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The Effect Of Physician Ownership On Quality Of Care For Outpatient Procedures

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THE EFFECT OF PHYSICIAN OWNERSHIP ON QUALITY OF CARE FOR OUTPATIENT PROCEDURES

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy at Virginia Commonwealth University

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Table Of Contents

List Of Tables

List Of Figures

List Of Abbreviations

ACA	Patient Protection and Affordable Care Act
ACG	American College of Gastroenterology
AHRQ	Agency for Healthcare Research and Quality
APC	Ambulatory Payment Classification
ARF	Area Resource File
ASC	Ambulatory Surgery Center
ASGE	American Society for Gastrointestinal Endoscopy
BMI	Body Mass Index
CDPH	California Department of Public Health
CIHI	Canadian Institute for Health Information
CMS	Centers for Medicare & Medicaid Services
CORI	Clinical Outcomes Research Initiative
CPT	Current Procedural Terminology
DCG/HCC	Diagnostic Cost Groups/Hierarchical Condition Categories
ED	Emergency Department
EGD	Esophagogastroduodenoscopy
FFS	Fee-for-service
GHLM	Generalized Hierarchical Linear Model
GI	Gastrointestinal

HCUP	Healthcare Cost & Utilization Project
HHI	Herfindahl–Hirschman Index
HMO	Health Maintenance Organization
ICD-9 CM	International Classification of Diseases, Ninth Revision, Clinical Modification
IOL	Intraocular lens
IOM	Institute of Medicine
KPNC	Kaiser Permanente of Northern California
MedPAC	Medicare Payment Advisory Commission
N/A	Not Available
OIG	Office of Inspector General
OPPS	Outpatient Prospective Payment System
OSHPD	Office of Statewide Health Planning and Development
PPO	Preferred Provider Organization
SASD	State Ambulatory Surgery Databases
SEDD	Emergency Department Databases
SEER	Surveillance, Epidemiology, and End Results
SID	State Inpatient Databases

Abstract

THE EFFECT OF PHYSICIAN OWNERSHIP ON QUALITY OF CARE FOR OUTPATIENT PROCEDURES

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Ambulatory surgery centers (ASCs) play an important role in providing surgical and diagnostic services in an outpatient setting. They can be owned by physicians who staff them. Previous studies focused on patient “cherry picking” and over-utilization of services due to physician ownership. Few studies examined the relationship between physician ownership and quality of care. Using a retrospective cohort of patients who underwent colonoscopy, this study examined the effect of physician ownership of ASCs on the occurrence of adverse events after outpatient colonoscopy.

Agency theory is used to as a conceptual framework. Depending on the extent to which consumers are able to assess quality of care differences across health care settings, physician

ownership can function as a mechanism to improve quality or as a deterrent to quality. Four adverse event measures are used in this study: same day ED visit or hospitalization, 30-day serious gastrointestinal events resulting in ED visit or hospitalization, 30-day other gastrointestinal events resulting in ED visit or hospitalization, and 30-day non-gastrointestinal events resulting in ED visit or hospitalization. Physician ownership status is determined based on a court decision in California in 2007. Data sources include the State Ambulatory Surgery Databases (SASD), State Inpatient Databases (SID), Emergency Department Databases (SEDD), State Utilization Data Files, the Area Resource File (ARF), and HMO/PPO data from Health Leaders.

After controlling for confounding factors, the study found that colonoscopy patients treated at a physician-owned ASC had similar odds of experiencing same day ED visit or hospitalization and 30-day non-gastrointestinal events resulting in ED visit or hospitalization as those treated in a hospital-based outpatient facility. But the former had significantly higher odds of experiencing 30-day serious gastrointestinal events and 30-day other gastrointestinal events resulting in ED visit or hospitalization. The results are robust to changes in propensity score adjustment approach and to the inclusion of a lagged quality indicator. They suggest that physician ownership of ASCs was not associated with better quality of care for colonoscopy patients. As more complex procedures are shifted from hospital-based outpatient facilities to ASCs, expanded efforts to monitor and report quality of care will be worthwhile.

Chapter 1: Introduction

Specific Aims

Containing health care costs while improving quality of care have been priorities of policy makers for many decades and is increasingly important given objectives of the Patient Protection and Affordable Care Act (ACA) (Kaiser Family Foundation, 2010). Shifting surgical services to outpatient settings, especially ambulatory surgery centers (ASCs) has the potential to achieve cost reduction and quality improvement at the same time (Casalino, Devers, & Brewster, 2003). ASCs are health care facilities that specialize in providing surgical services that do not require an overnight stay. Most ASCs are freestanding facilities independent from other facilities while about 1% are owned and operated by hospitals (Medicare Payment Advisory Commission, 2003; Medicare Payment Advisory Commission, 2011). ASCs play an important role in providing surgical and diagnostic services in an outpatient setting. The number of Medicare-certified ASCs reached 5,260 in 2009, up from 336 in 1985 (Centers for Medicare & Medicaid Services, 2002; Centers for Medicare & Medicaid Services, 2010).

ASCs can be owned by physicians who staff them. Physician owners collect both professional fees and a share of the facility's profits. A multitude of concerns arise about the potential conflicts of interest because physician owners are in a position to self-refer patients for procedures. Issues regarding patient "cherry picking" and over-utilization of services due to physician ownership of health care facilities are at the forefront of research and policy discussions (Hollingsworth et al., 2009; Hollingsworth et al., 2010b; Mitchell, 2010; Strope et al., 2009; Strope, Sarma, Ye, Wei, & Hollenbeck, 2009; Winter, 2003). However, the potential relationship between physician ownership and quality of care has not been examined in substantial depth. Proponents argue that physician-owned health facilities, including ASCs, provide better quality of care because physician ownership may enhance physician's accountability (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009; Office of Inspector General, 1999). By contrast, others contend that quality of care in physician owned facilities may be compromised due to potential financial conflicts of interest (Mitchell & Sass, 1995; O'Neill & Hartz, 2012). Yet, limited empirical study has been conducted to assess the potential influence of physician ownership of health care facilities on quality of care and no research has specifically examined this issue for physician-owned ASCs.

This study aims to address this knowledge gap by examining the effect of physician ownership of ASCs on the occurrence of adverse events after outpatient colonoscopy. Colonoscopy is widely used for the screening, diagnosis and treatment of colonic disorders. It has been accepted as the most effective colorectal cancer screening method (Rex, Johnson, Lieberman, Burt, & Sonnenberg, 2000). Examination of the quality of outpatient colonoscopy is needed to monitor and improve its quality and safety. The task is especially important given that colonoscopy has been migrating out of hospital-based outpatient facilities and into ASCs. The market share of Medicare-covered colonoscopies provided in ASCs increased from 22% in 2000 to 41% while the market share of these procedures at hospital-based outpatient facilities fell from 73% to 54% during the same period (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009). Through this study, we will gain a better understanding of the implications of physician ownership of ASCs on quality of outpatient colonoscopy care as well as a clearer picture about factors that affect the occurrence of adverse events after this procedure in outpatient surgical settings.

Study Overview and Research Questions

Physician ownership is common among ASCs. But the question of how physician ownership affects the production of quality outpatient surgical care needs to be assessed. This study addresses this question by examining how physician ownership affects the occurrence of adverse events after outpatient colonoscopy. Specifically, this study compares the rates of experiencing adverse events within 30 days of the procedure by patients who were treated at a physician-owned ASCs and those treated by a hospital-based outpatient facility.

The following research questions guide the investigation:

- Research question I: How does physician ownership affect the incidence of adverse events following outpatient colonoscopy?
- Research question II: Does the competitiveness of the health care market change the effect of physician-ownership on quality of care?
- Research question III: What patient-, facility-, and market-level factors are associated with the incidence of adverse events after outpatient colonoscopy?

Conceptual Framework

This study focuses on the relationship between physician ownership and quality of care in outpatient surgical settings. Agency theory is used to explain how physician ownership may shape two agency relationships, the one between other owners of an ASC (principals) and physicians (agents) who perform surgical procedures in the facility and the relationship between patients (principals) and physicians (agents) and ultimately affect patient outcomes. Depending on the extent to which consumers are able to assess quality of care differences across health care settings, physician ownership can function as a mechanism to improve quality or as a deterrent to quality. In addition to physician ownership, the study will also investigate the moderating effect of the market competition on ASC ownership.

Patient characteristics, financial incentives and other organizational factors, and market environment all affect physician choices of quality of output (Conrad & Christianson, 2004a). In order to isolate the potential effect of physician ownership, the study also controls for confounding factors. These include factors from patient-, facility-, and market levels.

The graphical depiction in Figure 1 presents the groups of factors that may influence the ultimate quality of care in outpatient surgical settings.

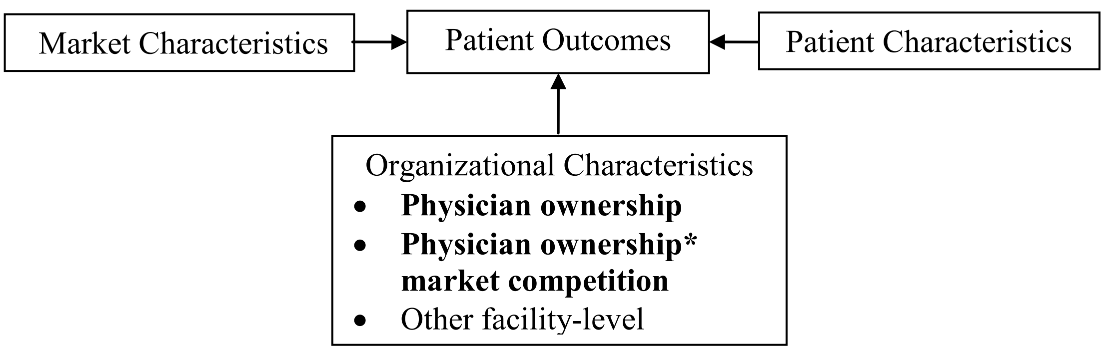

Figure 1. Brief Depiction of Multi-dimensional Factors that Affect Quality of Care for Outpatient Procedures

Study Approach

This study will examine the provision of colonoscopy services in the State of California. Several reasons lead to this choice of geographic location for the analysis. First, California has the largest number of ASCs and nearly three million ambulatory surgeries were performed in 2007 in California. Because there is no ambulatory surgery database at the national level, a study based on California is a good option given the large number of procedures in this state. Second, a court decision in California made it possible to identify full or partial physician ownership of

ASCs in the state. Third, information related to organizational factors can be obtained from national sources and also California state agencies.

The study examines a retrospective cohort of patients who underwent colonoscopy in physician-owned ASCs and hospital-based outpatient facilities between 2005 and 2007 in California. Primary data for the analysis comes from the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project, specifically the Agency's State Ambulatory Surgery Database (SASD). This database contains Current Procedural Terminology codes, which were used to identify patients receiving colonoscopy procedures. AHRQ also provides a revisit data file that allows researchers to examine whether patients in the SASD database had a subsequent emergency department visit or hospitalization. This study links AHRQ's State Inpatient Databases (SID) and Emergency Department Databases (SEDD) to the SASD for California. Adverse events that may be precipitated by the colonoscopy procedure were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) diagnosis codes reported in previous studies (Levin et al., 2006; Warren et al., 2009). The analytical database also includes information on (1) ASC and hospital-based outpatient facility characteristics from the State Utilization Data Files of Specialty Clinics and State Utilization Data Files of Hospitals; (2) community socioeconomic characteristics from the Area Resource File (ARF); and (3) data on HMO/PPO market shares from Health Leaders.

Four adverse event measures are used in this study: same day ED visit or hospitalization, 30-day serious gastrointestinal events resulting in ED visit or hospitalization, 30-day other gastrointestinal events resulting in ED visit or hospitalization, 30-day non-gastrointestinal events resulting in ED visit or hospitalization. Physician ownership status is determined based on a court decision in California in 2007, which changed the licensing requirements for ASCs wholly or partially owned by physicians. The study controls for patient-, facility-, and market-level factors using three-level generalized hierarchical linear models (GHLMs) to account for the clustering of patients within outpatient surgical facilities and the clustering of those facilities within health care markets.

Significance of the Study

The care provided by ASCs is seen by many to be a less costly alternative to the care furnished by hospital-based outpatient facilities. While existing studies largely focus on the relationship between physician ownership of health care facilities and potential over-utilization of services due to self-referral as well as issues of patient selection, limited evidence exists on the potential relationship between physician ownership and quality of care. In addition, the quality of outpatient surgical care is relatively understudied in terms of patient outcome measurement and the scope of factors that may affect it.

The study contributes to the body of existing research in several ways. First, it focuses on the effect of physician ownership on the quality of care in outpatient surgical settings, complementing prior studies of the impact of physician ownership on potential patient selection and overuse of services. Second, the study uses a heterogeneous and large sample to identify procedure-specific complications that result in ER visit or hospitalization after outpatient colonoscopy. Samples used by previous studies were limited to just Medicare or Medicaid patients or were restricted to a few hospitals (Ko & Dominitz, 2010). The largest sample size was 53,220 patients (Warren et al., 2009). Third, the study uses multilevel analysis techniques to account for the hierarchical structure of the data.

Results of the study have potential implications for theory, health policy, and health care management. First, this study serves as an example of applying agency theory to the examination of physician ownership and patient outcomes of care. It also assesses relationships noted in the outpatient surgical literature, such as the positive relationship between procedure volume and quality (Chukmaitov et al., 2008). From a policy perspective, a better understanding of the relationship between physician ownership and quality may help policy makers and payers evaluate the value of care provided by physician-owned ASCs and develop informed disclosure and payment policies. From a clinical or management perspective, the research findings could be used to identify subgroups of surgical patients who are at greater rates of developing complications after the procedure. Extra efforts may be needed to monitor high risk patients both in the facility and at home for potential complications that require medical attention. Targeting care for these vulnerable subgroups can be much more cost-effective than delivering interventions to the general patient population. This is especially the case considering that the rates of adverse events after outpatient surgery are low.

Summary of Remaining Chapters

The dissertation is organized into six chapters. This chapter provided a general introduction and discussed the aims, conceptual framework, scope and approach, and the significance of the study. Detailed information is given in subsequently chapters. Chapter 2 reviews the development of the ASC industry, relevant literature, and policies related to physician ownership in ASCs. Chapter 3 presents the conceptual framework based on agency theory. Chapter 4 covers research methods used in this study, including research design, empirical models, specification issues involved, and approaches for dealing with these specification issues. Chapter 5 presents study findings. Results of descriptive analysis, multivariate models, and sensitivity analysis are discussed. Chapter 6 summarizes research findings and discusses the implications and limitations of the study.

Chapter 2: Literature Review

Studies of ambulatory surgery centers (ASCs) have grown substantially in number in recent years. This chapter reviews the literature related to physician ownership of ASCs and its implications. The chapter is organized into five sections. The first section provides background on ambulatory surgery centers. Specifically, it covers the growth of the ASC industry, common surgical procedures provided by ASCs, and Medicare ASC payment policy. The second section discusses the prevalence and measurement of physician ownership among ASCs. The third section reviews the literature on the quality of outpatient surgery in general and that focused on outpatient colonoscopy specifically. The fourth section summarizes the effects of physician ownership on care in ASCs. The related literature can be grouped into studies examining patient selection and those focusing on services use. The fifth section summarizes the limitations of the literature and outlines how this study addresses the gap identified in the review.

Background on Ambulatory Surgery Centers

Over the last thirty years, there has been significant change in how surgical services are delivered. With the advances in medical technology and the external pressure to reduce costs, traditionally inpatient surgeries are increasingly performed in outpatient settings. In 1981, outpatient surgeries accounted for only 19% of all surgeries (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009). The most recent data indicate that the proportion has increased to a range between 60% and 70% (Medicare Payment Advisory Commission, 2004).

In addition, complex surgical procedures traditionally rendered in hospital-based outpatient facilities are migrating into ASCs and physician's office. During the period from early 1980s to 2005, the share of outpatient surgeries performed by hospital-based outpatient facilities has fallen from over 90% to 45%, while the shares performed in ASCs and physician's offices has increased from less than 5% each to 38% and 17%, respectively (American Hospital Association, 2006). Data from Pennsylvania suggest the same trend. From 2000 through 2009, ASC's share of outpatient diagnostic and surgical procedures performed on all patients rose from 10% to 33% (Pennsylvania Health Care Cost Containment Council, 2010).

The number of ambulatory surgery centers (ASCs) has increased substantially since the1980s. The first ASC was started by two surgeons back in early 1970s. In 1985, there were 336 Medicare-certified ASCs around the country. In 2010, the number had increased to 5,316 (Figure 2.). However, the growth of ASCs has slowed in recent years due to the economic downturn, Medicare payment system change in 2008, higher payments rates for the same outpatient surgical services in the hospital-based outpatient facility setting, and limited opportunities to develop new ASCs as most physicians are already affiliated with extant ASCs (Medicare Payment Advisory Commission, 2012).

ASCs tend to be concentrated geographically. As of 2007, five states, California, Florida, Maryland, Texas, and Georgia, had more than 39 percent of all ASCs while Arkansas and Rhode Island had fewer than 10 ASCs and Vermont had none (Medicare Payment Advisory Commission, 2009). California has the largest number of ASCs. The number of licensed ASCs in California grew by 15% from 2003 to 2007 (Figure 2.). But the number has dropped since 2007 because of the Capen v Shewry decision in 2007, after which about 450 ASCs were delicensed.

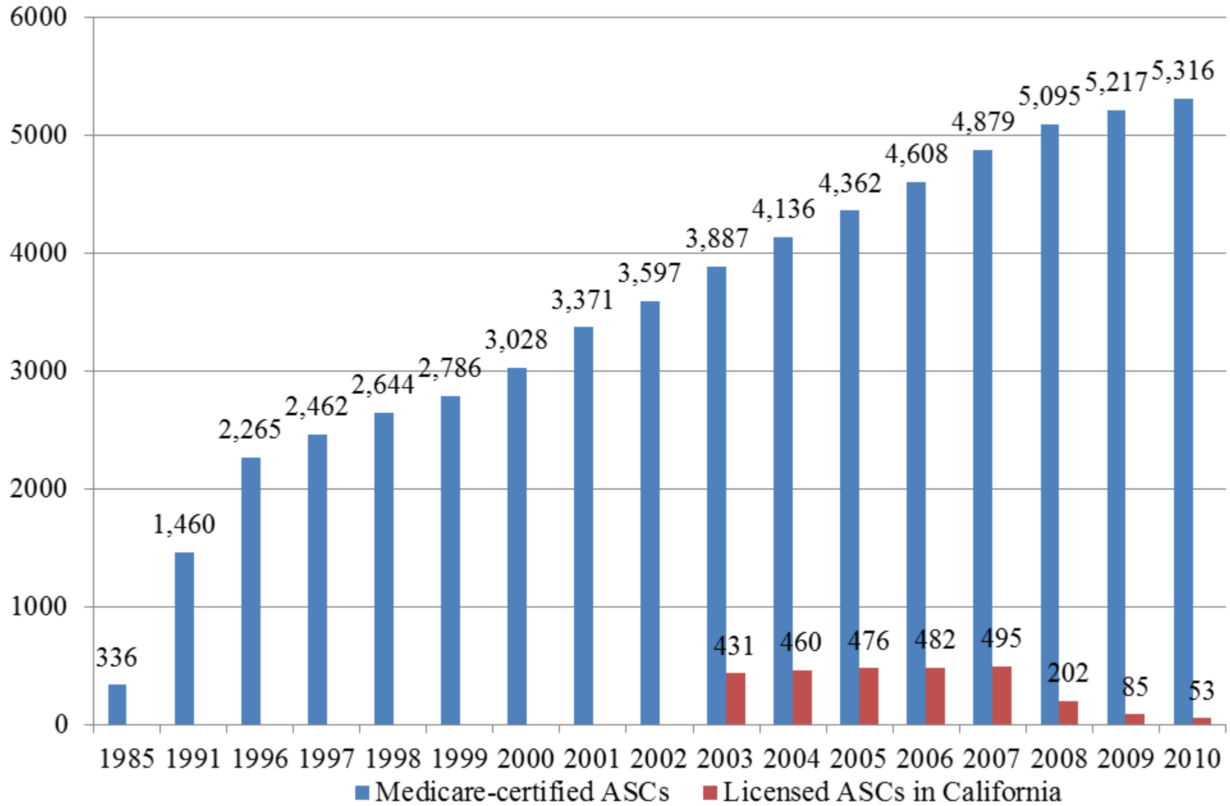

Figure 2. Number of Medicare-certified Ambulatory Surgical Centers, 1985 – 2010

Source: Centers for Medicare & Medicaid Services. 2002. Data Compendium, 2002 Edition; Medicare Payment Advisory Commission. March 2003/2009/2012. Report to Congress: Medicare Payment Policy; Office of Statewide Health Planning and Development (OSHPD). Surgical Clinics 2003-2007 Trends, Specialty Clinics Annual Utilization Data Files (2008-2010).

This decision provides the opportunity to distinguish physician-owned ASCs from non-physician-owned ASCs and will be discussed in detail below.

Since 1982, Medicare has covered certain surgical procedures provided in ASCs under Part B. CMS is responsible for determining whether a procedure can be performed safely in an ASC and thus can be eligible for Medicare payment. The list of procedures payable by Medicare in ASCs has expanded over time, especially in the 2008 revision to the ASC payment system. Medicare covers about 3,500 surgical procedures according to a MedPAC report (Medicare Payment Advisory Commission, 2012). Cataract surgery and endoscopy procedures are among the most common procedures provided to Medicare beneficiaries in ASCs (Table 1.). In many states, such as Florida, Nevada, Tennessee, and Washington, ASCs furnished more than half of all colonoscopies as of 2007 (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009). Even though CMS implemented no positive updates to ASC payment rates between 2004 and 2008, the volume of services provided by ASCs to Medicare fee-for-service (FFS) beneficiaries still increased by 10.2% per year from 2003 through 2007, with a 10.5% increase in 2008 (Medicare Payment Advisory Commission, 2010b).

Table 1

Most common categories of procedures provided to Medicare beneficiaries in ASCs, 2007 and 2010

Surgical service	2007		2010	
	Percent of volume	Rank	Percent of volume	Rank
Cataract surgery w/ IOL insert, 1 stage	19.9%	1	17.6%	1
Upper GI endoscopy, biopsy	7.9%	2	8.0%	2
Diagnostic colonoscopy	5.9%	3	4.2%	5
Colonoscopy and biopsy	5.5%	4	5.6%	3
After cataract laser surgery	5.4%	5	4.0%	6
Lesion removal colonoscopy, snare technique	4.8%	6	4.3%	4
Injection spine: lumbar, sacral (caudal)	4.3%	7	3.5%	8
Injection foramen epidural: lumbar, sacral	3.1%	8	3.8%	7
Injection paravertebral: lumbar, sacral add on*	2.9%	9	1.9%	11
Injection paravertebral: lumbar, sacral*	1.9%	10	2.1%	9
Total	61.6%		55.0%	

Note: IOL (intraocular lens), GI (gastrointestinal). *The description of these services changed in 2010 to include imaging guidance.

Source: Medicare Payment Advisory Commission. March 2012. Report to Congress: Medicare Payment Policy

Medicare's payment policy for ASCs underwent substantial revision in 2008, which added uncertainties to the growth of ASCs (Medicare Payment Advisory Commission, 2007; Medicare Payment Advisory Commission, 2010a). First, CMS loosened the criteria a surgical procedure must meet to be eligible for Medicare payment. Any surgical procedures, except for those that usually pose significant safety risk or may require an over-night stay, will be covered under the new ASC payment system (Medicare Payment Advisory Commission, 2010a). Second, qualified procedures are grouped into several hundred ambulatory payment classification (APC) groups and all services within an APC group have the same payment rate. The old ASC payment system had only nine procedure groups. Third, CMS implemented separate ASC payments for ancillary services, including certain radiology services, brachytherapy sources, many drugs, and some implantable devices. Finally, CMS set the payment rates for most procedures based on the relative weights in the hospital outpatient prospective payment system (OPPS). Overall, except for office-based procedures and device-intensive procedures, CMS on average pays ASCs about 60% of the hospital-based outpatient facility payment rate for providing the same services (Medicare Payment Advisory Commission, 2012).The revisions in the ASC payment system resulted in substantial changes in payments for a large number of procedures. To help ASCs adapt to the new payment system, CMS decided to phrase in the new payment system over a 4-year period, from 2008 through 2011.

To sum up, ASCs represent an innovative force in the health care delivery system. In the past thirty year, ASCs experienced rapid growth. However, ASCs face a number of uncertainties caused by the general economy and Medicare payment policy. The next section discusses a specific feature of ASCs, namely, physician ownership.

Physician Ownership of Ambulatory Surgery Centers

Physicians are allowed to invest in the ASC where they perform procedures (Office of Inspector General, 1999). However, it remains unclear that how many ASCs are owned partly or wholly by physicians[1]. Two studies have used trade association surveys to identify physician

[1] In the literature, physicians are called owners once they gain equity interests, regardless of the size of ownership.

ownership and estimate its prevalence among ASCs. One study reported that 83% of ASCs had physician owners based on a survey conducted by the American Association of Ambulatory Surgery Centers (Casalino, Devers, & Brewster, 2003). Another study stated that the percentage of ASCs with physician owners reached 91% in 2008, citing a survey conducted by the same association (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009). The percentage of physician-owned ASCs based on surveys conducted by the Ambulatory Surgery Center Association (the successor of the American Association of Ambulatory Surgery Centers and the Federated Ambulatory Surgery Association) may not be nationally representative because the Association has about 650 member ASCs while there are more than 5, 300 ASCs around the nation (Ambulatory Surgery Center Association, 2012; Medicare Payment Advisory Commission, 2012).

It is difficult to determine the physician ownership structure of an ASC, and it is even tougher to identify physician owners since no public information is available (Gabel et al., 2008). Researchers in previous studies tried to determine the physician ownership status of ASCs via public records or by directly contacting individual facilities. Mitchell (2010) combined information from public records maintained by a state agency and a private insurer and that from facilities with incomplete records. She reported that Idaho had 42 ASCs in 2007, 39 of which were owned entirely by referring physicians (Mitchell, 2010). Gabel et al (2008) used information from hospital association, insurers, phone calls and web search to determine the ownership of facilities. They found that 28 out of 43 ASCs in the Pittsburgh and Philadelphia metropolitan areas were owned by physicians (65%) (Gabel et al., 2008). Identifying physician ownership status by contacting providers directly has several limitations. First, it is time-consuming and resource-intensive, which has limited its application to broader geographic areas.

Second, since the survey involves a sensitive matter (i.e., reporting physician investment in a health care facility, which may be deemed as a conflict of interest), elicitation of accurate responses is a major concern. Finally, it is difficult to follow up changes in ownership over time.

Two other studies used proxy measures to distinguish physician owners from physician non-owners (Hollingsworth et al., 2010b; Strope et al., 2009). The safe harbor rule issued by the Office of Inspector General (1999) requires that owners of multispecialty ASCs must perform at least one-third of their procedures in the facility in which they have invested. Strope et al. (2009) claimed that the ASCs that provided outpatient urological procedures were multispecialty and defined physician-owners as those who performed more than 30% of their cases within a single ASC in each year. They attempted to validate this definition using the public records made available by the Florida Department of State Division of Corporation. The validation was conducted by first identifying a sample of ASCs with physicians listed as registered agents, counting all physicians practicing in these facilities as owners, and comparing the total numbers of physician owners with the number identified using the empirical definition (Strope et al., 2009). Hollingsworth et al. (2010) applied the same method to identify physician owners in ASCs that provided carpal tunnel release, cataract excision, colonoscopy, knee arthroscopy, and myringotomy with tympanostomy tube placement (Hollingsworth et al., 2010b; Strope et al., 2009). It is unclear whether all these ASCs were multispecialty and thus subjected to the one-third of procedures rule.

