038)	(0.056,0.062)
Coagulation deficiency	0.036**	0.068**	0.040**	0.071**
	(0.033, 0.039)	(0.066,0.071)	(0.036, 0.047)	(0.065,0.076)
Rheumatoid arthritis	0.006**	0.008**	0.009**	0.012*

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
	(0.005, 0.006)	(0.004,0.011)	(0.006, 0.011)	(0.001,0.022)
Obesity	0.010**	0.023**	0.009**	0.026**
	(0.009, 0.012)	(0.020,0.026)	(0.002, 0.011)	(0.016,0.036)
Pulmonary circulation disorder	0.076**	0.119**	0.079**	0.123**
	(0.072, 0.080)	(0.116,0.122)	(0.072, 0.084)	(0.115,0.130)
Blood loss anemia	0.066**	0.110**	0.074**	0.119**
	(0.061, 0.069)	(0.106,0.114)	(0.069, 0.080)	(0.111,0.126)
Metastatic cancer	0.021**	0.054**	0.017**	0.064**
	(0.020, 0.022)	(0.049,0.058)	(0.010, 0.021)	(0.050,0.078)
Lymphoma	0.006**	0.017**	0.001	0.041**
	(0.004, 0.007)	(0.010,0.025)	(-0.004, 0.006)	(0.016,0.067)
Liver disease	0.010**	0.029**	0.004	0.009
	(0.007, 0.012)	(0.023,0.035)	(-0.000, 0.009)	(-0.008,0.025)
Alcohol abuse	0.022**	0.057**	0.012**	0.027*
	(0.021, 0.026)	(0.050,0.065)	(0.008, 0.015)	(0.005,0.049)
Observations	5,277,762	5,277,762	1,005,122	1,005,122

** p<0.01, * p<0.05
95% confidence intervals in parentheses.

Appendix Table 6. Comparison of IV and FE estimates

Sample	**Comm.**	**Comm.**	**Comm.**	**NH**	**NH**	**NH**
Dependent variable	**ED use**	**ED use**	**Geriatric care**	**ED use**	**ED use**	**Geriatric care**
Model	**LPM, FE**	**IV**	**IV**	**LPM, FE**	**IV**	**IV**
Geriatric care in previous 6 months						
Any geriatric care						
(reference: 0 visits)	-0.009**	-0.074**			-0.117**	
	(-0.012,-0.006)	(-0.077, -0.071)			(-0.121, -0.112)	
Instrumental variables						
Geriatrician supply			0.001**			0.004**
			(0.001, 0.001)			(0.003, 0.006)
Differential distance to geriatrician			-0.000**			-0.001**
			(-0.000, -0.000)			(-0.002, -0.000)
Control variables						
Age (omitted: 66-74)						
75-79	-0.001	-0.001	0.002**	-0.003	-0.006**	0.003
	(-0.003,0.000)	(-0.002, 0.000)	(0.001, 0.004)	(-0.010,0.003)	(-0.009, -0.001)	(-0.004, 0.009)
80-84	0.000	0.003**	0.004**	-0.006	-0.007**	0.005
	(-0.003,0.002)	(0.002, 0.004)	(0.003, 0.005)	(-0.014,0.002)	(-0.011, -0.002)	(-0.001, 0.012)
85-89	0.001	0.007**	0.008**	-0.004	-0.009**	0.002
	(-0.002,0.004)	(0.006, 0.008)	(0.007, 0.010)	(-0.013,0.006)	(-0.013, -0.006)	(-0.003, 0.008)
90+	0.007**	0.012**	0.010**	0.002	-0.008**	0.008*
	(0.003,0.011)	(0.010, 0.013)	(0.008, 0.012)	(-0.009,0.013)	(-0.011, -0.004)	(0.004, 0.017)

