STUDIES IN THE IMPLEMENTATION AND IMPACT OF EARLY MEDICARE ACCOUNTABLE CARE ORGANIZATIONS

A DISSERTATION

SUBMITTED ON THE TWENTIETH DAY OF MARCH 2017

TO THE DEPARTMENT OF GLOBAL HEALTH MANAGEMENT AND POLICY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

OF THE SCHOOL OF PUBLIC HEALTH AND TROPICAL MEDICINE

OF TULANE UNIVERSITY

FOR THE DEGREE

OF

DOCTOR OF PHILOSOPHY

BY

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STUDIES IN THE IMPLEMENTATION AND IMPACT OF EARLY MEDICARE ACCOUNTABLE CARE ORGANIZATIONS

YONGKANG ZHANG

ABSTRACT

This dissertation, comprised of three papers, examines various important issues related to the Medicare Shared Savings Program accountable care organizations (ACOs). The ACO model is one of the major policy initiatives proposed by the Affordable Care Act trying to improve quality and control costs of health care through improved care coordination. Given the rapid expansion of ACOs across the country, studies are needed to examine the implementation and impact of ACOs. Specifically, this dissertation focuses on three topics about ACOs: (1) identify patterns and gaps of care coordination strategies and interventions implemented by providers and organizations; (2) analyze determinants of ACOs' success in achieving shared savings; and (3) examine the impact of ACO penetration on regional variation in Medicare per beneficiary spending. The first study presented in this dissertation is a systematic review of strategies and interventions providers have implemented to coordinate health care delivery. It summarizes elements of care coordination and identifies the gaps for effective care coordination. The second study of this dissertation examines the market and organizational characteristics associated with earned shared savings among ACOs. It identified factors that may contribute to better financial performance of ACOs. The third study of this dissertation is a longitudinal examination of the association between ACO penetration and regional variation in Medicare per beneficiary spending. These studies provide new evidence on the implementation and impact of the Medicare ACO program.

Keywords: Medicare, Affordable Care Act, accountable care organizations, health care quality, health care spending

DEDICATION

For my parents, who give me their unconditional love and support all the time. Thank you for your encouragement and for always believing in me.

ACKNOWLEDGEMENTS

I would like to thank my dissertation committee for their support and encouragement during the dissertation process. Specifically, I would like to thank the committee chair, Dr. Mark L. Diana for his support and his patience for this work. He is a great researcher and a good mentor. He always provides his insights when I have questions and problems. I would also like to thank Dr. Valerie A. Yeager for all her help and support in this dissertation process and in my doctoral study process. It is such a fortunate and my pleasure to have her at Tulane. She is not only a great mentor for my study, but also a dear friend in my life. I appreciate her support to help me improve my English skills, adapt my life here in New Orleans, and get more experience in research. I would like to thank Dr. Charles Stoecker for his excellent knowledge and guidance for econometrics. He never disappointed me regarding my econometric questions. He always has solutions for all kinds of question I have. There is no doubt that I have been more experienced in terms of research methodology because of his help, mentoring, and all the challenging questions from him. I owe Dr. Allison B. McCoy many thanks for sharing her time with me in this process. She is such a great mentor who have offered me valuable suggestions for all kinds of questions. She always likes to work with students and help them find their interests in research. I also would like to express sincere gratitude to my master advisor, Dr. Shengtian Hou. He supported and encouraged me to be dedicated to research and study abroad. He still gives me valuable suggestions in terms doing research and career development.

In addition, I would like to thank my cohort at Tulane, Catherine Counts, Josh Stroud, and Janna Wisniewski, and my best friend here Mengxi Zhang. Having them

around me at Tulane is absolutely a gift. I am also grateful for the administrative support from Alison Rinehart and Vanessa Bailey. They have been super supportive in the past four years. I also would like to thank Dr. Arthur Mora and Dr. Daniel Walker for sharing their insights about studies in health information technology and accountable care organizations. I also would like to thank Dr. Shengxu Li for his willingness to listen and give suggestions on my practice talks. My parents, other relatives, and friends have provided indispensable support in my doctoral study process. I love them and I own many thanks to them. Last but not the least, I really appreciate the mentoring and help I have received from Tulane's Department of Global Health Management and Policy. The studying experience in the department is invaluable and I recognize how fortunate I am able to work here in these four years.