Defining physician owners as those performing a large proportion of their procedures at an ASC also has some flaws. First, only physician owners practicing in multispecialty ASCs are required to perform at least one-third of procedures in the facilities they own. Second, performing more than 30% of one's procedures in an ASC is a necessary condition for being an owner, but not a sufficient condition. A physician may choose to perform a large proportion of his or her cases in an ASC merely out of personal preference. In short, identifying physician ownership status of ASCs remains to be challenging. A method that can reliably determine the physician ownership of ASCs within a large geographic area is still missing.

To sum up, this section reviews the prevalence of physician ownership among ASCs as reported in the literature and the empirical methods used by some studies to determine the physician ownership status of ASCs. The next section reviews studies that examined the outcome variables of interest-the quality of outpatient surgery and then more specifically the quality of outpatient colonoscopy.

Quality of Outpatient Surgery

Enormous importance has been attached to health care quality, both in relation to inpatient and outpatient care, since the release of the Institute of Medicine report “Crossing the Quality Chasm” (Institute of Medicine, 2001). This section reviews the literature examining the quality of outpatient surgeries in general and outpatient colonoscopy in particular. Specifically, it covers the following topics: how quality of outpatient surgery is measured, empirical approaches adopted by researchers, and factors found to affect the quality of outpatient surgery. After a general discussion of analyses focusing on outpatient surgery, the section then reviews studies specifically examining the quality of outpatient colonoscopy.

Quality measures of outpatient surgery.

The Institute of Medicine (IOM) proposed one of the widely accepted definitions of quality, which defines it as the “degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.” (Lohr, 1990) Although quality of outpatient surgery can also be captured by process of care indicators, postoperative morbidity, and patient satisfaction (Shnaider & Chung, 2006), researchers often use patient outcome indicators, such as mortality and adverse events after the outpatient surgical procedure to quantify the quality of care. These two types of quality measures are described below with detail shown in Table 2.

Mortality measures.

Mortality or patient death that occurs during a patient stay in a facility or within a period of follow-up is a traditional measure of quality and safety for surgery and anesthesia (Shnaider & Chung, 2006). As Table 2 reports, few studies in the literature used in-facility mortality to measure patient outcomes. One exception is the study conducted by Fleisher et al. (2004), which reported that out of 564,267 outpatient surgical procedures, no deaths occurred the day of surgery at a physician's office, 4 deaths the day of surgery at an ASC (2.3 per 100,000 outpatient procedures), and 9 deaths the day of surgery at an hospital outpatient department (2.5 per 100,000 procedures). Instead, researchers use mortality within 7 days (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007) or 30 days (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher,

Table 2

Measurements of Quality of Outpatient Surgery

Authors, Year, and Journal	Data Source /Study Period	Procedure(s) studied	Quality measures and definitions
Fortier et al. 1998. Candian Journal of Anethesia	Medical records from the outpatient department of Toronto Hospital, Western Division/32-month period (date unknown)	Nine surgery groups including ENT, dental, general surgery, ophathalmology, orthopaedic, etc.	Unplanned immediate hospitalization (documented by nurses while patients were still in the facility)
Fleisher, et al. 2004. Archives of Surgery	5% random sample of Medicare beneficiary claims data/1994-1999	cataract, femoral hernia, umbilical hernia, laparoscopic cholecystectomy, etc.	Death, hospitalizations, and ED visits within 7 days
Tan, et al. 2011. The Journal of Urology	Medical records from the outpatient department of the University of Michigan/1998-2008	Ureteroscopy	Unplanned immediate hospitalization (defined as a change in visit type to inpatient or outpatient observation)
Strope et al. 2009. The Journal of Urology	Florida SASD and SID from AHRQ/ 2004	Urinary stone surgeries	Rates of immediate hospitalization and death
Leffler et al. 2010. Archive of Internal Medicine	Medical records from the outpatient department of Beth Israel Deaconess Medical Center, Boston, Massachusetts/March 1 to November 30, 2007	Esophagogastroduodenoscopy (EGD) and colonoscopy	14-day Related ED visit and/or hospitalization
Menachemi et al, 2007, American Journal of Medical Quality	Hospital discharge data set, ambulatory discharge data set, and vital statistics data from Florida/1997-2004	Colonoscopy, cataract removal, upper gastrointestinal endoscopy, arthroscopy, and repair of inguinal hernia	7-day and 30-day mortality and 7-day and 30-day unexpected hospitalizations
Chukmaitov et al, 2008, Journal of Ambulatory Care Management	Hospital discharge data set, ambulatory discharge data set, and vital statistics data from Florida/1997-2004	Colonoscopy, cataract removal, and upper gastrointestinal endoscopy	7-day and 30-day mortality and 7-day and 30-day unexpected hospitalizations

Table 2 (continued)

Authors, Year, and Journal	Data Source /Study Period	Procedure(s) studied	Quality measures and definitions
Chukmaitov et al, 2008, Health Services Research	Hospital discharge data set, ambulatory discharge data set, and vital statistics data from Florida/1997-2004	Twelve most common ambulatory surgical procedures including colonoscopy	7-day and 30-day mortality and 7-day and 30-day unexpected hospitalizations
Menachemi et al, 2008, The Joint Commission Journal on Quality and Patient Safety	Hospital discharge data set and ambulatory discharge data set from Florida/2004	colonoscopy, cataract removal, upper gastrointestinal endoscopy, arthroscopy, and biopsy of the prostate	7-day and 30-day unexpected hospitalizations
Chukmaitov et al, 2010, Medical Care Research and Review	Hospital discharge data set and ambulatory discharge data/1997 to 2004 and ASC organizational characteristics data/2007	outpatient arthroscopy and colonoscopy procedures	30-day unexpected hospitalizations

Note: N/A: not available; BMI: body mass index; AHRQ: Agency for Healthcare Research and Quality

Pasternak, Herbert, & Anderson, 2004; Levin et al., 2006; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007) following an outpatient procedure.

There are some limitations with the mortality measure. First, although it may be applicable to outpatient surgery, this measure often reflects the overall health status of the patient undergoing the procedure, rather than the quality of care (Shnaider & Chung, 2006). Patient death may also be associated with anesthesia, surgery, medical conditions, or even unrelated factors, such as a car accident (Fleisher, Pasternak, Herbert, & Anderson, 2004). In empirical research, it could be difficult to determine the cause of death. Exceptions are studies using vital statistics data to identify mortality cases that were able to exclude deaths related to suicides and homicides (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007). Second, mortality is not a sensitive quality indicator because it is only observed in a very small proportion of outpatient surgical patients. Even when a 30-day follow-up is used, the morality rate in the outpatient surgical setting is still no more than 0.5 per 1,000 procedures (Fleisher, Pasternak, Herbert, & Anderson, 2004). Because of these limitations, many studies did not include mortality in the multivariate models and only used adverse events as outcome variables to reflect the quality of outpatient surgery (Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Ko et al., 2010; Warren et al., 2009).

Adverse event measures.

Adverse events in the literature of outpatient surgery are usually captured by emergency department (ED) visits and/or hospitalizations following the outpatient surgical procedure (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Fortier, Chung, & Su, 1998; Ko et al., 2010; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008; Strope, Wolf Jr., Faerber, Roberts, & Hollenbeck, 2009; Tan et al., 2011; Warren et al., 2009). The period of follow-up varied across studies. As shown in Table 2, two studies examined immediate unplanned hospital admission after outpatient ureteroscopy (Fortier, Chung, & Su, 1998; Tan et al., 2011). Fleisher et al. (2004) examined hospitalizations and ED visits within 7 days of the outpatient procedure. Leffler et al. (2010) evaluated 14-day related ED visit and/or hospitalization after endoscopy procedures. A series of studies examined both 7-day and 30-day hospitalizations after common outpatient surgical procedures (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008). In a recent article, Chukmaitov et al. (2010) focused on 30-day unplanned hospitalizations after arthroscopy and colonoscopy. Similar to mortality measures, adverse events after outpatient surgery are also relatively rare (Chukmaitov et al., 2008).

Adverse event measures have the same issues that plague mortality measures, namely, how to exclude adverse events caused by extraneous factors that may be unrelated to the outpatient surgical procedure. For example, hospital admissions may have been planned for some surgical outpatients as part of their protocol. Fleisher et al. (2004) found that among elderly Medicare patients, about one third of physician Medicare claims associated with inpatient hospital admissions after outpatient surgery were related to the pre-existing medical conditions. Additionally, Leffler et al. (2010) reported that only about 30% of 14-day ED visits and hospitalizations were procedure-related. As a result, only a few studies (Fleisher, Pasternak, Herbert, & Anderson, 2004; Fortier, Chung, & Su, 1998; Strope, Wolf Jr., Faerber, Roberts, &

Hollenbeck, 2009) included all-cause adverse events within a certain period of follow-up. Many studies examined medical records or the diagnosis codes and diagnoses related group (DRG) category listed in the discharge records to identify unexpected medical services use (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Leffler et al., 2010; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008; Tan et al., 2011). Some studies further narrowed down ER visits or hospitalizations to those caused by specified complications related to the surgical procedure or sedation (Ko et al., 2010; Warren et al., 2009).

An ED visit may or may not lead to a hospital admission. One study reported that a higher proportion of outpatient surgical patients paid visits to the ED but did not get hospitalized (Coley, Williams, DaPos, Chen, & Smith, 2002). In the literature, Fleisher et al. (2004) examined different adverse events separately. The study constructed independent models for 7-day ED visit and 7-day hospitalization. Alternatively, Leffler et al., (2010) combined ED visits with hospitalization into hospital use.

Data sources used in the literature for constructing mortality and adverse event measures include administrative data sets, medical charts, and death certificates. As Table 2 presents, researchers often combined multiple data sources in their studies. For example, in the study of Fleisher et al. (2004), mortality was assessed from the Medicare enrollment files, emergency department visits were captured by any new physician claim with emergency department as the place of service, and hospitalization by any Medicare Part B physician claims with the place of service coded as "inpatient." A series of studies led by Menachemi and by Chukmaitov used a hospital discharge data set, an ambulatory discharge data set, and vital statistics data from

Florida to study mortality and hospitalization after common outpatient surgeries (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008).

Using administrative data costs less than medical chart review. Consequently, the sample size of studies based on administrative data is typically large. By contrast, studies using medical chart review are often limited to one or a few facilities. For example, Tan et al. (2011) used medical records from the University of Michigan and found that there were only 70 immediate unplanned hospitalizations after outpatient ureteroscopy over a 11-year period (Tan et al., 2011). Similarly, Leffler et al. (2010) found that there were only 134 related ED visits and 76 hospitalizations within 14 days after 6,383 outpatient esophagogastroduodenoscopies and 11,632 outpatient colonoscopies.

This subsection reviewed two types of quality measures- mortality and adverse events- used by prior studies of outpatient surgery. It also discussed the pros and cons of each type of measures and typical sources of data used to obtain these measures. Next, empirical methods used in these studies will be reviewed.

Empirical approaches used in the literature.

The vast majority of the literature related to the empirical assessment of quality of outpatient surgery used a retrospective observational study design to assess practice patterns and compare patient outcomes (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008). Only one study had a prospective study design (Fortier, Chung, & Su, 1998). To address the issue that mortality and adverse events are relatively rare after outpatient surgery, many studies had a pooled cross-sectional design to combine observations over a period of multiple years (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008).

Two studies adopted different analytical strategies. Tan et al. (2011) matched each patient with unplanned hospital admission (cases) to three patients without admission (controls) based on surgeon, gender and date of surgery, with all controls having surgery within the month of the corresponding case. Chukmaitov et al. (2010) conducted a longitudinal study at the facility-year level. The unit of analysis in this study was facility-year. The total number of patients who were hospitalized after receiving outpatient procedures was used as the outcome variable and independent variables were also at the facility level.

As shown in Table 3, most previous studies used various risk adjustment strategies when studying the outcomes of outpatient surgery since the severity of patients undergoing outpatient surgical procedures can vary greatly (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008). One common approach to account for patient risk factors is to calculate Charlson et al. (1987) Index and its modified version (Deyo, Cherkin, & Ciol, 1992). This approach is also adopted by studies of outpatient surgery (David & Neuman, 2011; Fleisher, Pasternak, Herbert, & Anderson, 2004). Strope et al. (2009) used Elixhauser et al. (1998) Comorbidity Index to measure the comorbidity of patients. Increasingly more studies adopted the Diagnosis Cost Groups-Hierarchical Condition Categories (DCG-HCC) methodology (Pope et al., 2004) to do

Table 3

Empirical studies of the quality of outpatient surgery

Authors, Year, and Journal	Unit of Analysis/ Study sample	Quality measures	Independent variables	Risk adjustment method	Statistical Technique	Major Findings
Fortier et al. 1998. Candian Journal of Anethesia	Patient level/15,179 consecutive outpatient surgical patients	Unplanned immediate hospitalization	Preoperative, intraoperative, and postoperative factors	N/A	Descriptive analysis and logistic regression	Male, ASA status II and III, long duration of surgery, surgery finishing after 3 pm, postoperative bleeding, excessive pain, nausea and vomiting, and excessive drowsiness or dizziness are risk factors
Fleisher, et al. 2004. Archives of Surgery	Patient level/ Elderly beneficiaries undergoing 16 outpatient procedures	Death, hospitalizations, and ED visits within 7 days	Location of care, age group, sex, race, prior hospital admissions, and comorbidity	The modified Charlson Index by Deyo et al. (1992)	Descriptive analysis and logistic regression	More advanced age, prior hospital admission, being treated at a physician's office or outpatient hospital, and invasiveness of surgery were linked to increased risk of inpatient admission or death
Tan, et al. 2011. The Journal of Urology	Patient level/1,798 consecutive outpatient ureteroscopy	Unplanned immediate hospitalization	Clinical factors that are potentially associated with unplanned hospitalization	N/A	Conditional logistic regression	Any previous admission related to stone disease, history of psychiatric illness and bilateral procedure are associated with increased risk for immediate unplanned admission while a diagnosis of distal ureteral stones is a protective factor.

Table 3 (continued)

Authors, Year, and Journal	Unit of Analysis/ Study sample	Quality measures	Independent variables	Risk adjustment method	Statistical Technique	Major Findings
Strope et al. 2009. The Journal of Urology	Setting (hospital-based outpatient facility or ASC) level/Patients who underwent surgery for stone disease	Rates of immediate hospitalization and death	Location of care	N/A	Descriptive analysis	The ratios of short-term hospital transfer at a hospital-based outpatient facility and those at an ASC were 0.4/100,000 procedures and 2.5/100,000 procedures. Overall, stone surgery appears to be safely delivered outside of the hospital setting.
Leffler et al. 2010. Archive of Internal Medicine	Patient level/ patients of outpatient EGD and colonoscopy	14-day Related ED visit and/or hospitalization	N/A	N/A	Descriptive analysis	About 30% of the hospitalizations and ED visits 14 days after the procedure were procedure-related. Fourteen-day related hospital visits occurred in about 1% of outpatient endoscopy.
Menachemi et al, 2007, American Journal of Medical Quality	Patient level/3, 174, 436 patients receiving 5 common outpatient surgical procedures	7-day and 30-day mortality and 7-day and 30-day unexpected hospitalizations	Race/ethnicity and gender, Age group, payer type, facility type, and severity of illness.	DCG/HCC	Logistic regression models with a pooled cross-sectional design	African Americans were at a significantly increased risk for either mortality or unexpected hospitalization in 4 of the 5 procedures examined. Female gender was associated with lower level of unexpected hospital admission or mortality.

Table 3 (continued)

Authors, Year, and Journal	Unit of Analysis/ Study sample	Quality measures	Independent variables	Risk adjustment method	Statistical Technique	Major Findings
Chukmaitov et al, 2008, Journal of Ambulatory Care Management	Patient level/patients receiving colonoscopy, cataract removal, and upper GI endoscopy	7-day and 30-day mortality and 7-day and 30-day unexpected hospitalizations	Physician and facility volume, gender, age, race, insurance type, severity, and location of care	DCG/HCC	Logistic regression models with a pooled cross-sectional design	Patients treated by high-volume physicians or facilities had lower odds ratios for hospitalizations and mortality. Physician volume had a bigger impact on unexpected hospitalization compared with facility volume.
Chukmaitov et al, 2008, Health Services Research	Patient level/patients receiving 12 common outpatient surgeries	7-day and 30-day mortality and 7-day and 30-day unexpected hospitalizations	Location of care, gender, age, race, insurance type, severity, and time trend	DCG/HCC	Logistic regression models with a pooled cross-sectional design	The relative performance of ASCs and hospital-based outpatient facilities depended on the procedure examined. Risk-adjustment for comorbidities may affect the result.
Menachemi et al, 2008, The Joint Commission Journal on Quality and Patient Safety	Patient level/patients receiving 5 common outpatient surgeries	7-day and 30-day unexpected hospitalizations	Accreditation status, gender, age, race, insurance type, severity, and facility volume	DCG/HCC	Multivariate logistic regression models	Patients treated by Joint Commission–accredited facilities were still significantly less likely to be hospitalized after colonoscopy. No differences in unexpected hospitalization rates were detected in the other procedures examined.

Table 3 (continued)

Authors, Year, and Journal	Unit of Analysis/ Study sample	Quality measures	Independent variables	Risk adjustment method	Statistical Technique	Major Findings
Chukmaitov et al, 2010, Medical Care Research and Review	Facility-year level/facility-years providing arthroscopies and colonoscopies	30-day unexpected hospitalizations	Specialization, ownership type, facility volume, payer-mix, % of minority patients, mean severity measure, and time effects	DCG/HCC	Poisson regression models with a panel design and both fixed-effects and random-effects	The rate of specialization in ASCs was associated better patient outcomes (though at a diminishing rate). In addition, facility volume was weakly associated with improved patient outcomes.

Note: N/A: not available; BMI: body mass index; AHRQ: Agency for Healthcare Research and Quality; GI: gastrointestinal; EGD: esophagogastroduodenoscopy; DCG/HCC: Diagnostic cost groups/hierarchical condition categories risk-adjustment methodology risk adjustment (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008). This method has been validated as a proper measure of risk adjustment in the outpatient setting, but the cost of the software (DxCG,) constitutes a barrier to widespread adoption (Chukmaitov, Harless, Menachemi, Saunders, & Brooks, 2009).

Besides controlling for patient age, gender, race/ethnicity, some studies also accounted for previous medical use history (Fleisher, Pasternak, Herbert, & Anderson, 2004; Tan et al., 2011). For example, Fleisher et al. (2004) included the number of prior admissions to an inpatient hospital within 6 months prior to the quarter as a proxy for the propensity to use medical services. Using data abstracted from medical records, Tan et al. (2011) controlled for receipt of preoperative prophylactic antibiotics, preoperative imaging, and stone burden (size, location, and number) when studying the quality of ureteroscopy.

Previous studies noted that the accuracy and completeness of the coding of some variables might be problematic. Chukmaitov et al. (2008b) reported that healthcare professionals other than physicians were listed as operating physicians in some discharge records, which were likely to result from coding errors. In another study, Chukmaitov et al. (2008a) found that fewer secondary diagnoses were reported among ASCs compared with hospital-based outpatient facilities and some ASCs did not report secondary diagnoses at all during the study period. To address this concern, many studies eliminated providers with very low volume to minimize potential coding errors (Chukmaitov et al., 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Tan et al., 2011). For example, Tan et al (2011) excluded patients without renal or ureteral calculi as the primary indication from the sample of ureteroscopy patients. Chukmaitov et al.

(2008a) conducted sensitivity analyses to assess the effect of under-reporting of secondary diagnoses on risk adjustment.

As seen in quality of care research in inpatient settings (Gowrisankaran & Town, 1999), some independent variables may be endogenous. For example, high procedural volume may lead to high quality of care because it can improve the clinical skills and coordination efficiencies of medical teams in a facility. But it is also possible that a facility's high quality level attracts more patients that results in high procedural volume. Chukmaitov et al. (2010) argued that in the presence of potential reverse causation between independent variables and patient outcome variables, it is only possible to examine the association rather than causal relationship between the two groups of variables. They suggested that prospective study designs may resolve this reverse causality issue in the outpatient surgical setting.

To account for the fact that patient outcomes can vary widely across different outpatient surgeries, most studies stratified the sample by types of surgical procedures instead of mixing all outpatient surgical procedures (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Leffler et al., 2010; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Strope, Wolf Jr., Faerber, Roberts, & Hollenbeck, 2009). These researchers focused on a narrow scope of procedures by selecting specific Current Procedural Terminology (CPT) codes. On one hand, stratification of the study population improves the homogeneity of the sample and the internal validity. But on the other hand, it may be difficult to generalize research findings based on patients of one outpatient surgery to other patient populations.

In many studies, the outcome variables were binary (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, &

Anderson, 2004; Fortier, Chung, & Su, 1998; Leffler et al., 2010; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008; Strope, Wolf Jr., Faerber, Roberts, & Hollenbeck, 2009; Tan et al., 2011). As Table 3 presents, descriptive analysis and logistic regressions were major analytical approaches used in these patient level analyses (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Fortier, Chung, & Su, 1998; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008). Two studies used only descriptive analysis method (Leffler et al., 2010; Strope, Wolf Jr., Faerber, Roberts, & Hollenbeck, 2009). One study used conditional logistic regression analysis, corresponding to the case-control study design (Tan et al., 2011). Chukmaitov et al. (2010) used the total number of patients who were hospitalized unexpectedly after receiving an outpatient procedure in a facility as the outcome variable. They used Poisson regression models with a panel design in the study. Both fixed effects and random effects models were estimated.

The data used by many prior studies had hierarchical structures (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Fleisher, Pasternak, Herbert, & Anderson, 2004; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008; Strope, Wolf Jr., Faerber, Roberts, & Hollenbeck, 2009). If a group of patients were nested within hospital-based outpatient facilities or ASCs, patient outcomes might be correlated among patients treated by a single facility. Therefore, in the quality analysis of providers, both the variability between providers and that between patients nested within the providers should be considered. Chukmaitov et al. (2010) recognized that estimation of facility-level factors may be spuriously significant in nested models with patient level quality measures. To address this issue, they aggregated patient information to the facility level, as suggested by the literature (Bach, 2009). Another approach to address this issue is hierarchical linear modeling (Normand, Glickman, & Gatsonis, 1997). The advantage of the hierarchical modeling approach is that it accounts for the hierarchical or nested structure of the data by including random effects at each level of the hierarchy. This approach results in a more conservative estimation of the factors at higher levels.

Factors associated with quality of outpatient surgery.

Table 3 includes several empirical studies that examine the impact of patient characteristics, clinical factors, and characteristics of the facility where patients received outpatient surgery on patient outcomes. Patient-specific factors were found to be important predictors of mortality and adverse events following outpatient surgery (Fleisher, Pasternak, Herbert, & Anderson, 2004; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007). For example, Fleisher et al. (2004) used multivariate logistic regression models and found that compared with a white patient aged 65-69 years, advanced age (above 85), and being African American or Hispanic were associated with a significantly higher rate of 7-day ED visit or hospitalization. After controlling for age group, payer type, facility type, and severity of illness, Menachemi et al. (2007) found that African Americans were at a significantly increased rate for either mortality or unexpected hospitalization in 4 of the 5 procedures examined. They also found that patients aged above 84 were at greater risk for at least 1 negative outcome in all 5 procedures examined. Finally, they found that female gender was associated with lower level of unexpected hospital admission or mortality.

Clinical characteristics such as previous inpatient hospital admission, invasiveness of the procedure, and number of procedures performed in the encounter may also affect patient outcomes. Tan et al. (2011) found that the odds ratio of immediate hospitalization for patients of bilateral ureteroscopy were 2.88 compared with patients receiving the unilateral procedure. The invasiveness of the procedure was found to be linked to higher risks after outpatient surgery. Fleisher et al. (2004) reported 156 deaths within 7 days after the outpatient surgery in a sample of 546,267 elderly Medicare patients undergoing 16 outpatient surgical procedures. But no deaths happened to patients who underwent simple mastectomy, femoral hernia, or rotator cuff repair.

Various facility-level factors such as location of care, accreditation, volume, and specialization have also been examined in previous studies. The location of care (namely, physician's office, ASC, and hospital-based outpatient facility) may affect the quality of outpatient surgery in that different type of facilities vary greatly in term of patient population, level of volume and specialization, technologies, staffing, and access to emergency care (Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008). Fleisher et al. (2004) compared the quality of multiple outpatient surgical procedures in physician's office, ASCs, and hospital-based outpatient facilities using 5% Medicare beneficiary claims data and found that patients treated at ASCs have relatively better outcomes than those treated at physician's offices and hospital-based outpatient facilities. Specifically, in the 7-day ED visit model including multiple procedures, the study found that patients treated at ASCs had worse outcomes than those in physician's offices but better outcomes than those in hospital-based outpatient facilities. In the 7-day hospitalization model, patients treated at ASCs had best outcomes across all three settings. When each procedure was evaluated individually, patients treated at ASCs were associated with less negative outcomes such as hospitalization and mortality compared with those treated at physician's offices in 7 of 8 procedures of sufficient sample size while controlling for patient severity. Chukmaitov et al. (2008a) examined the quality of 12 common outpatient procedures performed in ASC and hospital-based outpatient facility settings. They reported that for 10 of the 12 procedures studied, there was no quality difference between ASCs and hospital-based outpatient facilities. For the unplanned hospitalization measure, hospital-based outpatient facilities performed better than ASCs in 9 out of 12 procedures when using all available diagnoses in risk adjustment. They concluded that neither ASCs nor hospital-based outpatient facilities was consistently associated with better quality of care. They also noted that the results of comparison of quality between the two types of facilities were sensitive to risk adjustment method used. The current study primarily builds on these latter two studies by further controlling for the physician ownership status of ASCs.

One study examined the relationship between accreditation status of ASCs and the quality of outpatient surgery. Menachemi et al. (2008) found that for outpatient colonoscopy, patients treated by Joint Commission–accredited facilities were significantly less likely to be hospitalized after controlling for patient characteristics and facility volume. But such effect was not observed in four other procedures examined.

Chukmaitov et al. (2008) examined whether an association exists between physician and facility volumes and patient outcomes in the outpatient settings. Two types of volume variables were used: a tertile variable created by ranking providers into low-, medium-, or high-volume categories and a continuous variable of the natural logarithm of providers' case load. They found a consistent, dose-responsive pattern that linked higher volumes to improved patient outcomes for the 3 types of procedures they studied. Moreover, when both physician and facility volumes were included, the physician volume variable demonstrated stronger effects than the facility volume variable in terms of magnitude and levels of significance in the hospitalization models and in the mortality models, facility volume had stronger effects.

Chukmaitov et al. (2010) further examined the relationship between several organizational characteristics and quality of arthroscopy and colonoscopy procedures provided by ASCs. Different from most previous studies, this study developed hypotheses regarding the potential effects of specialization, ownership type, and volume on quality of outpatient surgery, based on multiple organizational behavior and organizational theory perspectives and health services research literature. They found a positive association between the rate of specialization in ASCs and patient quality outcomes (though at a diminishing rate). Additionally, they found that facility volume was weakly associated with improved patient outcomes.

To summarize, patient characteristics, clinical factors, facility characteristics all can potentially affect patient outcomes in outpatient surgical settings. These factors explored by prior studies should be included in future studies. The current literature is limited to factors at patient level and facility level. Competition between hospital-based outpatient facilities and ASCs reported by previous studies (Bian & Morrisey, 2007; Carey, Burgess, & Young, 2011; Courtemanche & Plotzke, 2010) could have implications for quality. Therefore, it is necessary to further investigate whether health care market features such as the level of competition are associated with quality of outpatient surgery in future studies.