Male	N/A	-0.003**	-0.001	N/A	0.009**	0.002
		(-0.004, -0.002)	(-0.002, 0.000)		(0.006, 0.011)	(-0.001, 0.006)
Nonwhite	N/A	0.004**	0.003**	N/A	0.000	0.005
		(0.003, 0.005)	(0.002, 0.004)		(-0.005, 0.003)	(-0.001, 0.010)
Dual eligible	-0.003*	0.016**	-0.001	-0.010**	-0.009**	-0.005**
	(-0.006,-0.001)	(0.015, 0.017)	(-0.002, 0.000)	(-0.014,-0.007)	(-0.011, -0.006)	(-0.010, -0.003)
ZIP income quartile (omitted: First quartile)						
Second	-0.007**	0.000	-0.001	-0.014**	-0.002	0.003
	(-0.011,-0.003)	(-0.000, 0.001)	(-0.002, 0.000)	(-0.022,-0.006)	(-0.007, 0.001)	(-0.003, 0.007)
Third	-0.011**	-0.001	0.001	-0.019**	-0.004	0.007*
	(-0.015,-0.007)	(-0.002, 0.000)	(-0.000, 0.003)	(-0.027,-0.011)	(-0.007, -0.000)	(-0.000, 0.012)
Fourth	-0.020**	-0.004**	0.002**	-0.039**	-0.004	0.012**
	(-0.024,-0.015)	(-0.005, -0.003)	(0.000, 0.003)	(-0.048,-0.030)	(-0.009, 0.000)	(0.004, 0.016)
Metropolitan status (omitted: Metropolitan area)						
Micropolitan area	0.001	0.012**	-0.006**	-0.003	-0.007**	-0.023**
	(-0.003,0.006)	(0.011, 0.013)	(-0.007, -0.005)	(-0.015,0.009)	(-0.010, -0.003)	(-0.029, -0.018)
Small town	0.007*	0.018**	-0.008**	-0.001	0.000	-0.030**
	(0.001,0.012)	(0.016, 0.020)	(-0.009, -0.007)	(-0.014,0.013)	(-0.003, 0.004)	(-0.036, -0.025)
Rural area	0.008*	0.015**	-0.008**	0.002	-0.004	-0.031**
	(0.001,0.014)	(0.013, 0.016)	(-0.009, -0.007)	(-0.014,0.017)	(-0.007, 0.002)	(-0.037, -0.024)

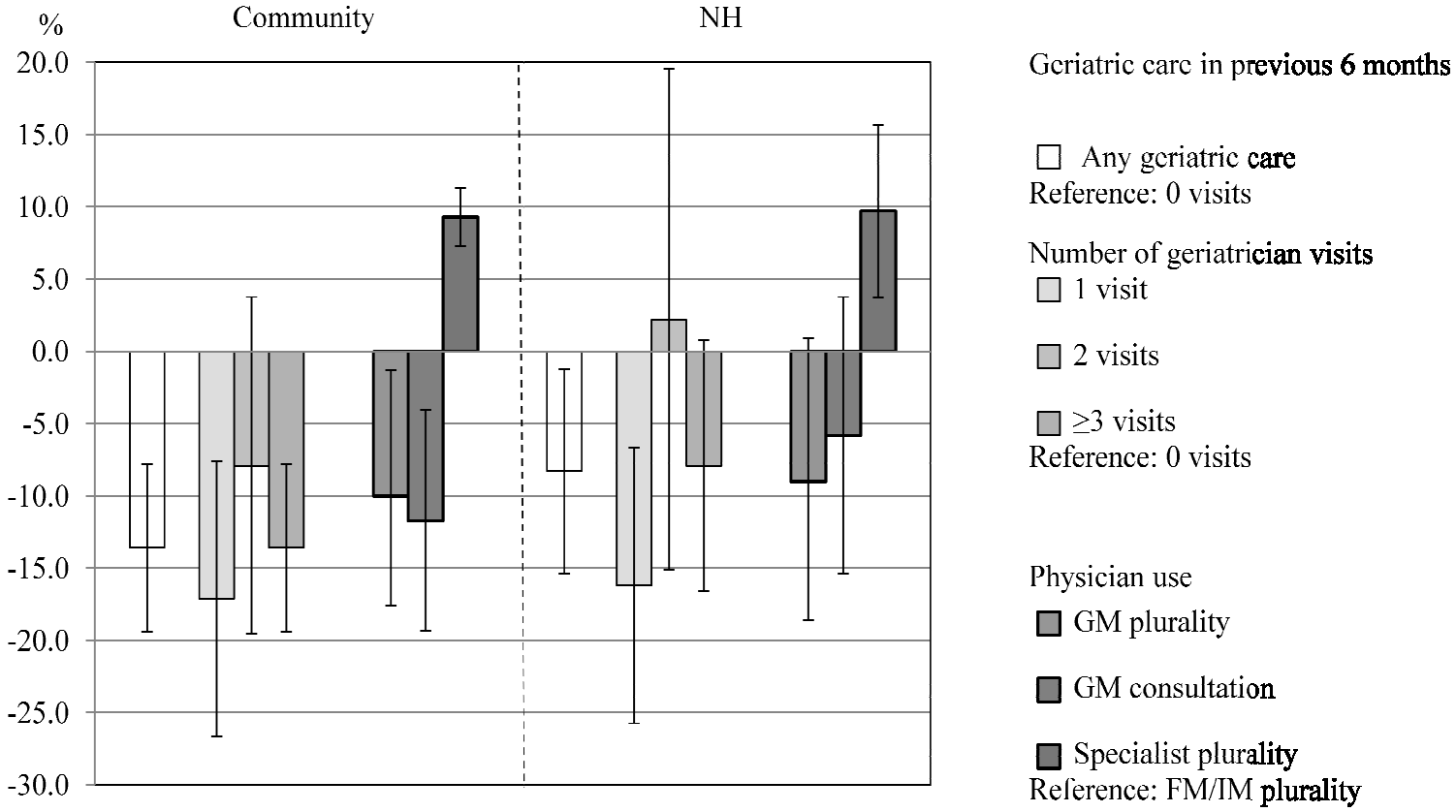
Appendix Table 7. Comparison of 2SRI and FE estimates