Quality of outpatient colonoscopy.

The previous subsection reviewed the literature on the quality of outpatient surgery in general. The literature related to the quality of outpatient colonoscopy deserves a separate review because procedure-specific quality measures, better defined study samples, and procedure-related control variables were used in these studies. Because this study is interested in examining all related complications after colonoscopy, this review includes studies that examined multiple quality measures in large patient populations. Studies that centered solely on colonic perforation are not included in the review. Similar to the last subsection, this subsection discusses the quality measures, data sources, and empirical methods used in prior studies of quality of outpatient colonoscopy. Finally, factors that were found to be associated with quality of care are reviewed.

Colonoscopy is recommended for polyps and cancer screening in average risk person, aged between 50 and 75 (U.S. Preventive Services Task Force, 2008). Medicare started to cover colonoscopy for colorectal cancer screening in 1998 (Medicare Payment Advisory Commission, 2011). It is estimated that over 14 million colonoscopies are performed annually in the United States (Seeff et al., 2004). With the aging of the population, the demand for colonoscopy will continue to increase. Therefore, it is important to investigate what factors affect patient outcomes after the procedure.

Ideally, quality indicators of colonoscopy should include measures in preprocedure, intraprocedure, and postprocedure periods as proposed by the American Society for Gastrointestinal Endoscopy (ASGE) and the American College of Gastroenterology (ACG) (Rex et al., 2006). But in the literature, a majority of studies still concentrated on mortality and adverse events after colonoscopy. Most colonoscopies are performed with the patient under moderate sedation ("conscious sedation") (Standards of Practice Committee et al., 2008). Similar to other types of outpatient surgeries, mortality after outpatient colonoscopy is also rare. Ko et al. (2010) identified 3 deaths following colonoscopy among 21, 375 patients. Additionally, Levin et al. (2006) identified 1 death related to colonoscopy while Rabeneck et al. (2008) identified 3 related deaths and 2 possibly related deaths out of 67,632 outpatient colonoscopy patients. As a result, many studies did not examine mortality measures in the multivariate regression models because the number of death were too small to support statistical analysis and the cause of death could not be determined (Ko et al., 2010; Levin et al., 2006; Warren et al., 2009).

Unlike studies that spanned multiple procedures as discussed in the prior subsection, colonoscopy studies that examined subsequent ED visits and/or hospitalizations that were potential quality issues focused on specific complications related to colonoscopy (Table 4). Many studies calculated the rates for certain complications by counting the number of ED visits and/or hospitalizations for such complications per 1000 colonoscopy (Ko et al., 2010; Levin et al., 2006; Warren et al., 2009). However, previous studies defined and reported colonoscopy related complications in various ways. Levin et al. (2006) defined any complication related to colonoscopy that led to hospitalization as a "serious complication." They reported incidence rates of lower gastrointestinal bleeding, colonic perforation, postpolypectomy syndrome, diverticulitis and other serious illness, including complications related to procedural sedation such as aspiration pneumonia, complications of procedures, complications secondary to anesthesia, et cetera. Warren et al. (2009) designated 3 adverse events (perforation, gastrointestinal bleeding, or the administration of blood transfusions) as serious gastrointestinal events. They included two other groups of adverse events, other gastrointestinal events (such as paralytic ileus, nausea, and vomiting) as well as cardiovascular events (such as myocardial infarction, arrhythmias, and congestive heart failure). Ko et al. (2010) operationalized serious events as perforation, postpolypectomy syndrome, gastrointestinal bleeding requiring hospitalization and/or transfusion, and diverticulitis. Besides these adverse events, they also examined cardiovascular events, neurological events, and other potentially related complications.

As can be seen in Table 5, medical record and administrative data were major sources of data in prior studies. One exception is the study conducted by Ko et al. (2010), which combined

Table 4

Quality measures used in previous outpatient colonoscopy studies

Authors, Year, and Journal	Data Source /Study Period	Quality measures and definitions
Warren et al, 2009, Annals of Internal Medicine	5% Medicare claims data in SEER cancer registry areas/ July 1, 2001 to October 31, 2005	30-day ED visit or hospitalization for serious gastrointestinal events (perforation, gastrointestinal bleeding, or the administration of blood transfusions); 30-day ED visit or hospitalization for other gastrointestinal events (paralytic ileus, nausea, vomiting and dehydration, abdominal pain); and 30-day ED visit or hospitalization for cardiovascular events (myocardial infarction or angina; arrhythmias; congestive heart failure; cardiac or respiratory arrest; or syncope, hypotension, or shock)
Ko et al, 2010, Clinical Gastroenterology and Hepatology	CORI, two waves of phone interviews, and National Death Index/NA	30-day hospitalization for complications directly related to colonoscopy (perforation, postpolypectomy syndrome, gastrointestinal bleeding requiring hospitalization and/or transfusion, and diverticulitis); 30-day hospitalization for complications potentially related to colonoscopy (angina, myocardial infarction, stroke, transient ischemic attack, and other potentially related complications such as abdominal pain or sedation-related events); 30-day hospitalization for complications directly and potentially related to colonoscopy;death within 30 days
Levin et al. 2006. Annals of Internal Medicine	Electronic medical records from KPNC/ January 1994 and July 2002	30-day hospitalization for perforation only; 30-day hospitalization for perforation, bleeding requiring transfusion, and diverticulitis requiring surgery; 30-day hospitalization for any serious complications (including complications listed above and other conditions (colitis, aspiration pneumonia, pneumonia, abdominal pain, complications of procedure, complications secondary to anesthesia, myocardial infarction, and stroke); death within 30 days
Rabeneck et al, 2008, Gastroenterology	CIHI Discharge Abstract Database/April 1, 2002, to March 31, 2003	30-day hospitalization for bleeding or perforation; death within 30 days

Table 4 (continued)

Authors, Year, and Journal	Data Source /Study Period	Quality measures and definitions
Viiala et al, 2003, Internal Medicine Journal	Medical records from 3 Australian hospitals, death certificates, and hospital records/5 September 1989-31 December 1999	30-day hospitalization for bleeding, perforation, and other complications (abdominal pain, nausea/vomiting, excess sedation, angina, atrial fibrillation, hypotension, transient ischemic attack, reversible ischemic neurologic deficit, and aspiration); death within 30 days

Abbreviation: SEER: Surveillance, Epidemiology, and End Results; KPNC: Kaiser Permanente of Northern California; CORI, Clinical Outcomes Research Initiative National Endoscopic Database; CIHI: Canadian Institute for Health Information.

Table 5

Summary of studies of the quality of outpatient colonoscopy

Authors, Year, and Journal	Unit of Analysis/ Study sample	Quality measures and definitions	Independent variables	Risk adjustment method	Statistical Technique	Major Findings
Warren et al, 2009, Annals of Internal Medicine	Patient level/53, 220 Medicare beneficiaries aged 66 through 95 years	30-day ED visit or hospitalization for serious gastrointestinal events, other gastrointestinal events, and cardiovascular events	patient age, race, sex, state/county, urban/rural, ZIP code level indicators, and comorbid conditions	The modified Charlson Index by Romano et al (1993)	Logistic regression with a matched cohort design	Rates of adverse events increased with age, polypectomy, comorbidities, and some conditions
Ko et al, 2010, Clinical Gastroenterology and Hepatology	Patient level/21, 375 patients aged 40 and over	30-day hospitalization for 4 serious events and other potentially related events; death within 30 days	Age, sex, race/ethnicity, use of some medications, biopsy or polypectomy, indication, trainee participation, and practice setting	N/A	Forward step-wise logistic regression	The risk of complications increased with preprocedure warfarin use, and polypectomy
Levin et al. 2006. Annals of Internal Medicine	Patient level/16,318 patients aged 40 and over	30-day hospitalization for (1) perforation only; 2) perforation, bleeding, or diverticulitis requiring surgery; and 3) any serious complication; death within 30 days	age, sex, and the performance of biopsy or polypectomy	N/A	Bivariate Poisson regression with a generalized estimating equation approach	Biopsy or polypectomy was associated with an increased risk for any serious complication.

Table 5 (continued)

Authors, Year, and Journal	Unit of Analysis/ Study sample	Quality measures and definitions	Independent variables	Risk adjustment method	Statistical Technique	Major Findings
Rabeneck et al, 2008, Gastroenterology	Patient level/97,091 patients aged between 50 to 75 years in 4 Canadian provinces	30-day hospitalization for bleeding or perforation; death within 30 days	age, sex, comorbidity, polypectomy, endoscopist's specialty and experience, and location of care.	The modified Charlson Index by Deyo et al. (1992)	Generalized estimating equations model	Older age, male sex, polypectomy, and being treated by low-volume endoscopist were more likely to have bleeding or perforation.
Viiala et al, 2003, Internal Medicine Journal	Patient level/23,508 patients aged between 13 to 102	30-day hospitalization for bleeding, perforation, and other complications; death within 30 days	Provider's experience and the type of procedure	N/A	Descriptive analysis	The complication rates were not higher among trainees compared with endoscopists.

Abbreviation: N/A: not available; SEER: Surveillance, Epidemiology, and End Results; KPNC: Kaiser Permanente of Northern California; CORI, Clinical Outcomes Research Initiative National Endoscopic Database; CIHI: Canadian Institute for Health Information.

information from two waves of phone interviews about 7 and 30 days after patients underwent colonoscopy, procedure reports based on medical records, and the National Death Index. The advantage of using patient surveys is that the researchers were able to ask patients about preprocedure use of aspirin, nonsteroidal anti-inflammatory agents, warfarin, and clopidogrel to examine the influence of these medications on complication risks. However, the study was also limited by the survey data. With a 53% overall response rate, the estimates of complication rates might be biased.

Compared with studies that examined multiple types of procedures, studies that focused on outpatient colonoscopy had better defined study samples. Levin et al. (2006) only included colonoscopies that had one of these indications: a family history of colorectal cancer or adenomatous polyp, a follow-up to a positive screening test, for surveillance because of a previously detected adenomatous polyp or colorectal cancer, or for primary screening. Excluded procedures fell into one of these categories: those performed for excluded indications or for symptoms, those with poor preparation (with a second procedure rescheduled in 90 days), those performed less than 6 months since a previous procedure, or those performed in patients with previous colon surgery, inpatient or outpatient visits 6 month before the procedure for abdominal pain, lower gastrointestinal bleeding, anemia, diarrhea, or constipation. Specific rules were used as to the inclusion/exclusion of multiple colonoscopies received by a single patient. If a colonoscopy was incomplete and a second colonoscopy was performed within 3 months, only the second one was included. If a second colonoscopy was performed to finish removal of a polyp, only the first colonoscopy was included. If a patient received more than one colonoscopy during the 7 year study period and the interval between the colonoscopies was greater than 6 months, these colonoscopies were included in the cohort. Rabeneck et al. (2008) excluded those patients who had a colonoscopy, a diagnosis of colorectal cancer, a hospitalization caused by inflammatory bowel disease, or a colonic resection in the 5 years preceding the index colonoscopy. They also excluded patients who had an endoscopy in the 7 days prior to or on the day of the index colonoscopy and who had the colonoscopy for endoscopic hemostasis, insertion of a colonic stent, endoscopic colonic dilatation, or endoscopic reduction of a sigmoid volvulus. Warren et al. (2009) excluded procedures coded by the physician as incomplete, and those done in patients at a high risk for perforation. Specifically, persons with preexisting conditions such as diverticulitis, Crohn's disease, ulcerative colitis, and colorectal cancer were excluded. Patients who received more than 2 colonoscopies during the study period or those who had 2 colonoscopies in less than 60 days were also excluded. Ko et al. (2010) excluded patients with a history of inflammatory bowel disease or recent visible gastrointestinal bleeding. They also restricted to the study sample to patients who received their first colonoscopy during the study period. Excluding atypical colonoscopy procedures from the study sample improved the homogeneity of studied cases and reduced the influence of confounding factors on the complication rates.

Most prior studies had a pooled cross-sectional design. An exception is that Warren et al. (2009) used a matched cohort study design to determine whether the risk for adverse events in colonoscopy patients was higher than that in the general Medicare population. Patients undergoing colonoscopy were matched to Medicare beneficiaries who had not undergone colonoscopy during the same period based on birth year, procedure year, race, sex, state or country of residence, and comorbidity score. As shown in Table 5, most studies controlled for patient age, gender, race/ethnicity, and the type of colonoscopy technique used. Warren et al. (2009) included the socioeconomic characteristics of patient's neighborhood. Rabeneck et al

(2008) and Warren et al. (2009) controlled for the severity of illness, using a modified Charlson Index. Rabeneck et al (2008) and Ko et al. (2010) also accounted for the effects of location of care (Ko et al., 2010; Rabeneck et al., 2008).

While Viiala et al. (2003) used mainly descriptive analyses to capture the incidence of multiple complications and compared the complication rates among providers with different training and among different types of procedures, other studies used both descriptive and multivariate regression analysis methods. Levin et al. (2006) conducted bivariate Poisson regression analyses to describe the association among complications and independent variables. Rabeneck et al. (2008) used generalized estimating equations models to assess risk factors for complications. Warren et al. (2009) estimated 3 separate logistic regression models for three dependent variables: serious gastrointestinal events, other gastrointestinal events, and cardiovascular events. In addition to demonstrating unadjusted rates for adverse events, they also calculated the predictive 30-day marginal rate per 1000 procedures associated with an intervention or risk factor by averaging the individual predicted rates. Ko et al. (2010) used forward step-wise logistic regression models to study the association between the incidence of complications and risk factors of interest. Except for age and sex, variables with global $P<.1$ were retained in the final model.

Overall, prior studies found that patient age and biopsy or polypectomy procedures were reliable predictors of complications related to colonoscopy (Ko et al., 2010; Levin et al., 2006; Rabeneck et al., 2008; Warren et al., 2009). Male gender was found to be associated with higher rates for adverse events after colonoscopy, which is consistent with the conclusion reached by Menachemi et al. (2007). The invasiveness of the intervention patients received during colonoscopy significantly influences the risk of complications. Prior studies indicated that polypectomy was associated with significantly higher risk of developing complications (Ko et al., 2010; Rabeneck et al., 2008; Warren et al., 2009).

Prior studies examining adverse events after outpatient colonoscopy had some limitations. First, existing studies were limited to Medicare patients (Warren et al., 2009), a few health care facilities (Levin et al., 2006; Viiala, Zimmerman, Cullen, & Hoffman, 2003), or patient populations with a narrow age range (Ko et al., 2010; Levin et al., 2006; Rabeneck et al., 2008; Warren et al., 2009). Only one of the prior studies examined complications after outpatient colonoscopy in the general population (Viiala, Zimmerman, Cullen, & Hoffman, 2003). Two prior studies selected patients above 40 years old, arguing that colonoscopy is used much less by young adults (Ko et al., 2010; Levin et al., 2006). Warren et al. (2009) limited the cohort to persons aged 66 through 95 years at the time of their procedure. Rabeneck et al. (2008) restricted the study sample to patients 50 to 75 years old who underwent screening colonoscopies. Several studies examined large general patient population (Chukmaitov et al., 2008; Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2007; Menachemi, Chukmaitov, Brown, Saunders, & Brooks, 2008) but these studies did not report specific adverse events related to colonoscopy.

Second, the diversity of definitions and reporting of adverse events after outpatient colonoscopy makes comparison of complication rates across studies problematic (Ko & Dominitz, 2010). Comparison of incidence rates of adverse events other than serious complications is even more challenging because many studies only reported aggregated measures (Ko et al., 2010; Levin et al., 2006; Warren et al., 2009). In addition, no study examined a full spectrum of colonoscopy-related adverse events. For example, Warren et al

(2009) examined serious gastrointestinal events, other gastrointestinal events, and cardiovascular events, but they did not include sedation-related complications, as did Levin et al. (2006).

Third, prior studies did not account for market-level factors or fully control for clustering among observations. As mentioned in the last subsection, some local health market features, such as the level of competition between hospital-based outpatient facilities and ASCs may affect providers' quality production decisions. Previous studies suggested that market-level factors such as HMO penetration and competition level affect providers' volume, revenues, costs and profits (Bian & Morrisey, 2007; Carey, Burgess, & Young, 2011; Courtemanche & Plotzke, 2010). Two prior studies recognized the issue of hierarchical structures in the data. Levin et al. (2006) accounted for the nested structure of data (colonoscopies were nested within individual colonoscopist) by using a generalized estimating equations approach. Rabeneck et al. (2008) also used generalized estimating equations models. In a study of patients in Canada, they clustered within province in a model that used data from four provinces, and clustered within physicians in the model that included endoscopist information. As mentioned in the last subsection, the method of hierarchical linear modeling is another promising approach that should be explored by future studies. While generalized estimating equations models account for the correlation between observations by use of empirical variance estimator, hierarchical modeling is able to model variability at each level of the hierarchy.

This subsection reviewed the quality measures, data sources, empirical methods used, and important factors of quality found in prior studies that specifically examined the quality of outpatient colonoscopy. It also discussed some limitation associated with these studies. These findings will be used to inform the design of the current study.

Effects of Physician Ownership on Care in Ambulatory Surgery Centers

The literature review in the previous section implies that prior studies of outpatient surgery in general as well as studies centered on outpatient colonoscopy largely overlooked the potential effect of physician ownership. In fact, the literature on the effects of physician ownership of ambulatory surgery centers generally followed two lines (Table 6). One line of research focused on how physicians' investment in ASCs affects their referral patterns. It has been demonstrated that physicians practicing in physician-owned ASCs are more likely than other physicians to refer Medicare and privately insured patients to their own facilities while directing Medicaid recipients to non-physician-owned facilities (Gabel et al., 2008; Hollingsworth et al., 2010b). Such type of patient profiling based on insurance types may create access barriers for less resourced patients to receive ASC services (Strope, Sarma, Ye, Wei, & Hollenbeck, 2009). Moreover, selective referral of patients to their own facilities and general hospitals by physician owners may weaken the ability of the latter to provide safety net services (Gabel et al., 2008; Mitchell, 2010).

The second line of research examined the effect of physician ownership on the use of surgical procedures. Prior studies indicated that the financial incentive linked to physician ownership of ASCs was associated with physicians' practice patterns. Physician owners were found to have higher use rates for 3 common orthopedic procedures compared with physician nonowners (Mitchell, 2010). Strope et al. (2009b) found that the increase in the rates of outpatient urological surgery with time coincided with greater utilization by new physician owners. Furthermore, these new owners increasingly performed a larger proportion of lucrative procedures. Hollingsworth et al. (2010) found that physician-ownership was associated with greater use of five common outpatient procedures and the acquisition of ownership status by a physician was associated with significant increases in the use of four surgical procedures. One possible interpretation of these research findings is that when physicians' income is tied to the profitability of the facility, they may induce demand for medical services. They may not only increase the volume of procedures performed by themselves, but may also refer patients to other doctors working in the physician-owned facility (Mitchell, 2005). If the financial incentive linked to physician ownership of ASCs results in greater overall volume of surgical services (part of which may not be medically necessary), savings due to lower payment rates in ASCs could be offset or eliminated and total health care spending may be driven to an even higher level. Nevertheless, a competing explanation is that high volume physicians are more likely to acquire ownership of an ASC. With the absence of a study that appropriately addresses the potential reverse causal relationship between physician ownership and volume, it remains unclear whether physician ownership results in increased utilization of outpatient surgical procedures.

While empirical studies that centered on the effect of physician ownership are not available, there is qualitative evidence from related areas that may provide some insights about the implication of physician ownership of ASCs for the quality of care. Medical group leaders participating in the Community Tracking Study asserted that physician-owned ASCs could improve quality because of physician owners' involvement in the design of the delivery system, dedicated staff and surgical equipment, and the focus of providing a limited scope of services (Casalino, Devers, & Brewster, 2003). If they can attract a large number of patients, physician-owned ASCs can function as focused factories which are able to control costs and improve quality by delivering a narrow range of procedures (Herzlinger, 1997). However, if newly built ASCs represent excess capacity in a community, the demand for outpatient surgery may not be able to support ASCs to perform a high volume and thus achieve improved quality (Casalino, Devers, & Brewster, 2003; Devers, Brewster, & Ginsburg, 2003). Moreover, if physician ownership results in overutilization in physician-owned ASCs, the quality of care may be worse in these facilities in that patients are exposed to the unnecessary risk associated with inappropriate medical interventions (Chassin MR, Galvin RW,and the National Roundtable on Health Care Quality, 1998; Devers, Brewster, & Ginsburg, 2003). By contrast, hospital-based facilities may benefit from hospital-wide quality improvement initiatives. Overall, there is inconclusive qualitative evidence for the effect of physician ownership of ASCs on quality.

Two empirical studies examined the effect of physician ownership on quality of care in physician-owned facilities. The seminal work by Mitchell and Sass (1995) examined the effect of physician ownership of physical therapy facilities using survey data (Table 6). They found that clinics that completely relied on physician owners' referrals treated patients for 50% more visits than clinics with no referrals from physician owners. They found no difference in quality of care across ownership structures. In addition, they found that physical therapists were less likely to work in physician-owned clinics in states that allowed them to practice independently. Overall, the findings suggested that it was more likely that physicians invested in ancillary facilities to induce and benefit from the demand for services than to exercise influence over the quality of such services. O'Neill and Hartz (2012) examined outcomes for patients who underwent percutaneous coronary interventions in 6 cardiac hospitals and 18 general hospitals in Texas. They found that the risk-adjusted in-hospital mortality rate for patients treated at specialty hospitals was significantly lower than the average level. However, the rate was significantly higher when physicians who owned cardiac hospitals treated patients in general hospitals. Their overall outcomes (mortality rate for patients treated at both cardiac and general hospitals) were not significantly different from the average outcomes. They suggested that both lower patient

Table 6

Empirical Studies of the Effect of Physician Ownership

Authors, year, and journal	Data Source/ Study Period	Outcome Measures	Unit of Analysis/ Study sample	Measurement of physician ownership	Control Variables	Statistical Technique	Major Findings
Gabel et al, 2008, Health Affairs	Pennsylvania Health Care Cost Containment Commission/ 2003	Patient socio-demographic characteristics, diagnostic group, and referral patterns	Facility level/ 1,008,038 outpatient surgery discharges in the Pittsburg and Philadelphia metropolitan areas	Physician-owned ASCs were identified by checking with public records and individual facilities. Physicians who account for the top 50% of referrals to these ASCs are regarded as physician owners.	NA	Bivariate analyses	Physician-owned ASCs treated less indigent, Medicaid, and African American patients. Physician-owners tended to refer well-insured patients to their facilities.
Strope et al, 2009, Medical Care	Florida State Ambulatory Surgery Database (SASD)/ 1998-2002	The rate of ambulatory surgery, the proportion of procedures with misaligned incentives, and the extra cost of changing procedure mix	Physician level/ 543,031 patients undergoing procedures of male genitourinary system and female urinary system	Physician owners were operationalized as those surgeons who performed more than 30% of their ambulatory surgery cases within a single ASC in a year.	Year, ownership status, and the interaction term of both	Chi-square tests, Poisson regression model with an exposure variable and linear regressions	. This increase in rates of ambulatory surgery was associated with the conversion of nonowners to owners and a shift to lucrative procedures among these new owners.

Table 6 (continued)

Authors, year, and journal	Data Source/ Study Period	Outcome Measures	Unit of Analysis/ Study sample	Measurement of physician ownership	Control Variables	Statistical Technique	Major Findings
Mitchell, 2010, Archives of Surgery	State documents and claims data from a large private insurer/ 2003-2007	The ratio of patients who received the surgical procedure of interest to all patients with same diagnoses treated by a physician in a year	Patient level/office visits of patients with diagnoses associated with three orthopedic surgical procedures	Physician ownership status of ASCs and specialty hospitals and physician owners were identified using data from state records and an insurer as well as by contacting facilities with incomplete records.	physician age and sex	Tests of differences between proportions, logistic regressions	The use for each of the orthopedic procedures examined was significantly higher for physician owners compared with physician nonowners.
Hollings-worth, et al, 2010, Health Affairs	HCUP State Ambulatory Surgery Databases of Florida/ 2003-2005	A physician's annual caseload (a count of one of the five procedures that a given physician performed over a year)	physician-year level/ patients who underwent five procedures	A physician was considered to be an owner if he or she carried out 30% or more of his or her ambulatory surgeries at a given ASC in a year.	patient characteristics aggregated to physician level; Hospital Referral Region, and the year	Bivariate analyses, two-level linear mixed models, and linear regression models	Physician owners operated on relatively healthier patients and performed more procedures. The use of 4 procedures rose much more rapidly among physicians who acquired ownership.

Table 6 (continued)

Authors, year, and journal	Data Source/ Study Period	Outcome Measures	Unit of Analysis/ Study sample	Measurement of physician ownership	Control Variables	Statistical Technique	Major Findings
Mitchell and Sass, 1995, Journal of Health Economics	A survey of physical therapy and rehabilitation facilities in Florida in 1989 and a salary survey conducted in 1988 by PT Forum/1988-1989	Consumption (the number of physical therapy visits per patient); quality/input mix (the minutes of physical therapist labor per visit); and the incidence of physician ownership	Patient level, encounter level, and physician/therapist level/patients who underwent physical therapy	Physician ownership status was measured as the fraction of referrals emanating from physician owners	Supply /demand factors, physician characteristics, induce demand incentives, existence of some regulations	Ordinary linear regression and probit regression models	A physical therapy clinic that 100% relied on referrals from physician owners provided 50% more visits. No quality of care difference was found across ownership structures.
O'Neill and Hartz, 2012, Health Affairs	Inpatient, hospital and physician information from the Texas Department of State Health Services /2004-2007	In-hospital mortality rate	Physician level/ 48,460 patients who underwent percutaneous coronary interventions	The physician ownership status of hospitals was first identified. Physician owners were defined as those performing a high percentage of procedures at a cardiac hospital	Admission type, comorbidities, age, Hispanic ethnicity, , hospital and physician volumes	A logistic regression model was used to predict the risk of mortality rate.	The outcomes for cardiologists who owned specialty hospitals were not significantly different from the average.

acuity and higher procedural volumes may have contributed to cardiac hospitals' nominally lower mortality rates.

In sum, research findings from prior studies found that physician ownership of ASCs was associated with patient "cherry-picking" and increased use of services in the outpatient surgical settings. Qualitative studies suggested that many factors may affect the relative quality performance of physician-owned ASCs in comparison with other non-physician-owned facilities. Yet no empirical studies focused on the effect of physician ownership on the quality of care in the outpatient surgical settings.

Summary

Ambulatory surgery centers are playing an increasingly important role in providing outpatient surgical and diagnostic procedures. A review of the literature reveals that a growing number of studies examined the quality of outpatient surgery in general and outpatient colonoscopy in particular. But it is still unclear that how prevalent physician ownership is among ASCs. Prior studies of physician ownership largely focused on its effects on patient selection and services use. Only two studies outside of the outpatient surgical settings investigated the relationship between physician ownership, services use and quality.

This review has identified a number of limitations and gaps in prior studies. First, a method that can reliably determine physician ownership of ASCs within a large geographic area has not been identified. Second, as with quality analysis in other settings, research on quality of care in outpatient surgical settings needs to address the possible endogeneity of key independent variables. Third, data used by many prior studies had hierarchical structures and special statistical methods need to be used to deal with clustered data and render valid estimates of standard errors. Fourth, existing studies only controlled for factors at the patient and facility levels. Some characteristics at the health market level, such as competition, should also be accounted for considering that competition between hospital-based outpatient facilities and ASCs may have quality implications. Fifth, prior studies examining adverse events after outpatient colonoscopy used limited patient populations and complication indicators. Finally, research findings from prior studies found that physician ownership of ASCs was associated with patient "cherry-picking" and increased use of services in the outpatient surgical settings. Some industry experts contend that physician ownership results in "cost-competitive, high-quality services" (Rozich, D'Amore, & Sloan, 2000). Yet no empirical studies compared outcomes and quality in physician-owned ASCs and other service settings.

This study aims to address these gaps in the literature. First, by examining the effect of physician ownership of ASCs on the quality of outpatient colonoscopy, this study expands the literature of physician ownership of ASC to outcomes beyond patient selection and service use. Second, the study uses the consequences of a court decision in California in 2007 that changed the licensure requirement for ASCs with physician ownership to determine the physician ownership status of ASCs in California. Third, the introduction of market characteristics on quality extends previous research that only examined the impact of patient, clinical, and organizational characteristics. Multilevel analysis will be used to account for the hierarchical structures in the data and a propensity score approach will be adopted to address the potential endogeneity in the location of a facility. Fourth, this study examines a comprehensive list of adverse events related to outpatient colonoscopy, using a large, all-payer, general patient population.

The following chapter describes the conceptual framework used in the study and develops hypotheses on the theoretical relationships between physician ownership and quality of care in outpatient surgical settings.

Chapter 3: Conceptual Framework

This study focuses on comparing the quality of care provided by physician-owned ASCs relative to the quality of care provided by hospital-based outpatient facilities. Literature from agency theory is drawn upon to provide conceptual guidance in this study. This chapter begins with a discussion of potential explanations for physician investment in ASCs. The second section examines physician ownership from the agency theory perspective. The third section discusses under what circumstances a strengthened agency relationship between owners and physicians can improve quality. The fourth section explains why physician ownership can also act as a deterrent to quality under certain conditions. Formal hypotheses are developed following theoretical discussions. The sixth section examines other factors that are potentially associated with the ultimate quality of care and thus should be controlled for in the empirical models. The chapter concludes with a diagrammatical depiction of the conceptual framework of the study.

Rationale for Physician Investment in ASCs

Physician investment constitutes an important contributing factor to the rapid growth of ASCs (Casalino, Devers, & Brewster, 2003). Three reasons have been given in the literature to explain physician ownership of ASCs. First of all, physicians investing in ASCs may be motivated by the financial gains associated with ownership (Becker & Biala, 2000; Devers, Brewster, & Ginsburg, 2003; Hollingsworth et al., 2010b; Medicare Payment Advisory Commission, 2011; Mitchell, 2010). Physicians who perform procedures in an ASC they own receive both professional fees and a share of facility fees. One study reported that when performing a cystoscopy in an ASC, a physician owner could collect $100 from the professional fee and part of the $340 facility fee (Strope et al., 2009). In an environment with stagnating or declining reimbursement for professional services, becoming an owner of a freestanding specialty hospital or ASC may provide an important means for a physician to generate income (Pham, Devers, May, & Berenson, 2004).

Second, physicians may seek ownership of a facility to assert greater control over their work environment (Devers, Brewster, & Ginsburg, 2003; Mitchell, 2010). As owners, physicians can get have greater authority in hiring, staffing levels, scheduling, and purchasing equipment. They are unlikely to have the same level of influence in these decisions in general hospitals.

Finally, greater efficiency may be another important reason for physicians to invest in ASCs. The patient turnover times are shorter in ASCs than in hospital-based outpatient facilities. An analysis of the data from the 2006 National Survey of Ambulatory Surgery found that the average surgery time in ASCs is nearly 40% shorter than in hospital-based outpatient facilities (Wynn, Hussey, & Ruder, 2011). Thus, physicians may be able to perform more procedures in a day in ASCs, thereby generating more professional fees. Moreover, because ASCs usually do not provide emergency care, disruption of scheduling for emergency cases are rare in ASCs (Casalino, Devers, & Brewster, 2003).

Agency Theory and Physician Ownership of ASCs

Agency theory is used to study the problems of motivating and aligning behaviors (Scott & Davis, 2007). This theory examines the agency relationship in which one party (the principal) contracts with another party (the agent) to perform some tasks on the principal's behalf (Jensen & Meckling, 1976). Two problems are focal to agency theory (Eisenhardt, 1989). First, there is the problem that arises when the principal and agent have different goals and it is not feasible for the principal to monitor the behavior of the agent. Second, there is the problem of risk sharing, which occurs when the principal and agent have different risk preferences. Agency theory is based a series of assumptions about individuals, organizations, and information (Eisenhardt, 1989). For example, the theory assumes that the agent has better information about the tasks than the principal. The primary goal of agency theory is to develop certain mechanisms so that the objectives of the principal and agent are better aligned (Eisenhardt, 1989).

Agency theory recognizes three mechanisms that can be used by principals for motivating the agent to act in their interests: monitoring, bonding, and ownership (Jensen & Meckling, 1976). Monitoring refers to efforts on the part of the principal to measure and control the behavior of the agent through budget restrictions, compensation policies, operating rules, or other mechanisms. In bonding, the agent guarantees the principal against loss due to the agent's fault. For example, a physician (agent) may promise to forgo a bonus at the end of a contract period if certain targets agreed to with the facility (principal) are not met. Ownership allows the agent to own a share of the asset, and thus financial returns generated by that asset.

Thus, physician ownership of ASCs can be conceptualized as an incentive by owners of a facility (i.e., principals) to induce and reward certain behaviors by physicians providing services at their facility (i.e., agents). Ownership is a "high-powered" incentive that tightly links individual physicians' financial interests to that of other facility owners. Physician owners enjoy the profits when revenues exceed costs and share the losses when costs exceed revenues. In addition, physician owners' financial stake grows with the value of the organization.

The next two sections discuss how agency theory may explain the effect of physician ownership on two different agency relationships existing within ASCs and the corresponding quality implications. Specifically, the two agency relationships that may be affected by physician ownership are the agency relationship between other owners of an ASC (principals) and physicians (agents) who perform surgical procedures in the facility and that between patients (principals) and physicians (agents).

Physician Ownership as a Mechanism to Improve Quality

Physicians constitute a key input in the production of outpatient surgical care. Agency theory predicts that ownership will strengthen the relationship between principals and agents, in the case of this study, between other owners of ASCs and physicians (Jensen & Meckling, 1976). Physician owners are more likely than physician non-owners to get involved in the daily operation of the facility. For example, physician owners are listed as managing members in some physician-owned ASCs. Under the safe harbor law, physician owners of multi-specialty ASCs are required to perform as least one third of their surgical procedures at the ASC in which they are investing (Office of Inspector General, 1999). Thus, they have to be actively involved with the ASC in which they invest to remain to be owners.

In the post-managed care era, nonprice competition becomes increasingly important and health care providers must focus on quality or related dimensions to attract business (Devers, Brewster, & Casalino, 2003). Currently, publicly available quality information is not available for outpatient surgeries[2]. But patients may gain a sense about the quality of care at a facility based on the personal experience of family and friends who used the facility and their health outcomes. Assuming that consumers in the marketplace are reasonably able to assess differences in quality across location of care and that patients value high quality care, physician owners will be motivated to ensure that their own facility provides high quality care. This is because when

[2] The Medicare Ambulatory Surgical Center (ASC) Quality Reporting Program will begin on October 1, 2012. For the 2012 reporting period, ASCs will need to report on five measures and more measures are required for later reporting periods. When these data will be made available to the public has not yet determined.

the facility provides poor quality care, it will lead to loss of business and reputation. All stakeholders of the facility, including physician owners will suffer financially.

There are a number of mechanisms through which physician owners may contribute to the quality of care provided by the facility they own. Physician owners may participate in the decision making process related to investment in organizational infrastructure. They may also help the facility choose the optimal mix and quality of medical inputs, such as the appropriate number and mix of qualified staff. These decisions are critical to producing quality care (Conrad & Christianson, 2004a; Kuhn, 2003). Such a level of physician involvement in decision-making is more difficult to achieve in non-physician-owned facilities (Schneider et al., 2008).

Physician owners may also boost the level of effort of medical and other facility staff. The production of outpatient surgical care involves the collaboration of physicians, anesthesiologists, nurses, medical assistants, and other support staff. Without a mechanism to monitor or measure each team member's efforts, the potential for shirking among team members increases since none of them bears the full cost of shirking (Alchian & Demsetz, 1972). When an adverse event occurs, it may be difficult for the patient to determine which team member to blame. Offering physicians equity interest (the right to claim residual profits) can prevent shirking by either physicians or other medical team members. Physician owners have the motivation to monitor the performance of other team members. They could be financially penalized if poor quality of care results in lost business or malpractice suits, and conversely, they can financially benefit if higher quality results in more business and higher profits (Alchian & Demsetz, 1972). Therefore, physician ownership may represent a direct mechanism that ensures the facility provides high quality care (McDowell, 1989).

The positive effect of physician ownership on quality of care may be stronger in competitive health care markets. As discussed above, physician owners have the expertise to identify a series of strategies to improve the quality of care. But some strategies such as adopting the latest medical equipment may involve sizable resources. In a less competitive health care market, physician owners may only implement some quality improvement efforts that are less resource-intensive (Pham, Devers, May, & Berenson, 2004). The competitive advantage associated with physician ownership may not manifest itself. In competitive health care markets, physician-owned ASCs may have the incentive to commit resources to more quality improvement initiatives that are identified by physician owners. By contrast, in face of the competition from ASCs, many hospitals strive to outperform ASCs by upgrading existing facilities and adding new outpatient centers, which are more likely to affect amenities than clinical quality (Devers, Brewster, & Casalino, 2003).

Physician Ownership as a Deterrent to Quality

Although patients may be able to assess the quality of care to a certain degree, as suggested in the prior section, it may instead be the case that patients are unable to do so based on their available knowledge and information. Without reliable comprehensive information about the clinical quality, comparison across facilities is difficult to achieve. In practice, patients may end up acquiescing to their physician's recommendation when deciding whether and where to receive medical care (Katz, 1996). Physician owners have broader concerns than physician non-owners; they are not only concerned about the quality of services they provide, but also about the operating expenses and profitability of the facility. The financial interest linked to ownership may conflict with the best interest of patients. A growing body of literature indicates that physicians' clinical decision making process can be influenced by the financial incentives created by various financial arrangements and organizational structures (Casalino, 1992; Conrad et al., 1996; Conrad & Christianson, 2004b; Matthews, 1993; McDowell, 1989; Murray, Greenfield, Kaplan, & Yano, 1992).

First of all, physician owners may not actively implement quality improvement initiatives even if they have the knowledge to improve the process of care. Potential physician owners of specialty hospitals and ASCs reported that they were not motivated to invest in organized quality improvement processes because payers did not provide corresponding financial incentives (Casalino, Devers, & Brewster, 2003; Pham, Devers, May, & Berenson, 2004).

Second, since third party payers set reimbursement rates for surgical procedures, physician owners may reduce quality to bring down costs and to increase their profits. This is likely to happen because ASCs are subject to less stringent regulation than hospital-based outpatient facilities (American Hospital Association, 2006). In an extreme case, nurse anesthetists were instructed by clinical staff (anecdotally physician owners) to reuse syringes to access vials and reuse bottles of anesthesia on multiple patients (Southern Nevada Health District Outbreak Investigation Team, 2009). When owners of an ASC underinvest in some quality infrastructure, physician non-owners may decide to direct their patients to facilities providing better quality of care. But physician owners may continue to refer patients to the facility even if it has suffered a decline in the quality of care because of their equity interest (Zientek, 2003). Of course, the extent to which physician owners can shirk on quality is limited by certification and accreditation regulations and potential malpractice law suits. For example, the outbreak of Hepatitis C in an physician-owned ASC in Nevada led to a half-million dollar fine and the prosecution of the chief administrator, a physician, and employees who provided or supervised unsafe medical procedures (Duran, 2008; Online Legal Media, 2008).

Hypotheses

Physician ownership of ASCs could potentially lead to improved quality of outpatient surgical care or to lower quality of care, depending on the degree to which consumers are able to assess quality of care differences across location of care, the extent to which they value high quality care, and physicians' desire to pursue their financial interest.

On one hand, physician ownership can work as a mechanism to improve quality of care by motivating physicians to actively participate in quality improvement efforts if consumers (or referring physicians) can observe quality differences and are responsive to quality of care. The positive effect of physician ownership on quality also relies on the degree to which physician owners can influence facility investment, process redesign, and staff performance evaluation. According to agency theory, physician ownership helps align the interests of physicians with those of other owners of ASCs. If consumers can detect differences in quality of care across different locations of care, facilities providing high quality care will gain better reputations and will attract more business. In order to protect their own financial interests, physician owners will be motivated to improve the quality of care provided by their own facility. Therefore, it is hypothesized that:

Hypothesis 1: Assuming that patients can assess differences in quality of care across locations of care, physician-owned ASCs will be associated with improved quality of care, all other things being equal.

Physician ownership as a mechanism to improve quality of care may be more fully realized in competitive health care markets. Again, assuming patients have the ability to determine quality of care, physician-owned ASCs will have the incentive to implement quality improvement initiatives identified by physician owners in competitive markets in order to attract business from individual patients and referring physicians. By contrast, hospitals in competitive markets may strive to outperform by upgrading existing facilities or adding new outpatient facilities. Therefore, it is hypothesized that:

Hypothesis 2: Assuming that patients have the ability to assess quality of care, the positive effect of physician ownership on quality will be more obvious in more competitive markets. In other words, physician-owned ASCs are expected to manifest larger quality advantages in competitive health care markets compared to non-physician-owned facilities (namely, hospital-based outpatient facilities).

On the other hand, physician ownership may be a deterrent to quality of care if patients do not have the ability to assess quality of care differences and if physician owners exploit this information void. Physician owners may reduce the quality of care to bring down operating expenditures. Therefore,

Hypothesis 3: Assuming that patients are not able to detect quality differences across different locations of care, physician-owned ASCs are expected to have lower quality of care in comparison to non-physician-owned facilities (namely, hospital-based outpatient facilities).

Overall, the effect of physician ownership of ASCs is theoretically unclear, as is evident from the hypotheses above. Empirical analysis is thus important to understand how physician-owned ASCs differ in quality of care from hospital-based outpatient facilities.

Control Variables

In addition to physician ownership, patient demographic and clinical characteristics, facility-level factors, and characteristics of the local healthcare market may also affect patient outcomes in the outpatient surgical settings. The following subsections motivate the relevance of these factors by drawing on related literature. These variables will be included in the empirical models as control variables.

Patient characteristics.

Patient type and behavior can significantly affect health outcomes (Conrad & Christianson, 2004b). A large body of literature indicates that many factors affect patient care-seeking behavior, which in turn affects the health outcomes. Without controlling for patient characteristics, the quality of care differences between physician-owned ASCs and hospital-based outpatient facilities may result from the differences in patient populations across these settings rather than being the effect of physician ownership status. According to the Behavioral Model developed by Anderson, patient characteristics can be divided into three categories: predisposing, enabling and need factors (Andersen, 1995). Predisposing factors relates to the propensity that an individual uses health services. These factors include demographic characteristics such as age, gender, social structures (e.g. education and race/ethnicity) and health beliefs (e.g. attitudes and knowledge of health and health services). In addition, previous medical care use may increase patients' propensity to use medical services in the future (Anderson & Steinberg, 1984). Therefore, this study will control for patient age group, gender, race/ethnicity, and medical care utilization history in the multivariate analysis. Due to limitation in the data, this study will not be able to measure and control for patients' education level and health beliefs.

Enabling factors are related to access to health care services, including insurance and financial resources that cover patient costs of care. Whether a patient resided in an urban or rural location also affect his or her access to medical care. For example, rural patients often travel a longer distance than urban patients to access the same medical care and therefore may use less care. Need factors relate to the reasons patients seek health care services, and can comprise perceived need (e.g. perceived symptoms) or evaluated need (e.g. diagnosed health status). Medical severity also can affect patients' need for health care and provider's ability to change their health status. It is critical to control for patients' severity of illness in a comparative study of the patient outcomes in physician-owned facilities and hospital-based outpatient facilities. Qualitative data suggested that physician owners may selectively refer relatively healthy patients to their own facilities for treatments (Devers, Brewster, & Ginsburg, 2003). If this is the case, physician-owned ASCs may appear to have better quality of care if patient severity of illness is not controlled for in the empirical analysis (Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008). Therefore, this study will control for patients' insurance status, income level, urban/rural location, and medical severity.

Moreover, the type of the procedure that patients receive during an encounter may make a difference in patient outcomes. For example, colonoscopy involving biopsy or polypectomy procedures are more invasive than colonoscopy without such procedures and consequently patients are more likely to develop complications afterwards (Ko et al., 2010; Levin et al., 2006; Rabeneck et al., 2008; Warren et al., 2009). This study therefore will control for the type of colonoscopy involved in the encounter (Diagnostic colonoscopy, Colonoscopy and biopsy, or Lesion removal colonoscopy).

Organizational characteristics.

The Institute of Medicine's report *Crossing the Quality Chasm* posited that quality of care is a systems problem, which can be affected by health care organizations and the larger health care environment (Institute of Medicine, 2001). Physician-owned ASCs differ from non-physician-owned facilities in many aspects other than the physician ownership status. For example, physician-owned ASCs and hospital-based outpatient facilities may have different volume and degree of specialization, which may also affect quality of care (Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010). Omitting these organizational characteristics from the analysis could artificially amplify the impact of physician ownership on quality. Empirical studies that link quality measures with organizational variables typically draw on the classic structure-process-outcome model and specific organization theory and organizational behavior frameworks (Mitchell & Shortell, 1997). Donabedian's structure-process-outcome model presumes that good organizational structure leads to good process of care, and ultimately better health outcomes (Donabedian, 1966; Donabedian, 1978; Donabedian, 1988). Donabedian defined structure as the attributes of the materials, human resources, and organizational arrangements that are involved in the production of care. Process refers to the approaches used to produce care and interactions between providers and patients as they receive care. Outcome is the health status of patients. This study controls for structural factors such as volume and specialization level of the facility. Due to limitations in the data, the study will not be able to control for process of care variables. In the literature, studies in the inpatient setting also predominantly examined the relationship between organizational structure and quality of care (Hearld, Alexander, Fraser, & Jiang, 2008).

It is well documented in the inpatient literature that a positive relationship exists between the volume of certain surgical procedures at a hospital and patient quality of care (Chukmaitov et al., 2008). This relationship was also found in the outpatient surgical settings (Chukmaitov et al., 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010). It is thus necessary for this study to control for the facility volume of the procedure of interest, namely, colonoscopy. Additionally, ASCs tend to provide a narrow range of procedures (Medicare Payment Advisory Commission, 2004) and thus, it may be that quality of care in highly specialized ASCs is higher because physicians and other staff can achieve proficiency by providing a smaller set of services often (Casalino, Devers, & Brewster, 2003). Moreover, ASCs specialized in providing certain types of procedures may do a better job in implementing evidence-based practices in a focused area (Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010). Therefore, it is also necessary to control for the extent of organizational specialization for this study. A specialization rate, the percentage of a certain type of procedure in a facility's total procedures, will be used to measure the degree of specialization. The specialization rate squared will also be included to account for the potential diminishing returns to specialization (Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010).

Market characteristics.

The larger health care environment may influence quality of care by affecting patients' access to necessary medical care and thus their health outcomes (Andersen & Davidson, 2001). Additionally, environmental forces may encourage or impede health care providers' efforts to improve quality. As stated by Pfeffer and Salancik (1978, p. 1), "to understand the behavior of an organization you must understand the context of that behavior-that is, the ecology of the organization." Market-level factors, such as competition, managed care penetration, physician supply, and patient demand factors, will be controlled for in this study. It is necessary to control for market characteristics when comparing patient outcomes in different health care facilities. This is because if physician-owned ASCs and hospital-based outpatient facilities may locate in different kinds of markets, and thus, not controlling for market factors will lead to biased estimation of the effect of physician ownership.

ASCs and hospital-based outpatient facilities have great overlap in the types of outpatient surgical services they provide. Evidence indicates that ASCs are meaningful competitors of general hospitals (Carey, Burgess, & Young, 2011). However, the theoretical relationship between competition and quality is complex. On one hand, competition between ASCs and hospital-owned outpatient facilities may reduce environmental munificence, namely, the availability of critical resources needed by these facilities to operate within an environment (Pfeffer & Salancik, 1978; 2003) and thus the available resources allocated to quality improvement efforts. But on the other hand, some studies that examined quality of inpatient services suggest that competition may lead to increased efficiency and thus mitigate the effect of financial pressure on quality (Kessler & McClellan, 2000; Pope, 1989). Additionally, evidence indicates that among patients for which organizations face regulated prices, competition for patient business will focus on the quality and great competition will improve the quality of health care. Whereas for markets where prices are set by providers rather than the government, both price and quality may be influenced by competition and the relationship between quality and competition is theoretically ambiguous (Gaynor, 2006). Therefore, the impact of competition on quality of care is theoretically unclear. This study will control for the competition level of the local health care market using the Herfindahl–Hirschman Index (HHI). As mentioned above, the interaction term of physician ownership and HHI will also be included.

Health Maintenance Organization (HMO) and Preferred Provider Organizations (PPOs) penetration may also affect the quality of care. Because premiums are a key factor when employers purchase group coverage for their employees (Legnini, Rosenberg, Perry, & Robertson, 2000), HMOs and PPOs attach much importance to prices when they contract with providers. Given this, health care providers may reduce the quality of care, under the pressure to control costs. High percentage of patients enrolled in HMOs or PPOs may induce changes in the treatment patterns and resource utilization across all patients in the area, affecting health outcomes of those not covered by managed care organizations (Baker, 2003). Therefore, facilities located within the high HMO or PPO penetration markets may be expected to have different patient outcomes than those located in the low HMO/PPO penetration markets.

In addition, the medical care resources in the community may influence health care organizations' investment in structural quality and ultimately affect patient outcomes (Conrad & Christianson, 2004b). For example, physician supply in the local market may affect the cost of human capital and thus the qualification and skills of physicians that staff health care organizations. This study therefore will control for the number of physicians in gastroenterology, primary care, and general surgery per 100,000 population in the county. These physicians are included because they either are directly involved in the delivery of colonoscopy or are a source of referrals. Furthermore, the population size, percentage of the population over age 65, and percentage of the population below age 65 without health insurance may determine the demand for medical care (Roggenkamp, White, & Bazzoli, 2005). These market factors will also be controlled for in the analysis.

Conceptual Framework

As shown in Figure 3, agency theory and evidence from the literature suggests that patient outcomes in the outpatient surgical settings can be influenced by multiple factors. This study examines the potential effects of physician ownership on quality of care by comparing the outcomes of patients treated at a physician-owned ASC with those achieved by patients treated by non-physician-owned facilities (i.e., hospital-based outpatient facilities). Specifically, this study is interested in investigating whether colonoscopy patients treated at a physician-owned ASC were less or more likely to experience adverse events that can develop after the procedure when compared to those treated at a hospital-based outpatient facility.

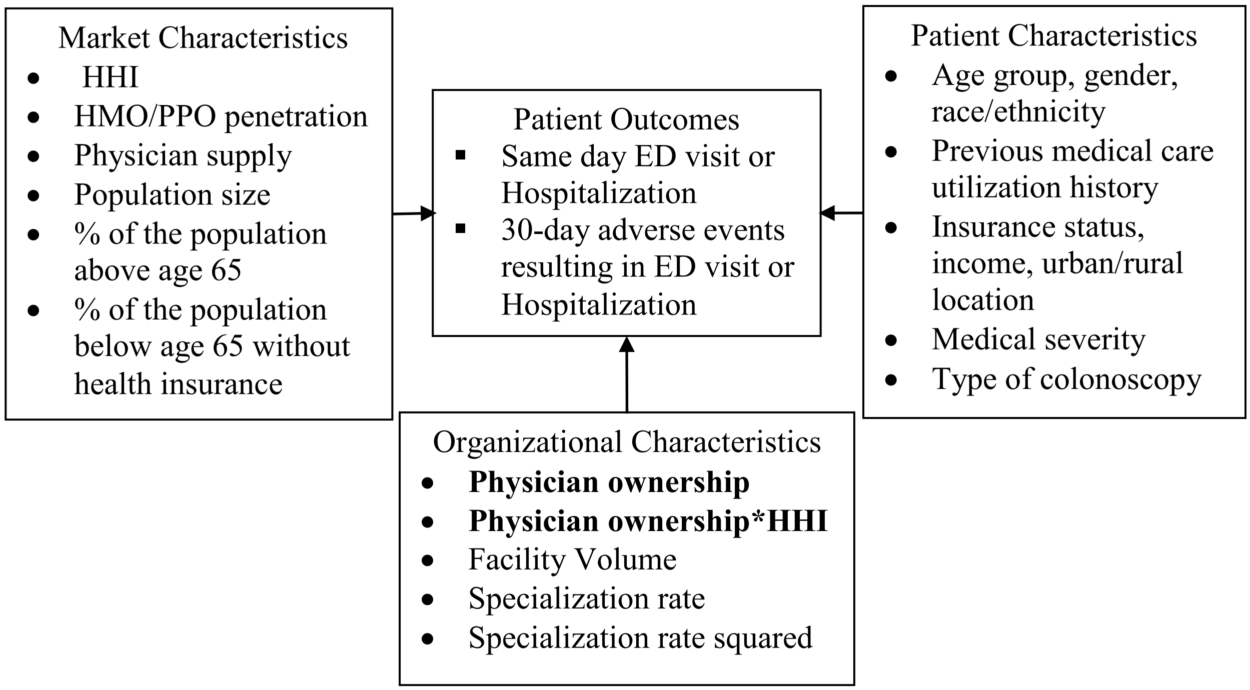

Figure 3. Conceptual Framework of the Effect of Physician Ownership on the Quality of Outpatient Colonoscopy

Note: HHI: Herfindahl–Hirschman Index; HMO: health maintenance organization; PPO: preferred provider organizations; ED: emergency department. The key independent variables appear in bold.

In order to control for other confounding factors that may affect patient outcomes, this study accounts for patient characteristics, organizational characteristics, and health care market characteristics in the analytical models.

Summary

This chapter drew on agency theory and the literature to develop a conceptual framework that examines the potential effects of physician ownership on the quality of outpatient surgical care. In theory, the relationship between physician ownership and quality of care was shown to be unclear. Assuming that patients can distinguish the quality differences across locations of care, physician ownership may work to improve quality. This is because physicians, as facility owners, can play an important role in quality improvement as it is important to their reputation and maintaining patient business. However, if patients cannot detect differences in quality of care, physician-owned facilities may make production decisions that lead to lower quality of care because this may provide greater financial returns through the reduction of costs of operation. The chapter also reviewed other factors that may affect patient outcomes in the outpatient surgical settings and thus should be controlled for in the analysis. Figure 3 diagrammatically presented the conceptual framework for this study. Chapter 4 covers the research methods used in this study, including research design, data sources, sampling process, variable measurements, and the overall analytical approach.

Chapter 4: Methodology

This chapter describes the research methods used to investigate the relationship between physician ownership and the quality of outpatient colonoscopy. The first section describes the research design, followed by a description of the study sample, data sources, and variable measurements. The fifth section discusses the model specification and technical issues that need to be addressed in the study. The chapter ends with a summary.

Research Design

This study aims to examine the effect of physician ownership of ASCs on the quality of outpatient colonoscopy. The California appellate court decision in *Capen v. Shewry* (2007) which led to the delicensing of ASCs with any physician ownership provides a unique opportunity for this study to identify physician owned ASCs in California. This study utilizes a pooled, cross-sectional design. This design enables the accumulation of a large number of colonoscopy cases to identify the relatively rare complications following outpatient colonoscopy. This study is retrospective and observational in nature. Because technological, market, and public policy factors jointly affect physicians' decision to invest in ASCs (Casalino, Devers, & Brewster, 2003), a propensity score approach is used to adjust potential physician selective investment in outpatient surgical facilities. Additionally, in sensitivity analysis, the propensity score method will be used instead to adjust for potential selective patient referrals.