Sample	Comm.	Comm.	NH	NH
Model	**FE**	**2SRI**	**FE**	**2SRI**
Geriatric care in previous 6 months				
Any geriatric care (reference: 0 visits)	-0.009**	-0.090**	-0.011**	-0.134**
Number of geriatrician visits (reference: 0 visits)				
1 visit	-0.006**	0.908**	-0.003	0.858**
2 visits	-0.012**	0.913**	-0.012**	0.870**
≥3 visits	-0.013**	0.916**	-0.018**	0.881**
Physician use (reference: FM/IM plurality)				
GM plurality	-0.008**	0.749**	-0.009**	0.825**
GM consultation	-0.009**	-0.236**	-0.010**	-0.150**
Specialist plurality	0.001	-0.203**	0.009**	-0.103**

** p<0.01, * p<0.05.

Bias-corrected confidence intervals for odds ratios in 2SRI models were estimated using bootstrapping 250 random samples.

Appendix Figure 1. Percent change in likelihood of in-hospital death associated with geriatric care



95% confidence intervals shown.
Percent change calculated as change in predicted probability of in-hospital death (Appendix Table 9) divided by the sample mean of in-hospital death (Appendix Table 8) multiplied by 100.

Appendix Table 8. Descriptive statistics for in-hospital death analysis

	Comm.	NH**		Comm.	NH**
Observations	72,244	36,796	*Geriatric care during previous 6 months*		
			Any geriatric care	0.020	0.058
Demographic characteristics					
Age			Number of geriatrician visits		
66-74	0.133	0.079	0 visits	0.980	0.943
75-79	0.179	0.127	1 visit	0.007	0.013
80-84	0.231	0.217	2 visits	0.005	0.009
85-89	0.230	0.261	≥3 visits	0.008	0.036
90+	0.226	0.315			
Male	0.432	0.320	Physician use		
Nonwhite	0.109	0.110	GM plurality	0.009	0.027
Dual eligible	0.197	0.399	GM consultation	0.011	0.030
ZIP median income	$42,095	$44,295	Specialist plurality	0.265	0.083
Metropolitan status			FM/IM plurality	0.715	0.859
Metropolitan area	0.677	0.736			
Micropolitan area	0.158	0.128	*Dependent variable*		
Small town	0.094	0.080	In-hospital death	0.420	0.277
Rural area	0.071	0.056			
Comorbidities, median	5	7			

**Differences between samples are statistically significant at $p<0.05$ for all variables except nonwhite.
Month indicators, time trends, and comorbidities omitted.

Appendix Table 9. Change in predicted probability of in-hospital death

Sample	**Comm.**	**Comm.**	**NH**	**NH**
Model	**Logit**	**LPM**	**Logit**	**LPM**
FE?	**No**	**Yes**	**No**	**Yes**
Geriatric care in previous 6 months				
Any geriatric care (reference: 0 visits)				
(reference: 0 visits)	-0.053**	-0.057**	-0.029**	-0.023*
	(-0.075, -0.034)	(-0.081,-0.032)	(-0.039, -0.019)	(-0.043,-0.003)
Number of geriatrician visits (reference: 0 visits)				
1 visit	-0.067**	-0.072**	-0.043*	-0.045*
	(-0.108, -0.038)	(-0.112,-0.032)	(-0.076, -0.005)	(-0.084,-0.005)
2 visits	-0.030	-0.033	0.002	0.006
	(-0.083, 0.029)	(-0.082,0.016)	(-0.036, 0.043)	(-0.042,0.054)
≥3 visits	-0.056**	-0.057**	-0.031**	-0.022
	(-0.091, -0.008)	(-0.095,-0.019)	(-0.055, -0.012)	(-0.046,0.002)
Physician use (reference: FM/IM plurality)				
GM plurality	-0.035	-0.042*	-0.031*	-0.025
	(-0.065, 0.001)	(-0.079,-0.006)	(-0.062, -0.008)	(-0.053,0.002)
GM consultation	-0.047**	-0.049**	-0.020	-0.016
	(-0.067, -0.016)	(-0.081,-0.017)	(-0.039, 0.006)	(-0.043,0.010)
Specialist plurality	0.044**	0.039**	0.043**	0.027**
	(0.038, 0.054)	(0.031,0.048)	(0.024, 0.055)	(0.011,0.043)

** p<0.01, * p<0.05. 95% confidence intervals in parentheses. Demographic variables, month indicators, and comorbidities omitted.