Data Sources

The main sources of data for this study are three discharge-level databases: the State Ambulatory Surgery Databases (SASD), State Emergency Department Databases (SEDD), and State Inpatient Databases (SID) for the state of California from 2005 to 2007. The SASD, SEDD, and SID are compiled by the Healthcare Cost & Utilization Project (HCUP), which is administered by the Agency for Healthcare Research and Quality. The primary reason for choosing California as the study site is that the Capen v. Sherwy (2007) decision makes it possible to identify physician ownership status of ASCs. Additionally, with the absence of national data, the state of California is a good choice for a study of ASCs. It has the largest number of ASCs around the country and accounts for the second largest number of visits out of all 17 participating states in HCUP SASD project. The number of records for 2005, 2006, and 2007 SASD files were 2.79 million, 2.87 million, and 3.00 million, respectively (Agency for Healthcare Research and Quality, 2012a). In addition, California SASD tracks discharges from freestanding ASCs and hospital-owned outpatient facilities (Agency for Healthcare Research and Quality, 2012b). Finally, California does not subject medical facilities to certificate of need requirements (National Conference of State Legislatures, 2011), which allows physicians and investors to freely respond to the changing demands for outpatient surgical care.

The SASD contain a core set of clinical and nonclinical information on all patients, regardless of payers. Variables from the SASD include patient demographic characteristics, International Classification of Diseases (ICD-9) diagnosis codes, Current Procedural Terminology (CPT) codes, discharge status, expected payment sources, and the identifier of the facility in which the patient received treatments. Using supplemental AHRQ files that identify patients with multiple types of health service use (i.e., their revisit files), the outpatient surgery records are merged with hospital emergency department and inpatient discharge data. The SEDD and SID contain information on all ED visits and hospital admissions in California.

The study also uses data from the annual utilization files of specialty clinics and hospitals, which are collected by the California Office of Statewide Health Planning and Development (OSHPD). All specialty clinics and hospitals are mandated by state law to file an Annual Utilization Report with OSHPD that contains utilization data for their licensed services. These files include information on facility location, original license date, control type, patient encounters, number of operating rooms, surgical volume, revenue, expenditure and other financial data. ASCs in California are specialty clinics licensed as surgical clinics[3].

Other databases such as the Area Resource File (ARF) 2009-2010 Release (Version 2) compiled by the Bureau of Health Professions, and the HMO and PPO enrollment data provided by HealthLeader are also included in the study to provide information on health market characteristics.

Study Sample

The outpatient surgery discharge records in California are used to identify a cohort of patients who underwent outpatient colonoscopy between January 1, 2005 and November 30, 2007. Hospital emergency department and inpatient discharge records in the period from 2005 to 2007 are merged to the outpatient surgery data. There are three uses of the emergency department and hospital data: 1) to provide additional information about patients' medical care use history and comorbidity conditions; 2) to identify patients transferred to emergency department or admitted to short-term acute care hospital in the same day of the colonoscopy; and 3) to identify colonoscopy related complications resulting in emergency department or hospital

3 Personal communication with Michael B. Derrick, manager of the Licensed Services Data Unit under the OSHPD (email received on 4/27/2009).

use within 30 days. The study sample includes patients aged 18 and older and those covered by all types of payers (Medicare, Medicaid, commercial insurance, or self-pay).

This study focuses on colonoscopy procedures because they are among the most common and profitable procedures for ASCs (Medicare Payment Advisory Commission, 2004). Specifically, this study examines colonoscopy procedures represented by five CPT codes (Table 7). The code 45378 is used to report a diagnostic colonoscopy, in which no biopsies or excisions are involved. CPT codes 45380, 45383, 45384, and 45385 are used to report therapeutic colonoscopy procedures that involve biopsy, polypectomy, or excision of a lesion.

Table 7

Description of the CPT Codes Examined in the Study

CPT code	Short Descriptor	Description	Final CY 2012 Payment Weight	Final CY 2012 Payment
45378	Diagnostic colonoscopy	Colonoscopy, flexible, proximal to splenic flexure; diagnostic, with or without collection of specimen(s) by brushing or washing, with or without colon decompression (separate procedure)	8.8699	$378.10
45380	Colonoscopy and biopsy	Colonoscopy, flexible, proximal to splenic flexure; with biopsy, single or multiple	8.8699	$378.10
45383	Lesion removal colonoscopy	Colonoscopy, flexible, proximal to splenic flexure; with ablation of tumor(s), polyp(s), or other lesion(s) not amenable to removal by hot biopsy forceps, bipolar cautery or snare technique	8.8699	$378.10
45384	Lesion remove colonoscopy	Colonoscopy, flexible, proximal to splenic flexure; with removal of tumor(s), polyp(s), or other lesion(s) by hot biopsy forceps or bipolar cautery	8.8699	$378.10
45385	Lesion removal colonoscopy	Colonoscopy, flexible, proximal to splenic flexure; with removal of tumor(s), polyp(s), or other lesion(s) by snare technique	8.8699	$378.10

Note: CPT: is a registered trademark of American Medical Association. Short descriptor, payment weight and rate information was published on the CMS website.

During the period from 2005 to 2007, 1,832,535 colonoscopy cases were performed in California, of which 131,440 cases are not linkable to emergency department and inpatient data and thus excluded from the sample. The colonoscopy cases performed on patients younger than 18 are excluded (N=22,370). Following previous studies (Warren et al., 2009), colonoscopies performed on patient with a diagnosis of diverticulitis, Crohn's disease, ulcerative colitis, and colorectal cancer are excluded from the study because they are prone to experience colonic perforation and gastrointestinal bleeding (N=116,144). If a patient had two colonoscopies less than three months apart, only the second colonoscopy is included in the sample, considering that the first one may be incomplete due to poor preparation (Levin et al., 2006). For those with more than two colonoscopies that were three or more months apart during the study period, only the first one is included. For these two reasons, 74,843 cases are removed. Cases without a facility identifier or performed in a facility that was not licensed by California Department of Public Health are excluded (N=68). To ensure that facilities of interest performed colonoscopy on a regular basis, cases associated with facilities which did not perform a minimum of 30 cases in a year are removed from the study as well (N=77,397). To ensure the completeness of a one month follow-up after the procedure, colonoscopy cases performed in December of 2007 are excluded (N=38,087). Missing values are found for patients' gender (about 13%) and race/ethnicity (about 32%). The missing values for these two variables are replaced by values found on emergency department or inpatient records during the study period. Missing values are also found in variables including the state quartile of the median household income for the patient's ZIP Code, payer type, and urban/rural location. Overall, due to missing values, 68,962 cases are excluded. Finally, cases provided by non-physician-owned ASCs (N=24,338) are also excluded due to small numbers. The final sample contains 1,278,886 colonoscopy cases.

Variable Measurement

Dependent variables.

This study examines all-cause ED visit and/or hospitalization in the same day of the colonoscopy procedure and also related complications occurring within 30 days after outpatient colonoscopy that were severe enough to require an emergency department visit or hospitalization. A follow up period of 30 days was chosen because some serious complications such as gastrointestinal bleeding can occur 3-4 weeks after a colonoscopy (Ko & Dominitz, 2010; Mezei & Chung, 1999). Thirty-day hospital admissions have commonly been used as quality measures in outpatient surgical settings (Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010; Mezei & Chung, 1999; Shnaider & Chung, 2006; Warner, Shields, & Chute, 1993; Warren et al., 2009). Following Warren et al. (2009), mortality is not included in the analysis because of the small number of patient deaths after colonoscopy and the complex causes of mortality.

The first dependent variable is all-cause ED visit and/or hospitalization in the same day of colonoscopy. Outpatient surgical patients are not expected to use emergency department or inpatient care immediately after their procedure. Thus, this variable is an indicator of a potential adverse event that required more intensive and immediate care (Fleisher, Pasternak, & Lyles, 2007).

The second to fourth dependent variables are related adverse events occurring within 30 days after outpatient colonoscopy that were severe enough to require an ED visit and/or hospitalization. Specifically, the second dependent variable is the occurrence of serious gastrointestinal events requiring ED visit and/or hospitalization within 30 days. The serious gastrointestinal complications included in the analysis are colonic perforation, lower gastrointestinal bleeding, and anemia (Levin et al., 2006; Warren et al., 2009).

The third dependent variable is the occurrence of other gastrointestinal events occurring within 30 days. Relevant complications for this variable include intestinal obstruction, abdominal pain, diverticulitis, ulcerative colitis, nausea and vomiting, and disorders of fluid (Levin et al., 2006; Warren et al., 2009). Note that the diverticulitis and ulcerative colitis are medical conditions developed after the patient received colonoscopy. Those with such conditions at the time of colonoscopy have been excluded.

The fourth dependent variable is the occurrence of other non-gastrointestinal events occurring within 30 days after outpatient colonoscopy. Relevant complications for this variable include sedation-related cardiopulmonary complications (aspiration pneumonia, pneumonia, organism unspecified, myocardial infarction/angina, arrhythmias, heart failure, stroke, syncope/dizziness, hypotension, shock after procedure, respiratory and/or cardiac arrest), infection (fever, bacteremia, and endocarditis following the procedure), and complications of procedure (failure of sterile precautions during procedure, foreign body accidentally left during a procedure, and postoperative infection) (Levin et al., 2006; Warren et al., 2009).

In some cases, a patient may experience more than one type of adverse events and the ensuing ED visit and/or hospitalization may not be attributed to one type of adverse events or another. To avoid underestimating the incidence rate, each type of adverse event is considered to have resulted in an ED visit and/or hospitalization in these cases. For example, if a patient had gastrointestinal bleeding and a stroke within 30 days of the procedure and got hospitalized, two binary variables, the occurrence of serious gastrointestinal events and the occurrence of other non-gastrointestinal events will be coded as 1. If a patient had multiple complications that belong to one type of adverse events, only the corresponding dependent variable will be coded as 1. For example, if a patient had an inpatient record with the diagnoses of abdominal pain and nausea and vomiting, only the occurrence of other gastrointestinal events for this patient will be coded as 1.

Key independent variable.

The primary interest of this study is examining how physician ownership status affects patient outcomes of colonoscopy procedures. Prior to the Capen v. Shewry lawsuit and corresponding court ruling, Section 1200, et seq. of the California Health and Safety Code required that certain types of clinics and surgical clinics be licensed by the California Department of Public Health (CDPH). CDPH had interpreted the Statute as excluding from mandatory licensure clinics that were solely owned physicians. But CDPH had licensed wholly physician-owned clinics if physicians voluntarily requested it. Most physician-owned ASCs elected to be licensed because most third party payers, such as Medi-Cal, have included being licensed as a condition for coverage (Fielding & Freedman, 2008).

The decision made by the Third District Court of Appeal on September 19, 2007 in the Capen v. Shewry lawsuit altered CDPH's licensing practices. The decision ruled that "physician owned and operated surgical clinics are to be regulated by a division of the Medical Board, when general anesthesia is used, and surgical clinics operated by non-physicians are to be regulated by the Department (CDPH)."(Court of Appeal, Third District, California, 2007) CDPH interpreted the decision as it no longer having authority to license or regulate any physician-owned ASCs, nor to issue licenses even if physicians applied for them voluntarily. Consequently, about 450 ASCs with physician ownership stopped filing annual reports to the CDPH. These facilities also stopped submitting discharge data. Post the court ruling, the Medical Board of California is solely responsible for oversight of any centers with any fraction of physician ownership.

The Office of Statewide Health Planning and Development (OSHPD) maintains information on all licensed health facilities in California. After the Capen v. Shewry decision, OSHPD began to identify and delicense ASCs with any physician ownership. The delicensing process did not happen immediately after the court ruling because many physician-owned ASCs continued to submit utilization reports to OSHPD. By 2012, all ASCs with physician-ownership have been delicensed. Based on the records maintained by OSHPD, this study is able to identify ASCs with at least partial physician ownership. This study assumed that physician ownership status remained unchanged during the study period, namely, from 2005 to 2007. Physician information was not available in the California data. Therefore, it is not possible to identify physicians who were practicing in physician-owned facilities or to identify which physicians were indeed owners of these facilities.

A dummy variable physician ownership is constructed to identify outpatient surgical facilities with physician ownership, namely, physician-owned ASCs and those without, namely, hospital-based outpatient facilities. The first type of facility includes freestanding ASCs that were solely or partially owned by physicians. This category also includes freestanding ASCs organized through joint ventures between hospitals and individual physicians or between hospitals and physician groups. The second type of facility includes hospital outpatient departments as well as hospital-owned ASCs that are not physically attached to the main hospital campus. Because all these hospital-owned facilities reported information at the hospital level, it is impossible to distinguish hospital outpatient departments from hospital-owned ASCs. In this study, hospital-based outpatient facility serves as the reference group.

Control variables.

All regressions included the same set of control variables. These control variables can be grouped into factors at the patient, organizational, and health care market-level as shown in Figure 3 of Chapter 3.

Patient characteristics.

Several demographic and clinical factors that may affect patients' likelihood of ED and hospital inpatient care use after outpatient surgery are included in the analysis. Specifically, patient demographic variables include: patient age group, gender, race/ethnicity, payer type, income proxy, and urban/rural location. This study selected colonoscopy patients who were 18 years or older on the date of admission. Following Chukmaitov et al (2008a), the age group variable is divided into five groups (18-49 [the reference group], 50-64, 65-74, 75-84, 85 and above). Patient gender is included as a binary variable (male is the reference group). Race/ethnicity is coded as non-Hispanic white (the reference group), non-Hispanic African American, Hispanic, or other (non-Hispanic, including unknowns). Patient payer types are categorized into five groups: Medicare, Medicaid, private insurance (the reference group), self-pay, or other payer.

Ideally, a patient's income should be measured directly by the income at the patient level or household level. However, such data are not publicly available. Instead, a quartile variable based on the median household income for the patient's ZIP code is used (first quartile, second quartile, third quartile, fourth quartile [the reference group]). The quartiles are identified by values of 1 to 4, with 1 indicating the poorest population and 4 the wealthiest population, respectively. The cut-offs for the quartile designation is determined by ranking the ranking the median household income for all the ZIP Codes within the state. This variable is used as a proxy for an individual patient's socioeconomic status. It is worth noting that it may also be an indicator of the community from which the outpatient surgery facility is drawing business.

Patient urban/rural location is classified as one of these categories: large metropolitan area with at least 1 million residents (the reference group), small metropolitan area with less than 1 million residents, micropolitan area, and not metropolitan or micropolitan area (rural area).

Several clinical factors may affect patient outcomes and thus should be controlled for. This study uses the Charlson et al. (1987) Index as a measure of medical severity of illness. Charlson et al. (1987) defined 17 comorbidities, including myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatic disease, peptic ulcer disease, mild liver disease, diabetes without chronic complication, diabetes with chronic complication, hemiplegia or paraplegia, renal disease, any malignancy, moderate or severe liver disease, metastatic solid tumor, and HIV/AIDS. Different comorbidities receive different weights in the construction of the Index. The first 10 conditions (from myocardial infarction to diabetes without chronic complication) are given a weight of 1. The eleventh to fourteenth conditions (from diabetes with chronic complication to any malignancy) are given a weight of 2. Moderate or severe liver disease is given a weight of 3 and metastatic solid tumor and HIV/AIDS are given a weight of 6. In this study, the Index is constructed using diagnosis information from the outpatient surgery records as well as emergency and inpatient records for the 6 months prior to and 6 months after the procedure, assuming comorbid conditions remain unchanged over this period of time. The calculation is based on the algorithms used in Quan et al (2005). Some conditions, such as acute myocardial infarction, are excluded from the calculation of the Index if they happened within 30 days after the procedure because these are regarded as colonoscopy related complications. The Charlson Index is treated as a continuous variable in the analysis.

This study also measures some other clinical factors. Following Fleisher et al (2004), the propensity to use medical services, which is measured by the number of previous ED visits and hospital admissions (within 6 months prior to the colonoscopy), is controlled for in this study. The study also controls for the procedures that patients received during the colonoscopy. Following prior studies (Ko et al., 2010; Levin et al., 2006; Warren et al., 2009), this study controls for the type of colonoscopy performed on the patient (Diagnostic colonoscopy [the reference group], Colonoscopy and biopsy, or Lesion removal colonoscopy).

Organizational characteristics.

Other organizational characteristics are also measured and controlled for in this study. Facility volume is measured through a tertile variable that represents the ranking of the volume of colonoscopies provided by a facility relative to the volume of all other facilities in a given year (Chukmaitov et al., 2008). The total number of colonoscopies performed by each facility is obtained by using unique facility identifiers and procedure identifiers. Following Chukmaitov et al. (2010), this study measures procedure specialization within an outpatient surgical facility. The variable specialization rate equals the number of colonoscopy procedures provided by the facility divided by the total number of outpatient surgeries in that facility in a given year. The specialization rate squared is also included to allow for the estimate of a quadratic relationship between organizational specialization and quality of care.

Market characteristics.

The proposed study also controls for several market characteristics that may affect the quality of outpatient surgical care, including degree of competition, HMO and PPO penetration, physician density, and demand-related factors. In this study, the health care market is defined as the county due to the availability of data. Alternative methods to define health care market include the use of the Hospital Referral Regions (HRRs) (Wennberg & Cooper, 1998) and fixed radius. Past work suggests that different definitions of markets do not substantially change the results (Krauchunas, 2011; McLaughlin, Normolle, Wolfe, McMahon, & Griffith, 1989).

Competition in this study is measured using a Herfindahl-Hirschman Index (HHI) that is based on the market share of colonoscopy for a facility, calculated with the county as the relevant market area. Outpatient surgical facilities operated by the same health care system in a county are treated as one organization with their market share combined to the system level. This is the standard practice in hospital related research. Health system identifiers are obtained from AHA annual survey. An interaction term of competition and facility type is included in the analysis as physician-owned ASCs may behave differently in highly competitive markets. HMO and PPO penetration rates are used to capture the financial pressure from managed care organizations. The HMO penetration rate is defined as the proportion of the total population enrolled in HMOs (including commercial, Medicare, and Medicaid enrollment) in a county following the literature (Scanlon, Chernew, Swaminathan, & Lee, 2006). The PPO penetration rate includes commercial, Medicare, and self insured enrollment and uses the total population in the county as the denominator.

This study also includes a set of physician supply variable to reflect the medical infrastructure in the local health care market. Specifically, the numbers of physicians practicing gastroenterology, primary care (including family medicine, general practice, and general internal medicine), and general surgery per 100,000 population in the county are included. Because ARF does not provide the physician supply variables for the year 2006, averages of the values in years

2005 and 2007 are used instead. Additionally, the study controls for several demand-related factors, including log-transformed population size at the county level, percentage of the population over age 65, and percentage of the population under age 65 without health insurance. Finally, time effects are accounted for in the model. Specifically, dummy variables for each year between 2005 and 2007 are constructed, with the reference group being 2005. Table 8 summarizes the variables included in the analysis, their definitions, and data sources.

Empirical Specification and Methodology

A descriptive analysis of colonoscopy patients' characteristics and the prevalence of adverse events related to outpatient colonoscopy by the ownership structure of the facility will first be conducted. To demonstrate the prevalence of colonoscopy related adverse events, the unadjusted rate per 1,000 persons for specific adverse events will be calculated by counting the number of specific adverse events within 30 days of the procedure, not controlling for covariates. Chi-square test will be used to determine whether the rate for adverse events differed significantly across two types of facilities, namely, physician-owned ASC and hospital-based outpatient facility.

Recognizing that a colonoscopy case is nested within an outpatient surgical facility, and the latter is nested within a certain health care market, three-level generalized hierarchical linear models (GHLM) will be constructed to investigate the factors associated with adverse events after colonoscopy. Patient characteristics will be modeled at level-1, organizational factors at level-2 and health care market characteristics at level-3. Separate models will be estimated for each dependent variable.

In the hierarchical modeling, a patient's log odds of experiencing an adverse event after the index colonoscopy may vary across both facilities and health care markets. First, a patient's

Table 8

Variable definitions and sources

Variable	Definition	Data Sources
Dependent Variables		
The incidence of same day ED visit and/or hospitalization	All-cause ED visit and/or hospitalization in the same day of colonoscopy. This variable is binary and equals to 1 if the patient experiences this type of adverse events and 0 otherwise.	HCUP-SEDD and SID
The incidence of serious gastrointestinal event	Serious gastrointestinal complications (colonic perforation, lower gastrointestinal bleeding, and anemia) requiring ED visit and/or hospitalization within 30 days following outpatient colonoscopy. This variable is binary and equals 1 if the patient experiences any of the complications under this category and 0 otherwise.	HCUP-SEDD and SID
The incidence of other gastrointestinal event	Other gastrointestinal complications including intestinal obstruction, abdominal pain, diverticulitis, ulcerative colitis, nausea and vomiting, and disorders of fluid occurring within 30 days after outpatient colonoscopy that were severe enough to require an emergency department visit or hospitalization. This variable is binary and equals 1 if the patient experiences any of the complications under this category and 0 otherwise.	HCUP-SEDD and SID
The incidence of other non-gastrointestinal event	Other non-gastrointestinal complications including sedation-related cardiopulmonary complications (aspiration pneumonia, pneumonia, organism unspecified, myocardial infarction/angina, arrhythmias, heart failure, stroke, syncope/dizziness, hypotension, shock after procedure, respiratory and/or cardiac arrest), infection (fever, bacteremia, and endocarditis following the procedure), and complications of procedure (failure of sterile precautions during procedure, foreign body accidentally left during a procedure, and postoperative infection) occurring within 30 days after outpatient colonoscopy that were severe enough to require an emergency department visit or hospitalization. This variable is binary and equals 1 if the patient experiences any of the complications under this category and 0 otherwise.	HCUP-SEDD and SID

Table 8 (continued)

Variable	Definition	Data Sources
Key Independent Variable		
Physician ownership	A dummy variable identifying physician-owned ASC and hospital-based outpatient facility (the reference group)	CA-OSHPD
Physician ownership interacted with HHI	The interaction term of the dummy variable identifying physician-owned ASC and Herfindahl-Hirschman Index (HHI)	HCUP-SASD CA-OSHPD
Control Variables		
Patient characteristics		
Age group	Dummy variables identifying these age groups: 18–49 [the reference group], 50–64, 65–74, 75–84, 85 and above.	HCUP-SASD
Gender	A dummy variable equal to 1 for male and 0 for female	HCUP-SASD
Race/ethnicity	Dummy variables identifying white (non-Hispanic, the reference group), African American (non-Hispanic), Hispanic, or other (including unknowns)	HCUP-SASD
Payer type	Dummy variables identifying Medicare (fee-for-service and managed care Medicare), Medicaid (fee-for-service and managed care Medicaid), private insurance (including Blue Cross, commercial carriers, and private HMOs and PPOs, the reference group), self-pay, or other payer (Worker's Compensation, CHAMPUS, CHAMPVA, Title V, and other government programs)	HCUP-SASD
Income level	Dummy variables indicating the quartile in which the median household income for the patient's ZIP code falls (first quartile, second quartile, third quartile, fourth quartile [the reference group]). The quartiles are identified by 1 to 4, with 1 indicating the poorest population and 4 the wealthiest population, respectively. The cut-offs for the quartile designation is determined by ranking the median household income for all ZIP Codes within the state.	HCUP-SASD
Urban/rural location	A series of dummy variables identifying patient urban/rural location as one of these: large metropolitan area with at least 1 million residents (the reference group), small metropolitan area with less than 1 million residents, micropolitan area, and not metropolitan or micropolitan area (nonmetro noncore area)	HCUP-SASD

Table 8 (continued)

Variable	Definition	Data Sources
Charlson Comorbidity Index	A continuous variable which represents the weighted number of comorbid conditions. It is calculated using diagnoses on the ambulatory surgery records as well as emergency department and inpatient records for the 6 months prior to and 6 months after the outpatient colonoscopy	HCUP-SASD, SEDD, and SID
# of previous ED visits and hospitalizations	The number of ED visits and hospital admissions within 6 months prior to the colonoscopy procedure	HCUP-SEDD and SID
Colonoscopy type	Dummy variables indicating diagnostic colonoscopy (the reference group), colonoscopy and biopsy, or lesion removal colonoscopy	HCUP-SASD
Organizational Characteristics		
Facility volume	Three dummy variables representing the low-, medium-, or high-volume tertile based on the facility volume of colonoscopy. The low tertile serves as the reference group. These tertile variables vary from year to year with cut-offs determined by ranking all facilities' volumes in a given year	HCUP-SASD
Specialization rate	The percentage which equals the number of colonoscopies provided by the facility divided by the number of outpatient surgeries for a facility in a year	HCUP-SASD
Specialization rate squared	A continuous variable which equals to the square of specialization rate	HCUP-SASD
Market Characteristics		
Herfindahl-Hirschman Index (HHI)	Sum of squares of market share of a facility's outpatient colonoscopy cases. The market shares for facilities that belonged to the same health systems within a county were combined	HCUP-SASD
HMO and PPO penetration	The percentage of the population enrolled in HMOs (including commercial, Medicare, and Medicaid) in a county and the percentage of the population in the county enrolled in commercial PPO, Medicare PPO, or self insured PPO.	Health-Leader
Number of gastroenterologists per 100,000 population	The ratio of the number of physicians in gastroenterology to 100,000 population in the county	ARF
Number of primary care physicians per 100,000 population	The ratio of the number of physicians practicing family medicine, general medicine, and internal medicine to 100,000 population in the county	ARF

Table 8 (continued)

Variable	Definition	Data Sources
Number of general surgeons per 100,000 population	The ratio of the number of physicians in general surgery to the total population in the county	ARF
Log-transformed population size	The log-transformation of the estimated total number of population in the county	ARF
% of the population above age 65	The percentage of the population above age 65	ARF
% of the population below age 65 without health insurance	The percentage of the population under age 65 that have no health insurance	ARF
Year dummy variables	A set of dummy variables for years 2005 (the reference group), 2006, and 2007	

Note: CA-OSHPD: State specialty clinic and hospital annual utilization reports from the Office of Statewide Health Planning and Development (OSHPD); HCUP-SASD: Healthcare Cost and Utilization Project-State Ambulatory Surgery Databases; HCUP-SEDD: Healthcare Cost and Utilization Project-State Emergency Department Databases; HCUP-SID: Healthcare Cost and Utilization Project-State Inpatient Databases; ARF: Area Resource File.

odds of having an adverse event will be modeled as a function of a facility mean and a random error (which was assumed to have a Bernoulli distribution with a mean of zero and a constant variance). Then, the organizational mean will be modeled as an outcome varying randomly around a health market mean with a random error (which was assumed to have a normal distribution with a mean of zero and a certain variance). Finally, each health market mean will be modeled as an outcome varying randomly around a grand mean with a random error (which was also assumed to have a normal distribution).

Suppose that y_{ijk} is a binary variable (e.g. same day ED visit and/or hospitalization) that equals 1 if a specific type of adverse events occurred in patient i who received care from facility j which was located in health markets k, the three-level logistic random-intercept model can be expressed by the following equation:

$$logit\left\{\Pr\left(y_{ijk}=1\middle|X_{ijk},\zeta_{jk}^{(2)},\zeta_{k}^{(3)}\right)\right\}= \\ =\beta_1+\beta_2 age_{grp2_{ijk}}+\beta_3 age_{grp3_{ijk}}+\cdots+\beta_{11}Physician\_owned\_ASC_{jk} \\ +\beta_{12}Physician\_owned\_ASC_{jk}\times HHI_k+\cdots+\zeta_{jk}^{(2)}+\beta_{21}HHI_{21,k} \\ +\beta_{22}HMO\_penetration_{22,k}+\cdots+\zeta_{k}^{(3)}$$

where $i=1,2,\ldots,n_{jk}\ patients, j=1,2,\ldots,n_k\ facilities, k=1,2,\ldots,N\ markets, y_{ijk}$ follows the Bernouli distribution, $y_{ijk}\sim Bin(1,y)$, $\zeta_{jk}^{(2)}|X_{ijk},\zeta_{k}^{(3)}\sim N(0,\psi^{(2)})$ is a random intercept varying over facilities (level2), $\zeta_{jk}^{(3)}|X_{ijk}\sim N(0,\psi^{(3)})$ is a random intercept varying over health care markets (level 3). $Physician\_owned\_ASC_{jk}\times HHI_k$ represents the cross-level interaction term between physician-ownership and market competition.

A common threat to the internal validity of this observational study is that physicians may selectively invest in outpatient surgical facilities in certain type of health care market.

Researchers have noted that technological, market, and public policy factors jointly influence physician decisions to invest in ASCs (Casalino, Devers, & Brewster, 2003). This study will use the propensity score approach (Rosenbaum & Rubin, 1983; Rosenbaum & Rubin, 1984) to identify facilities that are more likely to attract physician investment using market-level factors. Including the propensity score in the models ensures that facilities in different categories have similar joint distributions in observed variables related to decisions among physicians about where to locate facilities (Rosenbaum & Rubin, 1983; Rosenbaum & Rubin, 1984; Rubin, 1997). In theory, if physicians' selection of location wholly depends on the variables used in propensity score estimation, including propensity scores in the models can make the selection process "ignorable" (Rosenbaum & Rubin, 1983). But in practice, important factors that may influence such decisions may be unobservable and thus not incorporated into the propensity score.

Little evidence exists in the current literature on physician investment decisions. One qualitative study suggests that technological, market, and public policy factors jointly affect physicians' decision to invest in ASCs (Casalino, Devers, & Brewster, 2003; Pham, Devers, May, & Berenson, 2004). For example, the presence of large single-specialty physician groups is found to be an important contributing factor in the creation of a physician-owned ASC (Casalino, Devers, & Brewster, 2003). In addition, physician income pressure and physician's negotiation power relative to that of health insurance plans and hospitals also may play a role in physicians' decision to invest in specialty facilities (i.e., specialty hospitals or ASCs) (Pham, Devers, May, & Berenson, 2004). In this study, all market-level factors, including competition, HMO/PPO penetration, physician supply variables, and patient demand factors, are used in the propensity score analysis. The propensity score is calculated using logistic regression and is included in multilevel models as a covariate.

In this study, data management is conducted using SAS 9.2 and STATA 12.0. Multilevel logistic regressions are estimated using the GLIMMIX procedure in SAS. This study was reviewed and approved by the Institutional Review Board of the Virginia Commonwealth University.

Sensitivity Analyses

A sensitivity analysis is conducted to examine whether multivariate regression results are robust to the change in propensity score adjustment approach. It is possible that physician owners may selectively refer relatively healthier patients to their own facilities for treatments (Devers, Brewster, & Ginsburg, 2003; O'Neill & Hartz, 2012). At the same time, they may direct sicker patients and those with multiple comorbid conditions to other facilities for treatment because these patients may require a higher level of service and cost more to be taken care of. Thus, a separate propensity score will be constructed to account for favorable patient selection. Because little evidence exists about what patient characteristics are used in patient selection by physician owners, all patient-level factors will be used to construct the propensity score. Note that patients from remote rural areas may only have access to hospital outpatient facilities because there were no physician-owned ASCs nearby. In this case, patients' urban/rural location variable can be used to control for physical accessibility to physician-owned ASCs. The results will be compared with those of primary models that include propensity score adjusting for potential physician selective investment in outpatient surgical facilities.

An additional sensitivity analysis parallels the two series of models in the main analysis, with an added lagged quality indicator-unadjusted adverse event rate for a facility in the previous year. The inclusion of the lagged quality variable may be necessary for two reasons. First, lagged quality may affect patient outcomes in the current period due to the dynamic nature of quality

(Castle & Anderson, 2011). Second, this variable may in part pick up the influence of quality on patients' decisions if they are indeed able to ascertain differences in quality across different providers. These models are run as sensitivity tests rather than the main analysis considering that observations of year 2005 do not have lagged quality information and need to be dropped from the analysis. This loss of sample size is significant since the outcomes are rare adverse events.

Summary

This chapter covered the research design, data sources, variable measurements, and empirical specification and methods used in this study. This study will utilize a pooled, cross-sectional design. The ambulatory surgery, emergency department, and inpatient care discharge records from California will be linked together to identify a cohort of outpatient colonoscopy patients and their use of emergency department and/or hospital inpatient care within 30 days after the procedure. The Capen v Shewry decision in California in 2007 will be used to identify the physician ownership status of outpatient surgical facilities. Using hierarchical generalized linear modeling technique and propensity score adjustments, this study will attempt to examine the effect of physician ownership by comparing patient outcomes in facilities with physician ownership and in those with no physician ownership. The findings of this study are presented in Chapter 5.

Chapter 5: Results

This chapter presents the results of the empirical analyses. It is divided into four sections. The first section provides descriptive data on patients, outpatient surgical facilities, and health care markets for California during the 2005 to 2007 study period. The second section shows the unadjusted rate per 1,000 procedures for adverse events of interest. The third section presents results of multilevel models, with and without a propensity score adjusting for physician selective investment in outpatient surgical facilities. The fourth section reports the results of sensitivity analyses, in which a different propensity score is constructed to adjust for patient selection and lagged quality indicators are included in the empirical model. These results are compared with those obtained in the main analysis. The fifth and final section concludes the chapter with a brief summary.

Results of Descriptive Analysis

Numbers of colonoscopy patients, facilities, and markets.

During the study period (2005-2007), 1,832,535 colonoscopies were performed in California, of which 1,278,886 colonoscopies were performed on patients aged 18 or above and were included in the study. Physician-owned ASCs and hospital-based outpatient facilities provided 645,481 (50.5%) and 633,405 (49.5%) colonoscopies, respectively. There were 1,324 facility-years included in this study, with 494 physician-owned ASC-years and 830 hospital-based outpatient facility-years. On average, in each study year, there were 165 physician-owned ASCs and 277 hospital-based outpatient facilities with an annual facility volume of no less than

30 colonoscopies. Those outpatient surgical facilities were located in 58 counties. The counties of Alpine and Sierra did not have any health care facility that provided outpatient surgeries during the study period. In Modoc County, the only licensed health care facility, Modoc Medical Center, reported 7 outpatient surgeries (no colonoscopy) in 2005 and none in 2006 and 2007. Thus, Alpine, Sierra, and Modoc counties were excluded from the study. These three counties are the three least populated in California. Thus, the health care markets in 55 counties were examined in the study.

Characteristics of patients examined.

As reported in Table 9, a majority of colonoscopy patients (71.7%) were between age 50 and 74, which is consistent with the recommendation that colonoscopy be conducted for polyps and cancer screening in an average risk person, aged between 50 and 75 (U.S. Preventive Services Task Force, 2008). The distribution of patient age was similar at physician-owned ASCs and hospital-based outpatient facilities.

Outpatient colonoscopy patients were more likely to be female. Although a higher percentage of patients treated at a physician-owned ASC were male than patients treated at a hospital-based outpatient facility (45.7% versus 45.1%, $p<0.0001$), the magnitude of the difference may not have practical implications.

Extra caution needs to be exercised when interpreting the racial/ethnic composition of patients in different types of facilities. More patients at a physician-owned ASC had unknown race/ethnicity. In this situation, the racial-ethnic composition is calculated on the basis of patients with known race/ethnicity. Overall, non-Hispanic white, African American, and Hispanic patients accounted for 81.4%, 4.0%, and 14.6% of all patients with known race/ethnicity, respectively. In physician-

Table 9

Descriptive Statistics for Patient-level Characteristics by Facility Type from 2005 to 2007

	Physician-owned ASC		Hospital-owned Outpatient Facility		Total	
	# of cases	(%)	# of cases	(%)	# of cases	(%)
Patient age						
18-49 (reference)	86,918	(13.5)	95,244	(15.0)	182,162	(14.2)
50-64	323,124	(50.1)	317,479	(50.1)	640,603	(50.1)
65-74	144,779	(22.4)	131,783	(20.8)	276,562	(21.6)
75-84	79,831	(12.4)	76,348	(12.1)	156,179	(12.2)
85 or greater	10,829	(1.7)	12,551	(2.0)	23,380	(1.8)
Patient gender						
Male (reference)	294,799	(45.7)	285,914	(45.1)	580,713	(45.4)
Female	350,682	(54.3)	347,491	(54.9)	698,173	(54.6)
Patient race/ethnicity						
White (reference)	381,806	(59.2)	416,925	(65.8)	798,731	(62.5)
Black	19,832	(3.1)	19,963	(3.2)	39,795	(3.1)
Hispanic	61,020	(9.5)	82,110	(13.0)	143,130	(11.2)
Other	182,823	(28.3)	114,407	(18.1)	297,230	(23.2)
Payer						
Medicare	222,200	(34.4)	205,126	(32.4)	427,326	(33.4)
Medicaid	10,808	(1.7)	37,121	(5.9)	47,929	(3.7)
Private insurance (reference)	374,037	(57.9)	355,123	(56.1)	729,160	(57.0)
Self-pay	7,890	(1.2)	9,674	(1.5)	17,564	(1.4)
Other payer	30,546	(4.7)	26,361	(4.2)	56,907	(4.4)
Median household income quartile (ZIP code level)						
Lowest quartile of income	105,618	(16.4)	117,653	(18.6)	223,271	(17.5)
Second lowest quartile of income	125,518	(19.4)	151,213	(23.9)	276,731	(21.6)

Table 9 (continued)

	Physician-owned ASC		Hospital-owned Outpatient Facility		Total	
	# of cases	(%)	# of cases	(%)	# of cases	(%)
Second highest quartile of income	176,949	(27.4)	172,924	(27.3)	349,873	(27.4)
Highest quartile of income (reference)	237,396	(36.8)	191,615	(30.3)	429,011	(33.5)
Urban/rural location						
Metropolitan areas (>=1 million residents, reference)	466,053	(72.2)	448,594	(70.8)	914,647	(71.5)
Metropolitan areas (<1 million residents)	170,060	(26.3)	148,319	(23.4)	318,379	(24.9)
Micropolitan areas	4,870	(0.8)	26,074	(4.1)	30,944	(2.4)
Non-urban areas	4,498	(0.7)	10,418	(1.6)	14,916	(1.2)
Charlson Comorbidity Index[a]	0.17	(0.80)	0.35	(1.02)	0.26	(0.92)
Propensity to use medical services[a]	0.15	(0.55)	0.23	(0.74)	0.19	(0.65)
Colonoscopy type						
Diagnostic colonoscopy (reference)	337,922	(52.4)	334,998	(52.9)	672,920	(52.6)
Colonoscopy and biopsy	141,383	(21.9)	138,331	(21.8)	279,714	(21.9)
Lesion removal colonoscopy	166,176	(25.7)	160,076	(25.3)	326,252	(25.5)
Total	645,481	(100.0)	633,405	(100.0)	1,278,886	(100.0)

Note: Chi-square test was used to test the association between the row variables and facility type variables. [a] For Charlson Comorbidity Index and propensity to use medical services, mean and standard deviation are reported and t test was used to test the differences across facility types. All differences across the two types of facilities are significant at the $p<0.01$ level.

owned ASCs, the three percentages were 82.5%, 4.3%, and 13.2%, respectively while in hospital-based outpatient facilities, the three percentages were 80.3%, 3.8%, and 15.8%. Taking African American and Hispanic patients together, physician-owned ASCs served a relatively smaller percentage of patients from racial-ethnic minority groups (17.5%) than hospital-based outpatient facilities (19.7%).

The patients tended to be covered by private insurance or Medicare. Medicare patients and private insured patients accounted for a significantly larger percentage in physician-owned ASCs (92.3%) than in hospital-based outpatient facilities (88.5%). By contrast, Medicaid patients accounted for a significantly smaller percentage in physician-owned ASCs (1.7%) than in hospital-based outpatient facilities (5.9%).

Using the median household income quartile for the patient's ZIP code as a proxy for a patients' income, physician-owned ASCs had a significantly higher percentage of patients from the wealthiest quartile (36.8%) and a significantly lower percentage of patients from the poorest quartile (16.4%) than hospital-based outpatient facilities (30.3% and 18.6%, respectively).

A majority of colonoscopy patients came from metropolitan areas (96.4%). Physician-owned ASCs had significantly smaller percentages of patients from micropolitan and non-urban areas (0.8% and 0.7%, respectively) than hospital-based outpatient facilities (4.1% and 1.6%, respectively).

Outpatient colonoscopy patients were largely healthy. The average Charlson Comorbidity Index was 0.26 and the average number of the ED visits and hospitalizations in the six months prior to the colonoscopy was 0.19 per person. Physician-owned ASCs served significantly healthier patients. The mean Charlson Comorbidity Index for patients treated at a physician-owned ASC was 0.17 while the number was 0.35 for patients treated at a hospital-based outpatient facility. Patients treated at a physician-owned ASC had a significantly lower propensity to use medical services. The average number of previous ED visits and hospitalizations was 0.15 for patients treated at a physician-owned ASC while that number for patients treated at a hospital-based outpatient facility was 0.23.

More than half of outpatient colonoscopies were diagnostic colonoscopies. About one fifth were colonoscopy with biopsy and about one fourth were lesion removal colonoscopies. The composition of different colonoscopy procedures was similar across the two types of facilities. Overall, 52.6% of colonoscopy patients received diagnostic colonoscopy without biopsy or polypectomy, while 21.9% received colonoscopy and biopsy and 25.5% received lesion removal colonoscopy.

In sum, a majority of outpatient colonoscopy patients were above age 50. They were more likely to be female and non-Hispanic white. Private insurance and Medicare were two largest payers for this type of medical care. Patients from the wealthier two quartiles accounted for more than 60% of all the patients. Most patients lived in metropolitan areas. Outpatient colonoscopy patients were largely healthy. A little more than half of patients received diagnostic colonoscopy. There were significant differences among patients receiving the procedure at a physician-owned ASC and those treated by a hospital outpatient facility. Patients receiving the procedure at a physician-owned ASC were more likely to be non-Hispanic white, have private insurance or Medicare, live in wealthier zip codes and metropolitan areas, and have better health status.

Characteristics of outpatient surgical facilities.

As reported in Table 10, on average an outpatient surgical facility provided 1284 colonoscopies in a given year. On average 30% of all the surgeries in an outpatient facility were

Table 10

Descriptive Statistics for Facility-level Characteristics by Facility Type from 2005 to 2007

	Physician-owned ASC		Hospital-owned Outpatient Facility		Total	
	Mean (Standard deviation)		Mean (Standard deviation)		Mean (Standard deviation)	
Facility colonoscopy volume	1811.67	(1711.98)	970.69	(1088.72)	1284.47	(1414.36)
Facility colonoscopy volume group[a]						
30-430 cases per year (reference)	113	(22.9)	314	(37.8)	427	(32.3)
431-1333 cases per year	124	(25.1)	323	(38.9)	447	(33.8)
>= 1334 cases per year	257	(52.0)	193	(23.3)	450	(34.0)
Specialization rate	0.48	(0.27)	0.20	(0.12)	0.31	(0.23)
Facility-years	494	(100.0)	830	(100.0)	1,324	(100.0)

Note: Means are reported and standard deviations are in brackets. t test was used to check on the equality of means of row variables of different facility types. [a] For the Facility colonoscopy volume group variables, frequencies and column percentages are reported and chi-square test is used to test the association between row variables and facility type variables. All differences across the two types of facilities are significant at the $p<0.01$ level.

colonoscopy procedures. Physician-owned ASCs on average had a significantly higher colonoscopy volume (1,812 cases per year) than hospital-based outpatient facilities (971 cases per year). Correspondingly, 52.0% of physician-owned ASC-years fell into the highest volume group while 23.3% of hospital-based outpatient facilities belonged to that group. Physician-owned ASCs had a significantly higher level of specialization than hospital-based outpatient facilities. Among physician-owned ASCs, on average 48% of all outpatient surgeries were colonoscopy cases. In hospital-based outpatient facilities, only 20% of all outpatient surgeries were colonoscopies on average.

Characteristics of health care markets.

As mentioned before, counties are used to define health care markets in this study. The distribution of outpatient surgical facilities that performed outpatient colonoscopy varied greatly across counties. Among the 55 counties with at least one outpatient surgical facility that provided 30 or more outpatient colonoscopies in a given year, only 38 counties had both physician-owned ASCs and hospital-based outpatient facilities. The other 17 counties only had hospital-based outpatient facilities.

Table 11 depicts the characteristics of the health care markets based on the percentage of outpatient surgical center observations for the three year study period in a county that were physician-owned ASC observations rather than hospital-based outpatient facility observations. Twenty-five counties had low percentages of physician-owned ASC observations (0-29.9%), 17 counties belonged to the group of markets with moderate percentages (30.0-49.9%), and 10 belonged to the group of markets with high percentages of physician-owned ASC observations (above 50.0%). Markets with low percentages of physician-owned ASC observations had a much lower level of competition (HHI 0.6814) compared with markets with moderate or high percentages of physician-owned ASC observations (HHI 0.2820 and 0.3549, respectively). Markets with low percentages of physician-owned ASC observations also had a relatively lower HMO penetration rate, lower gastroenterologists per 100,000 population, higher primary care physicians per 100,000 population, higher general surgeon per 100,000 population, a smaller population size, and a higher percent of the population aged 65 or above. Little difference in the rate of individuals who are uninsured was found across the three market types.

Unadjusted rates for adverse events by facility type.

Table 12 presents the unadjusted rates for specific adverse events that developed within 30 days of outpatient colonoscopy and resulted in an ED visit or hospitalization by facility type. Here the rate is calculated by summing up all the complications across facilities of a particular

Table 11

Descriptive Statistics for Market-level Characteristics by Percentages of Outpatient Surgical Center Observations that were for Physician-owned ACSs[a]

% of Observations that were for Physician-owned ASC	HHI	HMO penetration	PPO penetration	# of GI per 100,000	# of PCP per 100,000	# of GS per 100,000	Log population	% of population age 65+	% of the uninsured
Low (0-29.9%)	0.6814	27.0%	32.1%	1.61	64.05	9.29	11.28	13.8%	19.7%
Medium (30.0-49.9%)	0.2820	39.0%	29.5%	2.99	59.64	9.22	13.34	11.1%	19.7%
High (>=50.0%)	0.3549	29.7%	37.2%	2.62	62.31	8.27	12.30	12.3%	19.8%
Overall	0.4768	31.9%	32.1%	2.30	62.13	9.08	12.22	12.6%	19.7%

Note: HHI: Herfindahl-Hirschman Index; GI: gastroenterologists; PCP: primary care physicians; GS: general surgeons. [a]The percentage was calculated by dividing the number of study observations for physician-owned ASCs during the three-year study period within a county by the total number of outpatient surgical center observations (i.e., physician-owned ASCs and hospital-based outpatient facilities) in that county.

Table 12

Unadjusted Rates per 1,000 procedures for Specific Adverse Events within 30 Days of Colonoscopy by Facility Type from 2005 to 2007

Adverse event	Physician-owned ASCs (n=645,481)		Hospital-based outpatient facilities (n=633,405)		Total (n=1,278,886)		P value
	Events, n	Rate	Events, n	Rate	Events, n	Rate	
Same day transfer to ED or Hospital	1,131	1.8	2,283	3.6	3,414	2.7	<0.001
Serious GI events resulting in an ED visit or hospitalization within 30 days	638	1.0	636	1.0	1,274	1.0	0.779
Other GI events resulting in an ED visit or hospitalization within 30 days	3,028	4.7	3,451	5.4	6,479	5.1	<0.001
Other non-GI events resulting in an ED visit or hospitalization within 30 days	7,683	11.9	9,951	15.7	17,634	13.8	<0.001

Note: ED: emergency department; GI=gastrointestinal.

ownership type and then dividing this by the total number of procedures (measured in 1000s) for that facility ownership type. The rate for same day transfer to ED or short-term acute care hospital was 2.7 per 1,000 procedures. Rate for same day transfer to ED or short-term acute care hospital was significantly lower for patients treated at a physician-owned ASC (1.8 per 1,000 procedures) than those treated at a hospital-based outpatient facility (3.6 per 1,000procedures) . The incidence of serious gastrointestinal events (colonic perforation or lower gastrointestinal bleeding) that resulted in an ED visit or hospitalization was 1.0 per 1,000 procedures. The rate for 30-day serious gastrointestinal events was not significantly different among patients treated at the two types of facilities.

The rate for other gastrointestinal adverse events (e.g. intestinal obstruction) that resulted in ED visit or hospitalization was 5.1 per 1,000 procedures. Rate for other gastrointestinal events was significantly lower among patients receiving colonoscopy at a physician-owned ASC (4.7 per 1,000 procedures) than those treated in a hospital-based outpatient facility (5.4 per 1,000 procedures). In addition, the incidence of non-gastrointestinal adverse events (cardiopulmonary events and complications associated with the procedure) was 13.8 per 1,000 procedures. Rate for non-gastrointestinal events was significantly lower among patients treated at a physician-owned ASC (11.9 per 1,000 procedures) than among those receiving procedures at a hospital-based outpatient facility (15.7 per 1,000 procedures).

In sum, a comparison of the unadjusted rates for adverse events after outpatient colonoscopy across the two types of facilities indicates that before controlling for other confounding factors, patients treated at a physician-owned ASC had relatively lower rates for developing complications that resulted in an ED visit or hospitalization than those receiving treatments in a hospital-based outpatient facility. Except for serious gastrointestinal events, which shows no difference across two types of facilities, patients treated at a physician-owned ASC had significantly lower rates for same day transfer, other gastrointestinal events and other non-gastro-intestinal events. However, these rates are unadjusted measures. The results are likely to change after controlling for variables that may affect patient outcomes.

Results of Multivariate Analysis

This section presents the estimation results of three-level hierarchical generalized linear models. Separate models are estimated for the incidence of four types of adverse events: same day ED visit and/or hospitalization, serious gastrointestinal events that resulted in an ED visit or hospitalization within 30 days, other gastrointestinal events that resulted in an ED visit or hospitalization within 30 days, and other non-gastrointestinal events that resulted in an ED visit or hospitalization within 30 days. For each dependent variable, basic models are first fitted. Then, models that also include a propensity score constructed to adjust for physician selective investment in outpatient surgical facilities are estimated.

To recap the theoretical hypotheses discussed in Chapter 3, this study expects that patients treated at a physician-owned ASC had better outcomes (lower odds for adverse events after colonoscopy) than those receiving treatment at a hospital-based outpatient facility, with the assumption that patients are able to assess quality of care difference across locations of care. Additionally, the quality advantage associated with physician ownership would be stronger in competitive health care markets. In other words, the odds ratio for the interaction term of physician ownership and Herfindahl-Hirschman Index should be greater than one. On the other hand, if patients do not have the ability to assess the quality differences and if physician owners exploit this information void, patients treated at a physician-owned ASC would have higher odds for adverse events examined in this study.

Results for the same day ED visit and/or hospitalization measure.

Table 13 presents the results generated from the three-level hierarchical models with the incidence of same day ED visit and/or hospitalization as the dependent variable, with and without the propensity score adjustment for physician selective investment in outpatient surgical facilities. The results of the model with propensity score adjustment are similar to those of the basic model when it comes to patient factors and facility-level factors. But the results for market-level factors are greatly different, and a few variables that are insignificant in the basic model become significant in the model with propensity score. Therefore, the results for the basic model plus propensity score are reported.

For same day ED visit and/or hospitalization, patients treated at a physician-owned ASC and those at a hospital-based outpatient facility had comparable outcomes. In the adjusted model, the variable physician ownership yielded an odds ratio of 0.95, which is not statistically significant. The competition level in the local health care market did not have significant influence over patient outcomes. The estimated odds ratio of the interaction term of physician ownership and the Herfindahl-Hirschman Index was 2.20 and statistically insignificant (p=0.26).

The results of the multilevel analysis show that several patient characteristics affect patients' odds for same day ED visit and/or hospitalization. Compared with patients aged 18 through 49, patients in age group 50-64 had a significantly lower odds for same day ED visit and/or hospitalization (odds ratio, 0.64). But for patients aged between 75 and 84, the odds of experiencing same day ED visit and/or hospitalization was significantly higher than patients aged between 18 and 49 (odds ratio, 1.35). The odds for patients in the age group of age 85 and above was even higher (odd ratio, 2.36). The odds for a female patient to experience same day ED visit and/or hospitalization was significantly higher than that for a male patient (odds ratio, 1.11).

Table 13

Results of Multilevel Models for Same day ED Visit and/or Hospitalization (2005-2007)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Key Independent Variables		
Physician ownership	1.03 (0.72, 1.46)	0.95 (0.66, 1.35)
Physician ownership*HHI	1.21 (0.33, 4.49)	2.20 (0.56, 8.61)
Patient characteristics		
Patient age		
18-49 (reference)		
50-64	0.64 (0.57, 0.71)	0.64 (0.57, 0.71)
65-74	0.91 (0.78, 1.05)	0.91 (0.78, 1.05)
75-84	1.35 (1.16, 1.58)	1.35 (1.16, 1.58)
85 or greater	2.36 (1.92, 2.90)	2.36 (1.92, 2.90)
Patient gender		
Male (reference)		
Female	1.11 (1.03, 1.20)	1.11 (1.03, 1.20)
Patient race/ethnicity		
White (reference)		
Black	1.13 (0.92, 1.39)	1.13 (0.92, 1.39)
Hispanic	1.00 (0.88, 1.13)	1.00 (0.88, 1.13)
Other	0.55 (0.49, 0.62)	0.55 (0.49, 0.62)
Payer		
Medicare	1.05 (0.93, 1.19)	1.05 (0.93, 1.19)
Medicaid	1.49 (1.25, 1.78)	1.50 (1.26, 1.78)
Private insurance (reference)		
Self-pay	1.57 (1.18, 2.08)	1.58 (1.19, 2.09)
Other payer	0.87 (0.67, 1.12)	0.86 (0.67, 1.12)
Median household income quartile (ZIP code level)		
Lowest quartile of income	1.13 (0.98, 1.30)	1.14 (0.99, 1.31)
Second lowest quartile of income	0.99 (0.87, 1.12)	0.99 (0.87, 1.13)
Second highest quartile of income	1.12 (1.00, 1.26)	1.13 (1.01, 1.26)
Highest quartile of income (reference)		
Urban/rural location		

Table 13 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Metropolitan areas (>=1 million, reference)		
Metropolitan areas (<1 million)	0.78 (0.62, 0.99)	0.81 (0.64, 1.02)
Micropolitan areas	2.04 (1.31, 3.16)	2.00 (1.29, 3.12)
Non-urban areas	0.98 (0.55, 1.75)	1.01 (0.57, 1.79)
Charlson Comorbidity Index	1.27 (1.25, 1.29)	1.27 (1.25, 1.29)
# of previous ED visits and hospitalizations	1.20 (1.17, 1.23)	1.20 (1.17, 1.23)
Colonoscopy type		
Diagnostic colonoscopy (reference)		
Colonoscopy and biopsy	1.04 (0.94, 1.15)	1.04 (0.94, 1.15)
Lesion removal colonoscopy	1.06 (0.96, 1.17)	1.06 (0.96, 1.17)
Organizational characteristics		
Facility colonoscopy volume group		
30-430 cases per year (reference)		
431-1333 cases per year	0.63 (0.49, 0.81)	0.63 (0.49, 0.81)
>= 1334 cases per year	0.66 (0.49, 0.88)	0.66 (0.49, 0.88)
Specialization rate	0.62 (0.10, 4.07)	0.53 (0.08, 3.50)
Specialization rate squared	1.05 (0.14, 7.70)	1.24 (0.17, 9.23)
Market characteristics		
Herfindahl-Hirschman Index (HHI)	0.28 (0.10, 0.79)	35.48 (2.01, 625.17)
HMO penetration rate	1.46 (0.63, 3.34)	1.11 (0.48, 2.59)
PPO penetration rate	1.80 (0.85, 3.78)	1.01 (0.45, 2.28)
# of gastroenterologists per 100,000	1.11 (0.95, 1.31)	0.57 (0.39, 0.85)
# of primary care physicians per 100,000	1.00 (0.99, 1.01)	1.02 (1.00, 1.03)
# of general surgeons per 100,000	0.98 (0.93, 1.04)	1.18 (1.05, 1.33)
Log-transformed population size	0.90 (0.75, 1.08)	1.45 (1.05, 2.00)
% of the population above age 65	0.05 (<0.001, 144.93)	0.06 (<0.001, 193.13)

Table 13 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
% of the population below age 65 without health insurance	0.07 (0.00, 2.47)	0.10 (0.00, 3.61)
Year dummies		
Year 2005 (reference)		
Year 2006	1.16 (1.03, 1.31)	1.16 (1.03, 1.31)
Year 2007	1.16 (1.02, 1.31)	1.13 (0.99, 1.28)
Propensity score		>999.99 (42.62, >999.99)
# of Observations	1,278,886	1,278,886
-2 Res Log Pseudo-Likelihood	11,932,011	11,935,483

Compared to patients covered by private health insurance, Medicaid and self-pay patients had a significantly higher odds of experiencing same day ED visit and/or hospitalization (odds ratios, 1.50 and 1.58, respectively). Patients with second highest quartile of income had significantly higher odds for same day ED visit and/or hospitalization than patients with highest quartile of income (odd ratio, 1.13). Patients from micropolitan areas had significantly higher odds of experiencing same day ED visit and/or hospitalization than patients from large metropolitan areas with more than 1 million residents (odds ratio, 2.00). Increasing number of comorbid conditions and ED visits and hospitalizations within 6 months prior to the colonoscopy procedure were both associated with significantly higher odds for same day ED visit and/or hospitalization (odds ratios, 1.27 and 1.20, respectively). Colonoscopy procedures with biopsy or lesion removal were not linked to elevated odds for same day ED visit and/or hospitalization.