Appendix Table 10. Comparison of OLS and Poisson models with FE, community sample

Model	OLS # FM/IM	Poisson # FM/IM	OLS # Specialist	Poisson # Specialist
Interpretation	**% change**	**IRR**	**% change**	**IRR**
Observations	1,006,879	874,297	1,006,879	874,297
Geriatric care in previous 6 months				
Any geriatric care	-13.7**	0.876**	-3.3*	0.968**
(reference: 0 visits)	(-16.1,-11.3)	(0.861,0.892)	(-6.3,-0.3)	(0.948,0.988)
Number of geriatrician visits (reference:: 0 visits)				
1 visit	-8.8**	0.934**	-4.1*	0.957**
	(-11.9,-5.7)	(0.912,0.956)	(-7.9, -0.3)	(0.931,0.983)
2 visits	-16.2**	0.843**	-5.4*	0.948**
	(-20.0,-12.4)	(0.816,0.870)	(-10.1, -0.7)	(0.916,0.981)
≥ 3 visits	-19.4**	0.811**	-0.2	0.997
	(-23.0,-15.8)	(0.787,0.835)	(-4.7, 4.3)	(0.968,1.028)

** p<0.01, * p<0.05
IRR: Incidence rate ratio
% change calculated as change in number of visits (Table 6.2) divided by the sample mean (Table 6.1) multiplied by 100.

Appendix Table 11. Comparison of OLS and Poisson models with FE, NH sample

Dependent variable	**# FM/IM**	**# FM/IM**	**# Specialist**	**# Specialist**
Model	**OLS**	**Poisson**	**OLS**	**Poisson**
Interpretation	**% change**	**IRR**	**% change**	**IRR**
Observations	195,433	170,763	195,433	170,763
Geriatric care in previous 6 months				
Any geriatric care	-13.8**	0.855**	-10.8**	0.912**
(reference: 0 visits)	(-16.7,-10.9)	(0.841,0.869)	(-17.7,-3.9)	(0.882,0.942)
Number of geriatrician visits (reference:: 0 visits)				
1 visit	-13.2**	0.896**	-1.2	0.996
	(-17.5,-8.9)	(0.874,0.918)	(-9.1,11.5)	(0.947,1.048)
2 visits	-10.4**	0.904**	-8.5	0.928*
	(-15.4, -5.4)	(0.877,0.931)	(-20.4,3.4)	(0.871,0.989)
≥ 3 visits	-15.5**	0.802**	-18.1**	0.852**
	(-19.1,-11.9)	(0.785,0.820)	(-26.8,-9.4)	(0.817,0.890)

** p<0.01, * p<0.05
IRR: Incidence rate ratio
% change calculated as change in number of visits (Table 6.3) divided by the sample mean (Table 6.1) multiplied by 100.

Appendix Table 12. OLS results for change in physician visits in six months, community sample

Dependent variable	FM/IM	FM/IM	Specialty	Specialty
FE?	No	Yes	No	Yes
Month (omitted: December)				
January	0.612**	0.009	0.406**	-0.008
	(0.576,0.648)	(-0.041,0.059)	(0.372,0.440)	(-0.052,0.037)
February	0.635**	-0.185**	0.436**	-0.189**
	(0.598,0.673)	(-0.244,-0.126)	(0.400,0.472)	(-0.241,-0.136)
March	0.610**	-0.232**	0.474**	-0.176**
	(0.573,0.646)	(-0.291,-0.174)	(0.440,0.509)	(-0.229,-0.123)
April	0.629**	-0.080**	0.475**	-0.120**
	(0.594,0.665)	(-0.134,-0.026)	(0.440,0.509)	(-0.168,-0.071)
May	0.645**	0.277**	0.502**	0.130**
	(0.610,0.679)	(0.233,0.321)	(0.469,0.536)	(0.091,0.169)
June	0.619**	0.538**	0.526**	0.484**
	(0.595,0.643)	(0.514,0.561)	(0.505,0.547)	(0.462,0.505)
July	0.490**	-0.101**	0.343**	-0.069**
	(0.457,0.523)	(-0.150,-0.052)	(0.311,0.375)	(-0.113,-0.025)
August	0.152**	-0.430**	0.134**	-0.328**
	(0.118,0.186)	(-0.488,-0.373)	(0.101,0.166)	(-0.379,-0.277)
September	-0.056**	-0.607**	0.015	-0.441**
	(-0.090,-0.021)	(-0.666,-0.548)	(-0.017,0.047)	(-0.494,-0.389)
October	-0.192**	-0.574**	-0.116**	-0.483**
	(-0.224,-0.159)	(-0.627,-0.521)	(-0.147,-0.085)	(-0.530,-0.435)
November	-0.269**	-0.376**	-0.178**	-0.360**
	(-0.301,-0.238)	(-0.419,-0.334)	(-0.209,-0.148)	(-0.398,-0.322)
Month in study	-0.326**	-0.338**	-0.244**	-0.320**
	(-0.339,-0.313)	(-0.350,-0.326)	(-0.255,-0.232)	(-0.331,-0.309)
Month squared	0.007**	0.010**	0.005**	0.015**
	(0.005,0.008)	(0.009,0.012)	(0.003,0.006)	(0.013,0.016)
Stroke	0.098**	-0.121**	-0.022	-0.176**
	(0.075,0.121)	(-0.149,-0.094)	(-0.044,0.000)	(-0.201,-0.151)
Dementia	-0.161**	-0.177**	-0.525**	-0.282**
	(-0.184,-0.137)	(-0.207,-0.147)	(-0.546,-0.504)	(-0.309,-0.255)
Osteoporosis	0.184**	-0.162**	0.167**	-0.225**
	(0.161,0.207)	(-0.192,-0.132)	(0.144,0.190)	(-0.252,-0.198)
Urinary incontinence	0.217**	-0.152**	0.602**	0.024
	(0.188,0.247)	(-0.192,-0.111)	(0.570,0.633)	(-0.012,0.060)

Dependent variable	FM/IM	FM/IM	Specialty	Specialty
FE?	No	Yes	No	Yes
Depression	0.611**	0.457**	-0.180**	-0.033**
	(0.583,0.638)	(0.436,0.478)	(-0.202,-0.158)	(-0.052,-0.015)
Dehydration	-0.036*	0.239**	-0.326**	0.01
	(-0.063,-0.008)	(0.218,0.260)	(-0.351,-0.302)	(-0.008,0.029)
Hearing impairment	0.073**	-0.302**	0.290**	-0.251**
	(0.039,0.106)	(-0.349,-0.256)	(0.253,0.328)	(-0.292,-0.209)
Syncope	0.301**	0.269**	0.271**	0.206**
	(0.274,0.328)	(0.249,0.290)	(0.246,0.296)	(0.188,0.225)
Fracture	0.242**	0.354**	-0.292**	-0.176**
	(0.215,0.269)	(0.333,0.375)	(-0.315,-0.270)	(-0.195,-0.158)
Pressure	0.213**	0.529**	-0.338**	0.067**
	(0.149,0.276)	(0.485,0.572)	(-0.392,-0.285)	(0.028,0.106)
Weight loss	0.222**	0.385**	-0.043*	0.143**
	(0.186,0.258)	(0.356,0.413)	(-0.077,-0.010)	(0.118,0.169)
Vision impairment	-0.161**	-0.173**	-0.185**	-0.257**
	(-0.226,-0.096)	(-0.264,-0.082)	(-0.251,-0.119)	(-0.338,-0.176)
Failure to thrive	0.176**	0.479**	-0.591**	-0.109**
	(0.063,0.289)	(0.392,0.565)	(-0.669,-0.513)	(-0.186,-0.032)
Laceration	0.717**	0.515**	0.142**	-0.011
	(0.658,0.777)	(0.477,0.553)	(0.092,0.193)	(-0.045,0.023)
Delirium	0.179**	0.324**	-0.470**	-0.141**
	(0.087,0.271)	(0.254,0.395)	(-0.535,-0.404)	(-0.204,-0.078)
Dislocation	0.095**	-0.056*	-0.009	-0.222**
	(0.029,0.161)	(-0.108,-0.004)	(-0.067,0.048)	(-0.268,-0.175)
Hypertension	0.734**	0.341**	0.323**	0.100**
	(0.707,0.761)	(0.306,0.376)	(0.295,0.350)	(0.069,0.131)
CHF	0.309**	0.035**	0.055**	-0.012
	(0.287,0.330)	(0.009,0.060)	(0.035,0.076)	(-0.035,0.011)
Diabetes	0.100**	-0.331**	-0.131**	-0.307**
	(0.077,0.122)	(-0.360,-0.301)	(-0.153,-0.110)	(-0.333,-0.281)
Deficiency anemia	0.417**	0.140**	0.501**	0.174**
	(0.396,0.438)	(0.115,0.166)	(0.481,0.521)	(0.152,0.197)
COPD	0.339**	-0.096**	0.174**	-0.085**
	(0.318,0.360)	(-0.123,-0.069)	(0.153,0.195)	(-0.110,-0.061)
PVD	0.216**	-0.044**	0.161**	-0.052**
	(0.194,0.238)	(-0.071,-0.017)	(0.140,0.183)	(-0.076,-0.027)