At the facility level, higher facility volume was associated with lower odds for same day ED visit and/or hospitalization. Specifically, the odds of experiencing same day ED visit and/or hospitalization were significantly lower for patients treated at a facility with second and third tertile colonoscopy volume (431-1333 cases per year and >=1334 cases per year) compared to those treated at a facility with a first tertile volume (30-430 cases per year, odds ratios, 0.63 and 0.66, respectively). Both specialization rate and its squared form were not significant.

Some market characteristics were found to be associated with patients' odds of same day ED visit and/or hospitalization. Higher Herfindahl-Hirschman Index (HHI), i.e., lower competition level in the market was associated with significantly higher odds of same day ED visit and/or hospitalization. Greater number of gastroenterologists per 100,000 population was associated with lower odds of same day ED visit and/or hospitalization while greater number of primary care physicians per 100,000 population and greater number of general surgeons were associated with greater odds of same day ED visit and/or hospitalization. Another market factor, population size, was associated with an increase in the odds for same day ED visit and/or hospitalization. The year dummy 2006 was significant in the model. This means that on average, the odds of experiencing same day ED visit and/or hospitalization were higher in 2006 than in 2005.

Results for 30-day serious gastrointestinal events resulting in ED visit or hospitalization.

As with the same day ED visit and/or hospitalization measure, the model of 30-day serious gastrointestinal events with propensity score adjustment results in different estimation for some market-level factors while that for other factors is very similar to the results from the model without propensity score adjustment (Table 14). Therefore, only results based on the model with propensity score adjustment are reported below.

Table 14

Results of Multilevel Models for Serious Gastrointestinal Events within 30 Days Resulting in ED Visit or Hospitalization (2005-2007)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Key Independent Variables		
Physician ownership	1.62 (1.33, 1.99)	1.62 (1.32, 1.98)
Physician ownership*HHI	0.57 (0.27, 1.19)	0.59 (0.27, 1.29)
Patient characteristics		
Patient age		
18-49 (reference)		
50-64	0.46 (0.39, 0.54)	0.46 (0.39, 0.54)
65-74	0.75 (0.61, 0.92)	0.75 (0.61, 0.92)
75-84	0.98 (0.79, 1.21)	0.98 (0.79, 1.21)
85 or greater	1.30 (0.95, 1.77)	1.30 (0.95, 1.77)
Patient gender		
Male (reference)		
Female	1.39 (1.24, 1.55)	1.39 (1.24, 1.55)
Patient race/ethnicity		
White (reference)		
Black	1.01 (0.77, 1.33)	1.01 (0.77, 1.33)
Hispanic	1.22 (1.04, 1.42)	1.22 (1.04, 1.42)
Other	0.50 (0.42, 0.60)	0.50 (0.42, 0.60)
Payer		
Medicare	1.06 (0.90, 1.26)	1.06 (0.90, 1.26)
Medicaid	1.42 (1.11, 1.81)	1.42 (1.12, 1.82)
Private insurance (reference)		
Self-pay	0.92 (0.54, 1.58)	0.92 (0.54, 1.58)
Other payer	1.27 (0.96, 1.67)	1.26 (0.95, 1.67)
Median household income quartile (ZIP code level)		
Lowest quartile of income	1.12 (0.93, 1.35)	1.12 (0.93, 1.35)
Second lowest quartile of income	1.13 (0.96, 1.33)	1.13 (0.96, 1.34)
Second highest quartile of income	1.11 (0.95, 1.29)	1.11 (0.95, 1.29)
Highest quartile of income (reference)		

Table 14 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Urban/rural location		
Metropolitan areas (>=1 million, reference)		
Metropolitan areas (<1 million)	0.97 (0.80, 1.17)	0.97 (0.80, 1.18)
Micropolitan areas	1.50 (0.97, 2.31)	1.49 (0.96, 2.31)
Non-urban areas	1.24 (0.69, 2.20)	1.24 (0.70, 2.20)
Charlson Comorbidity Index	1.37 (1.34, 1.40)	1.37 (1.34, 1.40)
# of previous ED visits and hospitalizations	1.18 (1.14, 1.21)	1.18 (1.14, 1.21)
Colonoscopy type		
Diagnostic colonoscopy (reference)		
Colonoscopy and biopsy	1.49 (1.31, 1.71)	1.49 (1.31, 1.71)
Lesion removal colonoscopy	1.44 (1.26, 1.65)	1.44 (1.26, 1.65)
Organizational characteristics		
Facility colonoscopy volume group		
30-430 cases per year (reference)		
431-1333 cases per year	0.88 (0.69, 1.13)	0.88 (0.69, 1.13)
>= 1334 cases per year	0.74 (0.58, 0.96)	0.74 (0.58, 0.96)
Specialization rate	1.70 (0.45, 6.47)	1.68 (0.44, 6.42)
Specialization rate squared	0.41 (0.11, 1.48)	0.42 (0.12, 1.50)
Market characteristics		
Herfindahl-Hirschman Index (HHI)	1.86 (0.92, 3.77)	2.63 (0.26, 26.72)
HMO penetration rate	1.49 (0.60, 3.69)	1.47 (0.59, 3.65)
PPO penetration rate	1.00 (0.40, 2.51)	0.96 (0.37, 2.49)
# of gastroenterologists per 100,000	1.00 (0.89, 1.12)	0.95 (0.68, 1.33)
# of primary care physicians per 100,000	1.00 (0.99, 1.01)	1.00 (0.99, 1.02)
# of general surgeons per 100,000	0.98 (0.94, 1.02)	0.99 (0.90, 1.10)
Log-transformed population size	1.09 (0.97, 1.23)	1.13 (0.88, 1.45)
% of the population above age 65	0.58 (0.00, 125.20)	0.59 (0.00, 128.10)
% of the population below age 65 without health insurance	0.31 (0.04, 2.63)	0.32 (0.04, 2.77)

Table 14 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Year dummies		
Year 2005 (reference)		
Year 2006	1.14 (0.98, 1.33)	1.14 (0.98, 1.33)
Year 2007	1.05 (0.91, 1.22)	1.05 (0.90, 1.22)
Propensity score		1.83 (0.04, 89.89)
# of Observations	1,278,886	1,278,886
-2 Res Log Pseudo-Likelihood	12,764,267	12,764,218

In the adjusted model, patients treated at a physician-owned ASC had significantly higher odds of experiencing serious gastrointestinal events within 30 days of their procedure that resulted in an ED visit or hospitalization than patients treated at a hospital-based outpatient facility (odds ratio, 1.61). The estimated odds ratio for the interaction term between physician ownership and competition in the market was less than one but not statistically significant at $p<0.05$ level.

Similar to the model of same day transfer to ED or hospital, female patients had higher odds than male patients of experiencing serious gastrointestinal events within 30 days. Medicaid patients had significantly higher odds for serious gastrointestinal events than privately insured patients. Charlson Comorbidity Index and the number of ED visits and hospitalizations within 6 months prior to the colonoscopy procedure were associated with significantly higher odds for serious gastrointestinal events. Among organizational factors, higher facility volume was linked to reduced odds for serious gastrointestinal events.

Different from the model of same day ED visit and/or hospitalization, patients in age groups 50-64 and 65-74 had significantly lower odds for serious adverse events within 30 days of colonoscopy than those in age group 18-49. Hispanic patients had significantly higher odds for serious gastrointestinal events than non-Hispanic white patients. In addition, receiving colonoscopy with biopsy or lesion removal were associated increased odds for serious gastrointestinal events. At the market level, no factors were statistically significant.

Results for 30-day other gastrointestinal events resulting in ED visit or hospitalization.

As with the two prior models, the results reported here are for the model with propensity score adjustment. The adjusted odds for other gastrointestinal events was significantly higher for patients treated at a physician-owned ASC compared to those treated at a hospital-based outpatient facility (Table 15). Again, the effect of physician ownership on quality of care was not influenced by the competition level in the market.

Similar to the prior model with the measure of same day transfer to ED or hospital, older patients aged 75 or above, being female, covered by Medicaid, being self-pay, having higher Charlson Comorbidity Index and larger number of ED visits and hospitalizations in the 6 months prior to the colonoscopy were associated with a higher adjusted odds for other gastrointestinal events.

Different from the model of same day transfer to ED or hospital, Hispanic patients had lower odds of having other gastrointestinal events compared with non-Hispanic white patients. Being covered by Medicare or other payers was associated with elevated odds of other gastrointestinal events compared with privately insured patients. Residing in metropolitan areas with less than 1 million population was associated with lowered odds of other gastrointestinal events. Certain types of procedure, including colonoscopy with biopsy and colonoscopy with lesion removal were associated with higher odds for other gastrointestinal events. This is

Table 15

Results of Multilevel Models for Other Gastrointestinal Events within 30 Days Resulting in ED visit or hospitalization (2005-2007)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Key Independent Variables		
Physician ownership	1.26 (1.14, 1.38)	1.27 (1.15, 1.40)
Physician ownership*HHI	1.08 (0.77, 1.50)	1.00 (0.70, 1.42)
Patient characteristics		
Patient age		
18-49 (reference)		
50-64	0.62 (0.57, 0.67)	0.61 (0.57, 0.67)
65-74	0.91 (0.82, 1.00)	0.91 (0.82, 1.00)
75-84	1.43 (1.29, 1.58)	1.43 (1.29, 1.58)
85 or greater	2.49 (2.19, 2.83)	2.49 (2.19, 2.83)
Patient gender		
Male (reference)		
Female	1.10 (1.05, 1.16)	1.10 (1.05, 1.16)
Patient race/ethnicity		
White (reference)		
Black	0.98 (0.87, 1.11)	0.98 (0.86, 1.11)
Hispanic	0.90 (0.83, 0.97)	0.90 (0.83, 0.97)
Other	0.50 (0.46, 0.54)	0.50 (0.46, 0.54)
Payer		
Medicare	1.22 (1.13, 1.32)	1.22 (1.13, 1.32)
Medicaid	1.14 (1.01, 1.30)	1.14 (1.01, 1.30)
Private insurance (reference)		
Self-pay	1.37 (1.11, 1.68)	1.36 (1.11, 1.68)
Other payer	1.23 (1.07, 1.40)	1.23 (1.07, 1.40)
Median household income quartile (ZIP code level)		
Lowest quartile of income	1.06 (0.97, 1.15)	1.06 (0.97, 1.15)
Second lowest quartile of income	0.98 (0.91, 1.06)	0.98 (0.91, 1.06)
Second highest quartile of income	1.00 (0.93, 1.07)	0.99 (0.93, 1.06)
Highest quartile of income (reference)		

Table 15 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Urban/rural location		
Metropolitan areas (>=1 million, reference)		
Metropolitan areas (<1 million)	0.92 (0.84, 1.01)	0.91 (0.84, 1.00)
Micropolitan areas	1.23 (1.00, 1.51)	1.24 (1.01, 1.52)
Non-urban areas	0.91 (0.68, 1.20)	0.91 (0.69, 1.20)
Charlson Comorbidity Index	1.50 (1.49, 1.51)	1.50 (1.49, 1.51)
# of previous ED visits and hospitalizations	1.24 (1.23, 1.26)	1.24 (1.23, 1.26)
Colonoscopy type		
Diagnostic colonoscopy (reference)		
Colonoscopy and biopsy	1.31 (1.23, 1.39)	1.31 (1.23, 1.39)
Lesion removal colonoscopy	1.15 (1.08, 1.23)	1.15 (1.08, 1.23)
Organizational characteristics		
Facility colonoscopy volume group		
30-430 cases per year (reference)		
431-1333 cases per year	0.91 (0.81, 1.03)	0.92 (0.82, 1.03)
>= 1334 cases per year	0.90 (0.80, 1.02)	0.90 (0.80, 1.02)
Specialization rate	1.37 (0.75, 2.53)	1.40 (0.76, 2.57)
Specialization rate squared	0.49 (0.27, 0.88)	0.48 (0.27, 0.86)
Market characteristics		
Herfindahl-Hirschman Index (HHI)	1.36 (0.98, 1.89)	0.69 (0.21, 2.31)
HMO penetration rate	0.81 (0.54, 1.21)	0.83 (0.56, 1.25)
PPO penetration rate	0.79 (0.52, 1.19)	0.84 (0.55, 1.29)
# of gastroenterologists per 100,000	1.02 (0.97, 1.08)	1.13 (0.95, 1.34)
# of primary care physicians per 100,000	1.00 (0.99, 1.00)	0.99 (0.99, 1.00)
# of general surgeons per 100,000	1.01 (0.99, 1.03)	0.98 (0.93, 1.03)
Log-transformed population size	1.04 (0.99, 1.10)	0.97 (0.86, 1.11)
% of the population above age 65	0.59 (0.05, 6.90)	0.55 (0.05, 6.47)
% of the population below age 65 without health insurance	0.12 (0.04, 0.30)	0.11 (0.04, 0.28)
Year dummies		
Year 2005 (reference)		

Table 15 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Year 2006	0.98 (0.91, 1.05)	0.98 (0.91, 1.05)
Year 2007	1.01 (0.95, 1.08)	1.01 (0.95, 1.08)
Propensity score		0.31 (0.04, 2.30)
# of Observations	1,278,886	1,278,886
-2 Res Log Pseudo-Likelihood	10,693,596	10,693,645

consistent with the model of serious gastrointestinal event. At the facility level, specialization rate squared was significantly associated with lower odds for other gastrointestinal events. But other facility-level variables were not significant. At the market level, the number of primary care physicians per 100,000 population and the uninsured rate were associated with lower odds for other gastrointestinal events.

Results for 30-day non-gastrointestinal events resulting in ED visit or hospitalization.

As with other models, the results discussed below relate to the model with propensity score adjustment. For the adjusted model of other non-gastrointestinal events resulting in 30-day ED visit or hospitalization, there was no significant difference in the odds among patients treated at a physician-owned ASC and those treated at a hospital-based outpatient facility (Table 16). In addition, the effect of physician ownership on quality of care was not influenced by the competition level in the market.

Similar to the prior model of same day transfer to ED or hospital, at the patient level, many factors influenced the adjusted odds for other non-gastrointestinal events. For example, the odds of experiencing other non-gastrointestinal events among patients in age group 50-64 was

Table 16

Results of Multilevel Models for Non-gastrointestinal Events within 30 Days Resulting in ED visit or hospitalization (2005-2007)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Key Independent Variables		
Physician ownership	1.05 (0.99, 1.12)	1.05 (0.99, 1.11)
Physician ownership*HHI	0.95 (0.77, 1.17)	1.00 (0.80, 1.24)
Patient characteristics		
Patient age		
18-49 (reference)		
50-64	0.92 (0.87, 0.97)	0.92 (0.87, 0.97)
65-74	1.51 (1.41, 1.61)	1.51 (1.41, 1.61)
75-84	2.41 (2.25, 2.57)	2.41 (2.25, 2.57)
85 or greater	3.89 (3.58, 4.23)	3.89 (3.58, 4.24)
Patient gender		
Male (reference)		
Female	0.92 (0.89, 0.95)	0.92 (0.89, 0.95)
Patient race/ethnicity		
White (reference)		
Black	1.25 (1.16, 1.34)	1.25 (1.16, 1.34)
Hispanic	0.98 (0.94, 1.03)	0.98 (0.94, 1.03)
Other	0.51 (0.48, 0.54)	0.51 (0.48, 0.54)
Payer		
Medicare	1.34 (1.28, 1.40)	1.34 (1.28, 1.40)
Medicaid	1.58 (1.47, 1.70)	1.58 (1.47, 1.70)
Private insurance (reference)		
Self-pay	1.44 (1.26, 1.64)	1.44 (1.26, 1.64)
Other payer	1.32 (1.22, 1.44)	1.32 (1.22, 1.44)
Median household income quartile (ZIP code level)		
Lowest quartile of income	1.15 (1.09, 1.21)	1.15 (1.09, 1.21)
Second lowest quartile of income	1.13 (1.08, 1.18)	1.13 (1.08, 1.18)
Second highest quartile of income	1.07 (1.03, 1.12)	1.07 (1.03, 1.12)

Table 16 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Metropolitan areas (>=1 million, reference)		
Metropolitan areas (<1 million)	1.02 (0.97, 1.08)	1.03 (0.97, 1.08)
Micropolitan areas	0.99 (0.87, 1.13)	0.98 (0.86, 1.12)
Non-urban areas	1.08 (0.92, 1.28)	1.08 (0.92, 1.27)
Charlson Comorbidity Index	1.49 (1.48, 1.50)	1.49 (1.48, 1.50)
# of previous ED visits and hospitalizations	1.30 (1.28, 1.31)	1.30 (1.28, 1.31)
Colonoscopy type		
Diagnostic colonoscopy (reference)		
Colonoscopy and biopsy	1.16 (1.11, 1.20)	1.16 (1.11, 1.20)
Lesion removal colonoscopy	1.26 (1.21, 1.30)	1.26 (1.21, 1.30)
Organizational characteristics		
Facility colonoscopy volume group		
30-430 cases per year (reference)		
431-1333 cases per year	0.86 (0.81, 0.93)	0.86 (0.81, 0.93)
>= 1334 cases per year	0.82 (0.77, 0.88)	0.82 (0.76, 0.88)
Specialization rate	1.09 (0.75, 1.58)	1.07 (0.74, 1.56)
Specialization rate squared	0.76 (0.53, 1.09)	0.78 (0.54, 1.11)
Market characteristics		
Herfindahl-Hirschman Index (HHI)	1.42 (1.15, 1.74)	2.29 (1.14, 4.57)
HMO penetration rate	1.08 (0.84, 1.39)	1.06 (0.82, 1.37)
PPO penetration rate	1.03 (0.80, 1.34)	0.99 (0.76, 1.29)
# of gastroenterologists per 100,000	1.02 (0.99, 1.05)	0.95 (0.86, 1.05)
# of primary care physicians per 100,000	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
# of general surgeons per 100,000	1.00 (0.99, 1.01)	1.02 (0.99, 1.05)
Log-transformed population size	1.06 (1.03, 1.10)	1.11 (1.03, 1.20)
% of the population above age 65	1.34 (0.30, 6.04)	1.38 (0.31, 6.22)
% of the population below age 65 without health insurance	0.46 (0.26, 0.84)	0.49 (0.27, 0.88)
Year dummies		
Year 2005 (reference)		

Table 16 (continued)

Variable	Basic Model	Basic Model Plus Propensity Score Adjusting for Market Selection
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Year 2006	0.95 (0.91, 0.99)	0.95 (0.91, 0.99)
Year 2007	0.96 (0.92, 1.00)	0.96 (0.92, 1.00)
Propensity score		2.28 (0.73, 7.15)
# of Observations	1,278,886	1,278,886
-2 Res Log Pseudo-Likelihood	9,500,756	9,500,846

significantly lower than among those in age group 18-49. Being 75 or older was associated with elevated odds of experiencing other non-gastrointestinal events. Medicaid and self-pay patients had higher odds of experiencing other non-gastrointestinal events compared with privately insured patients. Patients from ZIP codes with second highest income quartile had elevated odds for other non-gastrointestinal events compared with those from the highest income quartile. Having higher Charlson Comorbidity Index and a larger number of ED visits and hospitalizations in the 6 months prior to the colonoscopy were associated with higher odds for other non-gastrointestinal event. At the facility level, higher facility volume was associated with lower odds for other non-gastrointestinal event. At the market level, higher Herfindahl-Hirschman Index (HHI), i.e., lower competition level in the market was associated with significantly higher odds of other non-gastrointestinal events. The log-transformed population size was associated with elevated odds for other non-gastrointestinal events. The year dummy 2006 was statistically significant, meaning the odds for other non-gastrointestinal events were higher in 2006 than in 2005.

Different from the model of same day transfer to ED or hospital, the odds of having other non-gastrointestinal events was significantly higher among patients aged 65-74 years, compared with patients aged 18-49. Female gender and being African-American were associated with reduced odds for other non-gastrointestinal events. Being covered by Medicare and other payer were associated with elevated odds of other non-gastrointestinal events. This pattern was seen in the model of other gastrointestinal events. Patients from the lowest and second lowest income quartiles had elevated odds of other non-gastrointestinal events. Receiving colonoscopy with biopsy or lesion removal was associated with higher odds for other non-gastrointestinal event. At the market level, the uninsured rate and the year dummy 2007 were associated with lower odds of non-gastrointestinal events.

In sum, as presented in Table 17, after accounting for patient, organizational, and market characteristics, nested data structures, and physician selective investment, the odds for same day ED visit and/or hospitalization and other non-gastrointestinal events within 30 days of outpatient colonoscopy were not different among patients treated at a physician-owned ASC and those treated at a hospital-based outpatient facility. However, according to the adjusted models, patients treated at a physician-owned ASC had significantly higher odds for serious gastrointestinal events and other gastrointestinal events within 30 days of outpatient colonoscopy, in comparison to those treated at a hospital-based outpatient facility. In all the four adjusted models, the interaction term between physician ownership and competition level in the market was not statistically significant.

The differences in odds for adverse events after colonoscopy are illustrated more directly in Table 18, which presents the adjusted rate (incidence per 1,000 procedures) for different types of adverse events, stratified by location of care. After accounting for patient-, facility-, market-level factors, the nested data structures, and physician selective investment, the adjusted rates for same day transfer (2.82 per 1,000 procedures vs. 2.98 per 1,000 procedures) and the adjusted rate

Table 17

The Effects of Physician Ownership and Its Interaction Term with HHI on Quality of Outpatient Colonoscopy

Variable	Same day ED visit or Hospitalization	30-day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization
Physician ownership	0.95 (0.66, 1.35)	1.62 (1.32, 1.98)***	1.27 (1.15, 1.40)***	1.05 (0.99, 1.11)
Physician ownership*HHI	2.20 (0.56, 8.61)	0.59 (0.27, 1.29)	1.00 (0.70, 1.42)	1.00 (0.80, 1.24)

Note: The results are from basic models plus propensity score adjusting for market selection. Odds ratios are reported with 95% Confidence Intervals in brackets. ***Significant at the p<.01 level.

Table 18

Adjusted Rate per 1,000 procedures for an Adverse Event by Location of Care

Variable	Same day ED visit or Hospitalization Rate (95% CI)	30-Day Serious Gastrointestinal Event Resulting in ED Visit or Hospitalization Rate (95% CI)	30-Day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization Rate (95% CI)	30-Day Other Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization Rate (95% CI)
Physician-owned ASC	2.82 (2.07, 3.84)	1.78 (1.34, 2.36)***	5.94 (5.21, 6.77)***	16.78 (15.49, 18.18)
Hospital-based outpatient facility	2.98 (2.15, 4.13)	1.10 (0.82, 1.48)	4.69 (4.09, 5.37)	16.05 (14.79, 17.42)

Note: The results are from basic models plus propensity score adjusting for market selection. Adjusted rate is reported with 95% Confidence Intervals in brackets. ***Significant at the p<.01 level.

for other non-gastrointestinal events within 30 days (16.78 per 1,000 procedures vs. 16.05 per 1,000 procedures) are not significantly different across physician-owned ASCs and hospital-based outpatient facilities. But for the other two outcome measures, significant differences exist across location of care. The rate for serious gastrointestinal events was 1.78 per 1,000 procedures if the patient received the procedure at a physician-owned ASC while the number was 1.10 per 1,000 procedures if the patient was treated at a hospital-based outpatient facility. Similarly, the rate for other gastrointestinal events was 5.94 per 1,000 procedures if the patient received the procedure at a physician-owned ASC and the number was 4.69 per 1,000 procedures if the patient was treated at a hospital-based outpatient facility.

Sensitivity Analyses

Physicians' decision to invest in an outpatient surgical facility may be influenced by the characteristics of the market where the facility is located. Therefore, basic models plus a propensity score adjusting for physician selective investment in outpatient surgical facilities were presented as the main analysis in the sections above. However, referral of patients to physician-owned ASCs or hospital-based outpatient facilities may also be a nonrandom process. Physician owners may select relatively healthier and better insured patients (those covered by private insurance and Medicare) for ASCs in which they invest. The main analysis is thus supplemented with a sensitivity analysis to determine whether the direction and statistical significance of the relationships vary when a different propensity score that adjusts for patient selection is used. As discussed in the last chapter, all patient-level factors are used to construct the propensity score.

Two series of models, one with a propensity score adjusting for physician selective investment and another for patient selection, for the four dependent variables were compared. For most models, the findings for the key independent variables were consistent across the two methods of propensity score adjustment. One exception is that the model with a propensity score adjusting for physician selective investment did not show a significant relationship between physician ownership and the occurrence of other non-gastrointestinal events while the model with a propensity score adjusting for patient selection did (Table 19).

While the estimation of facility-level factors remained largely unchanged in the two models with different propensity scores, differences were found among estimates of patient-level factors, market-level factors, and sometimes year dummy variables (data not shown). Substituting the propensity score adjusting for physician selective investment with the one that adjusts for patient selection led to some market factors (such as Herfindahl-Hirschman Index (HHI), the number of primary care physicians per 100,000 population, the number of general surgeons per 100,000 population, the log-transformed population size, and the uninsured rate) becoming insignificant. In addition, some patient factors (such as being African American, being covered by Medicare, self-pay, or being covered by other payer, and urban/rural location variables) gained statistical significance. The interpretation of control variables thus appears to be sensitive to the propensity score method used.