Dependent variable FE?	FM/IM No	FM/IM Yes	Specialty No	Specialty Yes
Hypothyroidism	0.183**	-0.270**	0.155**	-0.226**
	(0.161,0.205)	(-0.301,-0.240)	(0.134,0.177)	(-0.254,-0.199)
Valvular disease	0.136**	-0.124**	0.568**	0.068**
	(0.112,0.159)	(-0.153,-0.095)	(0.544,0.592)	(0.042,0.094)
Other neurological	0.115**	-0.045*	0.164**	-0.052**
	(0.084,0.145)	(-0.081,-0.008)	(0.134,0.193)	(-0.085,-0.020)
Diabetes w/complications	0.166**	-0.211**	0.279**	-0.120**
	(0.135,0.196)	(-0.246,-0.175)	(0.249,0.309)	(-0.152,-0.088)
Renal failure	-0.169**	-0.053**	0.118**	-0.014
	(-0.198,-0.140)	(-0.083,-0.023)	(0.090,0.147)	(-0.041,0.012)
Tumor, no metastasis	-0.037**	-0.301**	0.885**	0.337**
	(-0.065,-0.009)	(-0.339,-0.263)	(0.853,0.917)	(0.303,0.371)
Electrolyte disorder	0.437**	0.491**	0.058**	0.190**
	(0.407,0.467)	(0.470,0.513)	(0.030,0.086)	(0.170,0.209)
Hypertension, complications	0.364**	0.428**	0.535**	0.433**
	(0.338,0.390)	(0.408,0.448)	(0.509,0.561)	(0.415,0.452)
Paralysis	-0.166**	-0.037	-0.197**	-0.055
	(-0.233,-0.100)	(-0.117,0.043)	(-0.263,-0.132)	(-0.126,0.016)
Psychoses	0.469**	0.404**	0.248**	0.134**
	(0.423,0.515)	(0.368,0.440)	(0.205,0.292)	(0.102,0.166)
Coagulation deficiency	0.710**	0.461**	0.866**	0.480**
	(0.654,0.766)	(0.424,0.498)	(0.805,0.927)	(0.447,0.513)
Rheumatoid arthritis	0.365**	-0.147**	0.822**	0.053*
	(0.325,0.406)	(-0.198,-0.097)	(0.776,0.868)	(0.008,0.098)
Obesity	0.185**	0.028	0.075**	0.037
	(0.133,0.237)	(-0.032,0.088)	(0.024,0.127)	(-0.017,0.090)
Pulm. circulation disorder	0.614**	0.573**	0.462**	0.422**
	(0.550,0.678)	(0.531,0.616)	(0.402,0.523)	(0.384,0.460)
Blood loss anemia	0.395**	0.476**	0.290**	0.273**
	(0.327,0.463)	(0.429,0.523)	(0.219,0.361)	(0.231,0.315)
Metastatic	-0.418**	-0.179**	0.993**	0.173**

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
FE?	**No**	**Yes**	**No**	**Yes**
cancer				
	(-0.481,-0.356)	(-0.249,-0.109)	(0.907,1.080)	(0.111,0.235)
Lymphoma	-0.056	-0.397**	1.759**	0.328**
	(-0.135,0.024)	(-0.501,-0.294)	(1.641,1.877)	(0.236,0.420)
Liver disease	0.135**	-0.301**	0.324**	-0.206**
	(0.045,0.225)	(-0.404,-0.198)	(0.225,0.424)	(-0.298,-0.114)
Alcohol abuse	-0.276**	-0.366**	-0.632**	-0.122*
	(-0.364,-0.188)	(-0.486,-0.245)	(-0.711,-0.552)	(-0.230,-0.015)

** p<0.01, * p<0.05

Appendix Table 13. OLS results for change in physician visits in six months, NH sample

Dependent variable	FM/IM	FM/IM	Specialty	Specialty
Fixed effects?	**No**	**Yes**	**No**	**Yes**
Month (omitted: December)				
January	0.753**	-0.216	0.219**	-0.011
	(0.609,0.897)	(-0.441,0.009)	(0.141,0.298)	(-0.130,0.109)
February	0.863**	-0.421**	0.196**	-0.076
	(0.713,1.014)	(-0.690,-0.151)	(0.116,0.275)	(-0.219,0.068)
March	0.791**	-0.479**	0.234**	-0.113
	(0.645,0.936)	(-0.752,-0.206)	(0.155,0.313)	(-0.258,0.033)
April	0.950**	-0.051	0.258**	0.123
	(0.804,1.095)	(-0.307,0.205)	(0.181,0.335)	(-0.014,0.259)
May	0.916**	0.318**	0.242**	0.115*
	(0.775,1.057)	(0.114,0.522)	(0.168,0.316)	(0.006,0.223)
June	0.846**	0.736**	0.222**	0.227**
	(0.740,0.952)	(0.632,0.839)	(0.167,0.278)	(0.171,0.282)
July	0.695**	-0.406**	0.145**	-0.088
	(0.556,0.833)	(-0.627,-0.185)	(0.074,0.216)	(-0.205,0.030)
August	0.205**	-0.885**	0.021	-0.197**
	(0.070,0.339)	(-1.149,-0.622)	(-0.049,0.092)	(-0.338,-0.057)
September	-0.065	-1.110**	-0.016	-0.255**
	(-0.201,0.071)	(-1.382,-0.837)	(-0.090,0.059)	(-0.400,-0.110)
October	-0.374**	-0.971**	-0.101**	-0.128
	(-0.506,-0.242)	(-1.221,-0.720)	(-0.169,-0.032)	(-0.261,0.006)
November	-0.400**	-0.738**	-0.125**	-0.185**
	(-0.531,-0.270)	(-0.937,-0.539)	(-0.191,-0.059)	(-0.291,-0.079)
Month in study	-2.016**	-2.313**	-0.428**	-0.540**
	(-2.076,-1.956)	(-2.371,-2.254)	(-0.459,-0.398)	(-0.571,-0.509)
Month squared	0.189**	0.222**	0.039**	0.048**
	(0.181,0.197)	(0.215,0.230)	(0.035,0.042)	(0.044,0.053)
Stroke	0.144**	-0.294**	-0.015	-0.108**
	(0.068,0.220)	(-0.423,-0.164)	(-0.054,0.025)	(-0.177,-0.039)
Dementia	0.053	-0.051	-0.336**	-0.081*
	(-0.020,0.126)	(-0.183,0.081)	(-0.378,-0.295)	(-0.151,-0.011)
Osteoporosis	-0.039	-0.805**	-0.003	-0.226**
	(-0.122,0.044)	(-0.940,-0.670)	(-0.047,0.041)	(-0.298,-0.154)
Urinary incontinence	0.057	-0.350**	0.263**	0.017
	(-0.049,0.162)	(-0.523,-0.177)	(0.206,0.320)	(-0.075,0.109)

Dependent variable	FM/IM	FM/IM	Specialty	Specialty
Fixed effects?	**No**	**Yes**	**No**	**Yes**
Depression	0.838**	0.773**	0.03	0.101**
	(0.761,0.914)	(0.700,0.846)	(-0.009,0.069)	(0.063,0.140)
Dehydration	0.012	0.477**	-0.070**	0.063**
	(-0.081,0.104)	(0.396,0.558)	(-0.117,-0.023)	(0.020,0.106)
Hearing impairment	0.120	-0.564**	0.124**	-0.172**
	(-0.030,0.271)	(-0.769,-0.359)	(0.044,0.204)	(-0.281,-0.063)
Syncope	0.288**	0.326**	0.263**	0.197**
	(0.173,0.403)	(0.224,0.427)	(0.201,0.325)	(0.143,0.251)
Fracture	0.650**	0.983**	0.205**	0.226**
	(0.561,0.739)	(0.902,1.064)	(0.154,0.255)	(0.183,0.269)
Pressure	1.892**	1.746**	0.134**	0.238**
	(1.731,2.053)	(1.629,1.863)	(0.052,0.217)	(0.175,0.300)
Weight loss	0.686**	0.764**	-0.135**	-0.03
	(0.558,0.815)	(0.656,0.871)	(-0.192,-0.077)	(-0.087,0.027)
Vision impairment	0.159	0.028	-0.073	-0.055
	(-0.062,0.381)	(-0.327,0.382)	(-0.182,0.035)	(-0.244,0.134)
Failure to thrive	1.103**	1.180**	-0.312**	-0.024
	(0.857,1.350)	(0.954,1.407)	(-0.406,-0.218)	(-0.145,0.096)
Laceration	1.464**	1.119**	0.230**	0.173**
	(1.275,1.653)	(0.979,1.260)	(0.135,0.325)	(0.098,0.248)
Delirium	0.889**	0.852**	-0.108*	0.039
	(0.658,1.120)	(0.659,1.044)	(-0.209,-0.008)	(-0.064,0.141)
Dislocation	-0.163	0.064	-0.051	-0.107
	(-0.484,0.157)	(-0.247,0.375)	(-0.251,0.149)	(-0.272,0.059)
Hypertension	0.644**	0.267**	0.189**	0.116*
	(0.516,0.772)	(0.085,0.448)	(0.108,0.270)	(0.019,0.213)
CHF	0.385**	0.162*	0.041	0.001
	(0.308,0.462)	(0.030,0.294)	(-0.000,0.083)	(-0.070,0.071)
Diabetes	0.050	-0.661**	-0.043	-0.202**
	(-0.034,0.133)	(-0.790,-0.532)	(-0.089,0.002)	(-0.270,-0.133)
Deficiency anemia	0.691**	0.325**	0.246**	0.131**
	(0.621,0.762)	(0.201,0.448)	(0.208,0.284)	(0.065,0.197)
COPD	0.282**	-0.415**	0.092**	-0.067*
	(0.207,0.358)	(-0.537,-0.294)	(0.052,0.133)	(-0.132,-0.003)
PVD	0.253**	-0.019	0.075**	0.01
	(0.181,0.325)	(-0.143,0.105)	(0.036,0.115)	(-0.056,0.076)