A second sensitivity analysis focused on whether the direction and statistical significance of key independent variables varied when a lagged quality indicator was included (Table 20). The lagged quality indicator was operationalized as the unadjusted adverse event rate (per 1,000 procedures) for a given facility in the prior year. Because the lagged quality indictor was missing for all colonoscopy cases performed in 2005, only 819,126 cases were included in the analysis for the years 2006 and 2007. Table 20 presents the results of the model with a propensity score adjusting for physician selective investment and a model with the lagged quality indicator added. The direction and statistical significance of the odds ratios for most key independent variables

Table 19

Sensitivity Analysis Comparing Two Models with Different Propensity Score Adjustments

Dependent Variable	Key Independent Variable	Basic Model Plus Propensity Score Adjusting for Market Selection	Basic Model Plus Propensity Score Adjusting for Patient Selection[a]
		Odds Ratio (95% CI)	Odds Ratio (95% CI)
Same Day ED Visit or Hospitalization	Physician ownership	0.95 (0.66, 1.35)	1.05 (0.74, 1.49)
	Physician ownership*HHI	2.20 (0.56, 8.61)	1.14 (0.31, 4.23)
	Propensity score	>999.99 (42.62, >999.99)	0.00 (<0.001, 0.01)
	-2 Res Log Pseudo-Likelihood	11,935,483	11,957,307
30-Day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	Physician ownership	1.62 (1.32, 1.98)	1.66 (1.35, 2.03)
	Physician ownership*HHI	0.59 (0.27, 1.29)	0.56 (0.27, 1.16)
	Propensity score	1.83 (0.04, 89.89)	<0.001 (<0.001, 0.00)
	-2 Res Log Pseudo-Likelihood	12,764,218	18,831
30-Day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	Physician ownership	1.27 (1.15, 1.40)	1.29 (1.17, 1.41)
	Physician ownership*HHI	1.00 (0.70, 1.42)	1.07 (0.77, 1.49)
	Propensity score	0.31 (0.04, 2.30)	<0.001 (<0.001, <0.001)
	-2 Res Log Pseudo-Likelihood	10,693,645	10,781,797
30-Day Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization	Physician ownership	1.05 (0.99, 1.11)	1.08 (1.01, 1.14)
	Physician ownership*HHI	1.00 (0.80, 1.24)	0.95 (0.77, 1.16)
	Propensity score	2.28 (0.73, 7.15)	<0.001 (<0.001, <0.001)
	-2 Res Log Pseudo-Likelihood	9,500,846	9,567,860

[a]The procedure GLIMMIX did not converge for the model examining 30-day serious gastrointestinal events resulting in ED visit or hospitalization. Therefore, the procedure logistic was used instead for this outcome measure.

Table 20

Sensitivity Analysis Comparing Models With and Without the Lagged Quality Indicator

Dependent Variable	Key Independent Variable	Model with Propensity Score Adjusting for Market Selection	Model with Propensity Score Adjusting for Market Selection and Lagged Quality[a]
		Odds Ratio (95% CI)	Odds Ratio (95% CI)
Same Day ED Visit or Hospitalization	Physician ownership	0.95 (0.66, 1.35)	0.92 (0.77, 1.09)
	Physician ownership*HHI	2.20 (0.56, 8.61)	1.23 (0.60, 2.50)
	Propensity score	>999.99 (42.62, >999.99)	31.46 (1.36, 727.98)
	Lagged quality	-	1.01 (1.01, 1.01)
	-2 Res Log Pseudo-Likelihood	11,935,483	23,959
30-Day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	Physician ownership	1.62 (1.32, 1.98)	1.55 (1.17, 2.04)
	Physician ownership*HHI	0.59 (0.27, 1.29)	0.73 (0.25, 2.12)
	Propensity score	1.83 (0.04, 89.89)	1.19 (0.01, 194.23)
	Lagged quality	-	1.01 (0.96, 1.06)
	-2 Res Log Pseudo-Likelihood	12,764,218	8,124,484
30-Day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	Physician ownership	1.27 (1.15, 1.40)	1.23 (1.09, 1.39)
	Physician ownership*HHI	1.00 (0.70, 1.42)	1.01 (0.65, 1.57)
	Propensity score	0.31 (0.04, 2.30)	0.20 (0.01, 2.80)
	Lagged quality	-	1.02 (1.01, 1.03)
	-2 Res Log Pseudo-Likelihood	10,693,645	6,864,247
30-Day Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization	Physician ownership	1.05 (0.99, 1.11)	1.08 (1.00, 1.16)
	Physician ownership*HHI	1.00 (0.80, 1.24)	1.14 (0.88, 1.49)
	Propensity score	2.28 (0.73, 7.15)	5.07 (1.30, 19.67)
	Lagged quality	-	1.01 (1.01, 1.01)
	-2 Res Log Pseudo-Likelihood	9,500,846	6,106,330

[a] The procedure GLIMMIX did not converge for the model examining same day ED visit or hospitalization. Therefore, the procedure logistic was used instead for this outcome measure.

were similar in both models for all 4 dependent variables with one exception. The relationship between physician ownership and the incidence of other non-gastrointestinal events became significant after including the lagged quality indicator with individuals treated in these facilities having higher odds of 30-day other non-GI events resulting in an ED visit or hospitalization relative to individuals treated in hospital-owned outpatient facilities. The lagged quality indicator had a positive and statistically significant effect in three of the models. The odds ratios ranged from 1.01 to 1.02, which means a one unit increase in the rate of a specific type of adverse events in the previous year increased the odds of patient having a particular adverse event by 1% to 2%. The estimation results support the idea that quality of care is autocorrelated, i.e., the value of the measure in the previous period can affect the value in the following period.

In sum, the results from the sensitivity analysis were generally consistent with those from the main analysis, suggesting the findings are robust to changes in propensity score adjustment approach and to the inclusion of a lagged quality indicator.

Summary

This chapter presented the results of descriptive and multivariate analyses. Findings of this study indicate that physician-owned ASCs and hospital-based outpatient facilities served different patient population, had different organizational characteristics, and were located in health care markets with different characteristics. When examining the unadjusted occurrence of adverse events, physician-owned ASCs had lower incidence of these events relative to hospital-based outpatient facilities. But when controlling for variables at the patient, facility, and market-levels, nested data structures, and potential physician selective investment in outpatient surgical facilities, the results suggested that physician-owned ASCs had similar or worse performance compared to hospital-based outpatient facilities. The main analysis suggested poorer performance for physician owned facilities on two indicators (30-day serious gastrointestinal events and 30-day other gastrointestinal events, both of which resulted in ED visit or hospitalization). Sensitivity analysis found similar results for these two measures and also suggested poorer performance for the 30-day non- gastrointestinal events that resulted in ED visit or hospitalization among physician owned facilities. The interaction term between physician ownership and competition level in the market was not statistically significant.

These results lend support for Hypothesis 3, but not for Hypothesis 1 and Hypothesis 2. This implies that physicians may be taking advantage of information gaps faced by patients and providing lower quality colonoscopy care in their outpatient facilities. The next chapter will provide a more detailed summary of research findings. It will also discuss some of the managerial, policy, and research implications of this study.

Chapter 6: Discussion

Physicians' investment in ASCs (along with their investment in specialty hospitals, diagnostic imaging centers and other health care facilities) has attracted the attention of both policy makers and researchers for a number of years. Physician-owned ASCs provide largely identical services to hospital-based outpatient facilities. A number of studies report that physician ownership is associated with patient "cherry picking" and overutilization of services due to self-referral (Gabel et al., 2008; Hollingsworth et al., 2010b; Strope et al., 2009). However, limited empirical evidence exists on the potential relationship between physician ownership and patient quality of care. Some have argued that physician-owned ASCs provide better quality of care and their patients should have better outcomes because physician ownership may enhance physicians' accountability (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009; Office of Inspector General, 1999). By contrast, others contend that quality of care may be compromised at physician owned facilities because physician ownership creates financial conflicts of interest (Mitchell & Sass, 1995; Mitchell, 2010; O'Neill & Hartz, 2012). A small number of studies have compared patient outcomes in ASCs (combining physician-owned and non-physician-owned facilities) to those in hospital-based outpatient facilities, but these studies have yielded mixed results (Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008; Fleisher, Pasternak, Herbert, & Anderson, 2004; Hollingsworth et al., 2012).

This study examined the relationship between physician ownership and quality of care by comparing patient outcomes for outpatient colonoscopy in physician-owned ASCs versus those treated in hospital-based outpatient facilities, while controlling for factors at patient, organizational and market levels. Using a licensing requirement change that occurred in California due to a court decision, the study was able to identify ASCs with whole or partial physician ownership. Procedure-related adverse events that developed after the procedure were used to measure patient outcomes. Four categories of adverse events were examined: same day ED visit and/or hospitalization, 30-day serious gastrointestinal events resulting in ED visit or hospitalization. 30-day other gastrointestinal events resulting in ED visit or hospitalization, and 30-day other non-gastrointestinal events resulting in ED visit or hospitalization. This chapter begins with a summary of the research findings. Then it reviews the limitation of the study, followed by a discussion of the implications of the study for theory, policy and practice, and future research. The last section concludes the study.

Summary

Findings of the descriptive analysis.

During the study period, physician-owned ASCs delivered slightly more than half of outpatient colonoscopy in California. Overall, outpatient colonoscopy patients were more likely to be age 50 or above, female, and non-Hispanic white, covered by Medicare or private insurance, from the top two income quartiles, living in metropolitan areas, and largely healthy. The composition of different types of outpatient colonoscopy procedures (diagnostic, with biopsy, and with lesion removal) furnished in physician-owned ASCs and hospital-based outpatient facilities were largely the same. However, there were significant differences among patients treated by physician-owned ASCs and those by hospital outpatient facilities. The former were less likely to be racial/ethnic minorities and Medicaid recipients. This is consistent with the finding of previous studies (Gabel et al., 2008; O'Sullivan, 2007). In addition, patients treated by physician-owned ASCs were more likely to be covered by Medicare or private insurance and come from more affluent neighborhood and metropolitan areas. They also had significantly lower Charlson Comorbidity Index and lower propensity to use medical services as measured by inpatient and emergency department service use in the six months before their colonoscopy.

At the organizational level, physician-owned ASCs on average had a significantly higher colonoscopy volume compared with hospital outpatient facilities. In addition, they had a significantly larger proportion of colonoscopy procedures compared with hospital-based outpatient facility. At the market level, there was a great variation as to the representation of physician-owned ASCs across different geographic areas. Health care markets (counties) with a low percentage of study observations that were represented by physician-owned ASC facilities rather than hospital-based outpatient facilities had lower levels of outpatient surgical care competition, a lower HMO penetration rate, lower gastroenterologists per 100,000 population, higher primary care physicians per 100,000 population, and higher general surgeons per 100,000 population. Such markets tended to have a smaller population size and higher percent of the population aged 65 or above.

The unadjusted incidence rates for adverse events that resulted in an ED visit or hospitalization within 30 days of outpatient colonoscopy were low. Physician-owned ASCs had lower rates of same day ED visit or hospitalization, 30-day other gastrointestinal events resulting in ED visit or hospitalization, and 30-day non-gastrointestinal events resulting in ED visit or hospitalization than hospital-based outpatient facilities. There was no difference in the rate of 30-

day serious gastrointestinal events resulting in ED visit or hospitalization across outpatient surgery settings.

Summary of multivariate analysis.

This study drew on agency theory as a conceptual framework to examine the association between physician ownership and quality of care. Patients treated at a physician-owned ASC were hypothesized to have better outcomes (lower rates of adverse events after colonoscopy) than those receiving treatment at a hospital-based outpatient facility, with the assumption that patients are able to assess quality of care difference across outpatient surgical facilities. In addition, the quality advantage associated with physician ownership was hypothesized to be stronger in more competitive health care markets. Alternatively, if patients do not have the ability to assess quality differences and if physician owners exploit this information void, patients treated at a physician-owned ASC were hypothesized to have higher rates of adverse events, holding other factors constant. To better isolate the relationship between physician ownership and outcomes of care, three-level generalized hierarchical linear models (GHLM) were used to control for confounding factors at patient, facility, and market levels.

The study found that after risk adjustment, colonoscopy patients treated at a physician-owned ASC had similar odds of experiencing same day ED visit or hospitalization and 30-day non-gastrointestinal events resulting in ED visit or hospitalization as those treated in a hospital-based outpatient facility. But the former had significantly higher odds of experiencing 30-day serious gastrointestinal events resulting in ED visit or hospitalization and 30-day other gastrointestinal events resulting in ED visit or hospitalization. This suggests that the odds of experiencing certain adverse events after outpatient colonoscopy vary by site of care, with physician-owned ASCs having similar or worse performance when compared to hospital-based outpatient facilities on the measures of colonoscopy quality of care examined in this study.

The study results do not support the hypotheses that physician ownership leads to better patient outcomes and that this effect is more prominent in relatively competitive health care markets. Instead, they lend support to the hypothesis that patients treated at physician-owned ASCs may have higher incidence of adverse events because they may not have the ability to assess quality differences across sites of care and physician owners may be exploiting this information void. While this variation in surgical quality across settings was statistically significant, it is important to note that the occurrence of these events tend to be very low, especially for same day ED visit or hospitalization and for 30-day serious gastrointestinal events that result in an ED visit or hospitalization.

The study also found several interesting associations between some control variables and quality measures (Table 21). Some factors had a consistent effect on the outcome measures examined in this study. For example, compared with being in the age group 18-49, being in the age group 50-64 was associated with lower odds for all outcome measures. By contrast, being aged 75 and above was associated with higher odds for three outcome measures: same day ED visit or hospitalization, 30-day other gastrointestinal events, and 30-day non-gastrointestinal events resulting in ED visit or hospitalization. Compared with privately insured patients, Medicaid patients were associated with higher odds for all four outcome measures while self-pay patients were associated with higher odds for the first, third and fourth quality measures. Increase in the Charlson Index or the number of ED visits or hospitalizations in the prior six months was associated with higher odds for all four quality measures. Receiving more invasive procedures (Colonoscopy and biopsy or Lesion removal colonoscopy) versus diagnostic colonoscopy was

Table 21

Summary of Significant Associations of Control Variables with Measures of Quality of Outpatient Colonoscopy

Variable	Same day ED visit or Hospitalization	30-day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization
Patient characteristics				
Patient age				
18-49 (reference)				
50-64	-	-	-	-
65-74		-	-	+
75-84	+		+	+
85 or greater	+		+	+
Patient gender				
Male (reference)				
Female	+	+	+	-
Patient race/ethnicity				
White (reference)				
Black				+
Hispanic		+	-	
Other	-	-	-	-
Payer				
Medicare			+	+
Medicaid	+	+	+	+
Private insurance (reference)				
Self-pay	+		+	+
Other payer			+	

Table 21 (continued)

Variable	Same day ED visit or Hospitalization	30-day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization
Median household income quartile (ZIP code level)				
Lowest quartile of income				+
Second lowest quartile of income				+
Second highest quartile of income	+			+
Highest quartile of income (reference)				
Urban/rural location				
Metropolitan areas (>=1 million, reference)				
Metropolitan areas (<1 million)			-	
Micropolitan areas	+		+	
Non-urban areas				
Charlson Comorbidity Index	+	+	+	+
# of previous ED visits and hospitalizations	+	+	+	+
Colonoscopy type				
Diagnostic colonoscopy (reference)				
Colonoscopy and biopsy		+	+	+
Lesion removal colonoscopy		+	+	+

Table 21 (continued)

Variable	Same day ED visit or Hospitalization	30-day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization
Organizational characteristics				
Facility colonoscopy volume group				
30-430 cases per year (reference)				
431-1333 cases per year	-			-
>= 1334 cases per year	-	-		-
Specialization rate				
Specialization rate squared			-	
Market characteristics				
Herfindahl-Hirschman Index (HHI)	+			+
HMO penetration rate				
PPO penetration rate				
# of gastroenterologists per 100,000	-			
# of primary care physicians per 100,000	+		-	
# of general surgeons per 100,000	+			
Log-transformed population size	+			+
% of the population above age 65				
% of the population below age 65 without health insurance			-	-
Year dummies				
Year 2005 (reference)				

Table 21 (continued)

Variable	Same day ED visit or Hospitalization	30-day Serious Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Gastrointestinal Events Resulting in ED Visit or Hospitalization	30-day Other Non-Gastrointestinal Events Resulting in ED Visit or Hospitalization
Year 2006	+			-
Year 2007				-

Note: +: implies a significant odds ratio greater than 1.00; -: implies a significant odds ratio that is less than 1.00. All relationships noted above were significant at the p<.05 level. The results reported here come from primary models that included propensity score adjustment for physician market selection.

associated with higher odds for three quality measures with same day ED visit or hospitalization as an exception. Among organizational-level factors, having moderate or high facility colonoscopy volume was associated with lower odds for two to three of the four quality measures. Similar findings have been reported (Chukmaitov et al., 2008; Chukmaitov, Devers, Harless, Menachemi, & Brooks, 2010). At the market level, higher HHI index (lower competition level in the market) was associated with higher odds for same day ED visit or hospitalization and 30-day non-gastrointestinal events resulting in ED visit or hospitalization. The uninsured rate was associated with lower odds for 30-day other gastrointestinal events resulting in ED visit or hospitalization and 30-day non-gastrointestinal events resulting in ED visit or hospitalization. These findings indicate that future studies of quality of care should consider a systematic exploration of relevant factors at multiple levels.

The relationship between some control variables and outcome measures was found to be inconsistent. For example, female gender was associated with higher odds for the first three quality measures but lower odds for the last quality measure. This may be due to the fact that females tend to have lower rate of cardiovascular diseases, which represented a large part of the 30-day non-gastrointestinal events. In addition, being Hispanic was found to be associated with higher odds for 30-day serious gastrointestinal events resulting in ED visit or hospitalization but lower odds for 30-day other gastrointestinal events resulting in ED visit or hospitalization. Higher number of primary care physicians per 100,000 population was associated with higher odds for same day ED visit or hospitalization and lower odds for 30-day other gastrointestinal events resulting in ED visit or hospitalization. Higher log-transformed population size was associated with higher odds for same day ED visit or hospitalization and lower odds for 30-day other gastrointestinal events and non-gastrointestinal events resulting in ED visit or hospitalization. These inconsistent patterns suggest that the different types of adverse events represented by outcome measures examined in this study have different determinants.

Some factors were not found to be significant. For example, the specialization rate (the percentage of colonoscopy procedures to all outpatient surgeries provided by a facility) was not significant in any models. Other examples included HMO and PPO penetration and the percentage of the population above age 65.

Limitations of the Study

This study has several limitations that merit discussion. First, this study was based on administrative data. Details about the surgical procedure, such as type of anesthesia, operating room time, or monitoring were not available in the data and thus, could not be controlled. It is also possible that physicians may choose certain locations to treat their patients based on information not available in the administrative data. Additionally, other than facility volume and specialization, there are other organizational characteristics that may affect quality of care that could not be examined, such as number of operating rooms, number of support staff, number of physicians providing care at the facility, the number of years the facility was in operation, etc. Moreover, the accuracy of the analysis was limited to the accuracy and completeness of the coding in the data files. There may have been coding errors in CPT codes and ICD diagnosis codes. Finally, an existing study reported that fewer secondary diagnoses are present among cases treated in ASCs than those in a hospital-based outpatient facility (Chukmaitov, Menachemi, Brown, Saunders, & Brooks, 2008). This study added diagnosis information from linked inpatient and emergency department records around the procedure date when conducting risk adjustment. But the comorbidities of those cases without linked inpatient or emergency department records may be underestimated, which may undermine the observed quality of care provided by physician-owned ASCs.

Additionally, this study was only able to identify physician ownership at the facility level and compared the quality of colonoscopy procedures furnished in physician-owned ASCs and hospital-based outpatient facilities. It is possible that some physicians who perform procedures in ASCs may not be owners. But it was not possible to identify individual physician owners. In fact, the California data do not include physician identifiers. The study dropped colonoscopy cases performed in non-physician-owned ASCs because there were too few observations to examine. It is also noteworthy that hospital-based outpatient facility category included both hospital outpatient departments as well as free-standing ASCs wholly owned by hospitals.

Third, this study dealt with selection issues (both physician investment and patient referral) through the use of propensity matching techniques. However, these techniques only control for observable characteristics. It could be that unobservable factors that the study could not measure are influencing these decisions and as a result, estimated effects could be biased to some degree by residual selection issues.

Fourth, the generalizability of the findings of this study is restricted for three reasons. First of all, this study relied on data strictly for the State of California. The California health care market likely differs from those of other states. In particular, California lacks certificate of need requirements for new ASCs, its HMO penetration rate is relatively high, and it has a high percentage of its population that is uninsured. These differences may make it hard to generalize findings from California to other geographic areas. A second factor is that the study used counties to define health care markets. Although prior studies suggest that changing the definition of health care markets do not substantially affect the results (Krauchunas, 2011;

McLaughlin, Normolle, Wolfe, McMahon, & Griffith, 1989), using counties as the boundaries of health care market in this study may add some bias because counties are extremely wide geographically in California. Finally, the study chose to examine the quality of care of outpatient colonoscopy. While it enabled the study to examine procedure-specific quality measures, focusing on one type of outpatient surgery makes it difficult to generalize the conclusions to patients receiving other types of outpatient surgical procedures.

Implications of the Findings

Implications for theory.

This study used agency theory to conceptualize physician ownership and its potential relationships to quality of care, examining two different agency relationships: the one between other owners of an ASC (principals) and physicians (agents) who perform surgical procedures in the facility and the one between patients (principals) and physicians (agents). Agency theory does not specifically predict whether physician ownership would improve or detract from the quality performance of an outpatient surgical facility. Depending on the extent to which consumers are able to assess quality of care differences across settings of care, physician ownership can function as a mechanism to improve quality or as a deterrent to quality. The study results support the latter, namely physician ownership may be a deterrent to quality in practice.

There are several reasons why the hypothesis of physician ownership as a mechanism to improve quality and the mediating effect of market competition were not supported. Lack of information on clinical aspects of care quality may limit the ability of patients and their referring physicians to make decisions about care setting for colonoscopy procedures. Additionally, patients may be more focused on amenities and convenience when they talk to other patients about potential sites of care. As a result, physician owners may not have the motivation to improve technical aspects of the quality of care, even if they have the knowledge and expertise to do so. In a competitive health market, physician owners of ASCs may also decide to compete with hospital-based outpatient facilities on factors such as amenities, convenience, shorter waiting times, or other factors that patients value in health care services. Finally, given existing reimbursement policies, physician owners may be willing to sacrifice aspects of the quality of care to the degree that these are not noticeable to the patients so that they can lower operating costs and enhance facility profits.

Implications for policy and management.

Quality and cost represent two important considerations in health policy decision-making. Quality of care has drawn enormous attention after the seminal Institute of Medicine report *Crossing the Quality Chasm* was published (Institute of Medicine, 2001). The Affordable Care Act calls for the establishment of a value-based purchasing (VBP) for Medicare payments paid to ASCs (U.S. Department of Health and Human Services, 2011). The VBP program represents an important step for Medicare to move from rewarding volume toward rewarding better value and outcomes. Although much of the discussion about physician ownership has been focused on uncovering its impact on patient selection and service overutilization, this study and a few other studies (Mitchell & Sass, 1995; O'Neill & Hartz, 2012) have directed the attention toward the relationship between physician ownership and patient outcomes.

From a policy perspective, Medicare as well as private payers may consider more stringent physician financial interest disclosure policies based on the findings of this study. To qualify for safe harbor protection under the federal Anti-Kickback Statute, a physician with an ownership interest in an ASC must "fully inform" the patients of his or her ownership interest when he or she refers patients to that facility (Centers for Medicare & Medicaid Services (CMS), HHS, 2007). While further research is needed, the findings of this study and other earlier studies (Hollingsworth et al., 2009; Hollingsworth et al., 2010a; Mitchell, 2010; O'Neill & Hartz, 2012; Strope et al., 2009) suggest that the disclosure of physician ownership to a larger audience may be warranted. For example, if financial disclosure information on referring physicians becomes available for monitoring and research purposes, the potential effects of physician investment can be further studied and controlled. Moreover, the study may some implication for California's corporate practice of medicine prohibition. The prohibition precludes hospitals from directly employing physicians with the intention of preventing unlicensed persons from interfering with or influencing the physician's professional judgment. Evidence from this study implies that physician's professional judgment may be influenced by many other factors even when they have the ownership or control of the business. When hospitals partner with physicians to provide outpatient colonoscopy, the quality of care is as good as or better than the quality of care provided in physician-owned ASCs. Therefore, further studies of the ban on the corporate practice of medicine may be needed.

Medicare and other payers should adopt strategies to collect quality of care data and make them available to the patients to encourage evidence-based decision-making about where to receive care. In 2012, CMS launched the ASC Quality Reporting System (Centers for Medicare & Medicaid Services (CMS), HHS, 2011). ASCs are required to report five quality measures beginning October 1, 2012, for calendar year (CY) 2014 payment determination. These five measures, in addition to two structural measures, will be used for the CY 2015 payment determination. This study suggests that it is worthwhile to use procedure-specific quality measures. Using only generic measures such as same day ED visit or hospitalization may miss some meaningful quality variations across location of care.

From a clinical or management perspective, the study provides useful information about how to identify patient subgroups that are prone to develop certain type of adverse events after outpatient colonoscopy. For example, senior age, female gender, being covered by Medicaid, high Charlson Comorbidity Index, a history of using medical services six month prior to the surgery, receiving colonoscopy procedures with biopsy or lesion removal were identified as risk factors for developing other gastrointestinal events such as intestinal obstruction and abdominal pain that result in ED visit or hospitalization within 30 days of the surgery. The information can be used to focus adverse event prevention efforts. Additionally, such information should be made available to physicians, health care facility managers, and patients to reduce the occurrence of adverse events. In this sense, the study findings may help to improve postoperative care and the smooth transition from the outpatient surgical settings to other settings.

Suggestions for Future Research

This study represents an initial effort to assess the effect of physician ownership of ASCs on the quality of care. There are some suggestions for future studies given the limitations identified above. This study operationalized the quality of outpatient colonoscopy using adverse events developed after the surgery due to limitations of the data. However, the American Society for Gastrointestinal Endoscopy (ASGE) and the American College of Gastroenterology (ACG) proposed quality indicators for colonoscopy that encompass the preprocedure, intraprocedure, and postprocedure periods (Rex et al., 2006). Future studies should further examine technical indicators of quality of outpatient colonoscopy, such as colonoscopy withdrawal time, polyp detection rate, and cecal intubation. It is also important to explore process of care measures and patient experience measures.

As discussed previously, the current study was only able to identify physician ownership at the facility level. A comparison of quality of care at the physician level will be of interest. More detailed information about physician ownership, such as an individual physician's ownership share of an ASC should be included if the data are available.

In addition, research is needed on other types of outpatient surgical services. For example, it is worthwhile to compare outcomes of patients who receive urological procedures in physician-owned ASCs and those treated in hospital-based outpatient facilities. Moreover, more studies need to be conducted in different states in different time periods to see if the findings are robust and generalizable to other markets.

Conclusions

Physician ownership is common among ASCs. This study using a large, diverse patient population and found that physician ownership of ASCs was not associated with better quality of care for colonoscopy patients. Instead, patients treated by physician-owned ASCs had significantly worse outcomes in two quality measures and similar outcomes in two other measures when compared to colonoscopy patients treated by hospital-based outpatient facilities. However, ASCs are believed to provide more convenient location, shorter waiting time, and more patient-center care with a lower price (American Association of Orthopaedic Surgeons, 2010; Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009). Thus, it may be difficult to compare the value of care provided by physician-owned ASCs and that by hospital-based outpatient facilities. As more complex procedures are shifted from hospital-based outpatient facilities to ASCs, expanded efforts to monitor and report quality of care will be worthwhile.

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Vita

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