Dependent variable	FM/IM	FM/IM	Specialty	Specialty
Fixed effects?	**No**	**Yes**	**No**	**Yes**
Hypothyroidism	0.092*	-0.729**	0.028	-0.295**
	(0.014,0.169)	(-0.865,-0.593)	(-0.012,0.069)	(-0.368,-0.223)
Valvular disease	-0.171**	-0.670**	0.269**	-0.057
	(-0.257,-0.085)	(-0.809,-0.532)	(0.222,0.316)	(-0.131,0.017)
Other neurological	0.222**	0.059	0.069**	0.039
	(0.134,0.309)	(-0.090,0.208)	(0.022,0.116)	(-0.040,0.118)
Diabetes w/complications	0.027	-0.490**	0.102**	-0.014
	(-0.077,0.130)	(-0.646,-0.333)	(0.044,0.159)	(-0.098,0.069)
Renal failure	-0.161**	-0.297**	-0.013	-0.008
	(-0.254,-0.068)	(-0.426,-0.169)	(-0.060,0.034)	(-0.077,0.060)
Tumor, no metastasis	-0.059	-0.916**	0.369**	-0.003
	(-0.172,0.053)	(-1.084,-0.749)	(0.299,0.439)	(-0.092,0.087)
Electrolyte disorder	0.893**	0.906**	0.112**	0.128**
	(0.797,0.990)	(0.826,0.987)	(0.063,0.160)	(0.085,0.170)
Hypertension, complications	0.461**	0.599**	0.326**	0.259**
	(0.361,0.561)	(0.510,0.688)	(0.270,0.382)	(0.212,0.307)
Paralysis	0.194*	-0.166	0.07	-0.081
	(0.027,0.362)	(-0.469,0.137)	(-0.030,0.170)	(-0.242,0.081)
Psychoses	0.911**	0.951**	0.397**	0.321**
	(0.812,1.009)	(0.860,1.043)	(0.344,0.450)	(0.272,0.370)
Coagulation deficiency	0.832**	0.783**	0.328**	0.259**
	(0.655,1.009)	(0.635,0.931)	(0.234,0.423)	(0.180,0.337)
Rheumatoid arthritis	0.105	-0.681**	0.306**	-0.082
	(-0.049,0.259)	(-0.922,-0.439)	(0.222,0.390)	(-0.210,0.047)
Obesity	0.284**	-0.22	0.059	0.056
	(0.099,0.469)	(-0.510,0.071)	(-0.041,0.159)	(-0.099,0.211)
Pulm. circulation disorder	0.782**	0.865**	0.151**	0.241**
	(0.570,0.994)	(0.682,1.048)	(0.041,0.261)	(0.143,0.338)
Blood loss anemia	0.390**	0.704**	0.181**	0.208**
	(0.181,0.598)	(0.517,0.890)	(0.055,0.307)	(0.109,0.308)
Metastatic	-0.289*	-0.796**	0.205*	-0.184*

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
Fixed effects?	**No**	**Yes**	**No**	**Yes**
cancer				
	(-0.543,-0.035)	(-1.130,-0.462)	(0.049,0.362)	(-0.362,-0.006)
Lymphoma	-0.006	-1.260**	0.785**	-0.244
	(-0.323,0.312)	(-1.740,-0.779)	(0.542,1.029)	(-0.500,0.012)
Liver disease	-0.18	-0.631**	0.118	-0.03
	(-0.481,0.121)	(-1.087,-0.174)	(-0.085,0.322)	(-0.273,0.213)
Alcohol abuse	-0.432**	-0.692*	-0.215*	-0.370*
	(-0.704,-0.161)	(-1.247,-0.136)	(-0.393,-0.037)	(-0.665,-0.074)

** p<0.01, * p<0.05

Appendix Table 14. Effect of any geriatric care: comparison of IV and OLS FE estimates

Dependent variable	**FM/IM**	**FM/IM**	**Specialty**	**Specialty**
Model	**OLS with FE**	**IV**	**OLS with FE**	**IV**
Community sample	-0.396**	6.885**	-0.070*	2.326**
	(-0.467,-0.326)	(5.608, 8.150)	(-0.133,-0.007)	(1.060, 3.226)
NH sample	-0.799**	8.858**	-0.140**	0.037
	(-0.968,-0.631)	(6.318, 11.232)	(-0.230,-0.051)	(-1.021, 1.255)

** p<0.01, * p<0.05

Bias-corrected confidence intervals for changes in the predicted number of physician visits were generated by bootstrapping 100 random samples drawn at the beneficiary level with replacement.

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