INTRODUCTION

Fragmented care delivery happens when health care is spread out across a large number providers without coordination (Agha, Frandsen, & Rebitzer, 2017). In the US, health care has been delivered by many stand-alone physicians and organizations with little coordination and collaboration identified among them (Cebul, Rebitzer, Taylor, & Votruba, 2008). Studies have found that care fragmentation is associated with poor quality and increased costs (Cebul et al., 2008; Frandsen, Joynt, Rebitzer, & Jha, 2015; Stange, 2009). Policy makers are trying to address care fragmentation through improved care coordination. Care coordination is defined as "deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services" (McDonald, 2010). Evidence indicated that care coordination is associated with reduced unnecessary health care utilization, improved health care quality, and lower health costs (Havens, Vasey, Gittell, & Lin, 2010; Hernandez et al., 2010; Koehler et al., 2009).

Accountable care organizations (ACOs) are one of the major policy efforts to control the growth of costs and improve quality of health care through improved care coordination. An ACO is a group of individual physicians, physician groups, hospitals, and other health care providers, such as skilled nursing homes and rural clinical centers (Fisher & Shortell, 2010). By participating in an ACO, providers agree to coordinate health care for a defined population of patients, with possible financial rewards if they contain costs while satisfying assigned quality benchmarks. The implementation of ACOs is proceeding rapidly across the United States. More than 700 ACOs, including

Medicare, Medicaid, and private ACOs have been identified as of January 2015, covering more than 20 million patients in the United States (Tu, David, Lawrence, & Ross, 2015).

As the ACO program expands rapidly across the county, there is a growing interest to examine the implementation and impact of ACOs. This dissertation, focusing on Medicare Shared Savings Program (SSP) ACOs established in 2012 and 2013, contributes to the filed through the examination of three key aspects of the ACO model. Specifically, the three papers of this dissertation will (1) systematically review strategies and interventions of care coordination implemented by providers; (2) examine market and organizational characteristics of ACOs associated with their performance in achieving shared savings, and (3) investigate the impact of ACO penetration on regional variation in Medicare spending. Details of each papers will be discussed after the summary of state of knowledge about ACOs.

Summary of Existing Studies on ACOs

Health care has long been delivered across a variety of distinct and often competing entities, each with its own objectives, obligations, and capabilities (Cebul et al., 2008). Patients, especially those with chronic diseases, receive health care from these entities with little coordination. Under the traditional fee-for-services payment model, providers have little incentive to coordinate care delivery. This care fragmentation is associated with various problems, such as poor communication among providers, lack of clear accountability, increased medical errors, unnecessary duplications, and overuse of high-cost, intensive medical interventions (Cebul et al., 2008; McKethan, 2009; Shih & Fund, 2008). To address these issues, various payment and delivery models were

proposed by Affordable Care Act with fundamental changes in how care is delivered and how providers are reimbursed.

Accountable care organizations (ACOs) are one of the leading payment and delivery innovations. The Centers for Medicare and Medicaid Services (CMS) implemented the Pioneer ACO model and Shared Savings Program (SSP) ACO model since 2012. A growing number of studies have been conducted to examine the implementation of the ACO program, investigate the formation and participation of ACOs, and evaluate the impact of ACOs on quality and costs of health care.

Implementation of the ACO Model

Early studies were conducted to discuss how to implement the ACO model. Although a general rule of the ACO model was proposed, there is no consensus about how to form an ACO, what kind of providers should be involved, and what capacities an ACO should have to improve quality and control costs of health care. These studies attempted to clarify principles of the ACO model, identify potential barriers to implement ACOs, propose possible strategies to address them, and propose capacities an ACO should build on.

Based on the previous studies on health maintenance organizations (HMOs) and integrated delivery systems (IDSs), studies proposed key components of the ACO model. These include strong base of primary care (McClellan, McKethan, Lewis, Roski, & Fisher, 2010; Rittenhouse, Shortell, & Fisher, 2009), collaboration among providers (Crosson, 2011; Shortell & Casalino, 2010), timely evaluation and monitoring using common measures for quality and costs assessment (Shields, Patel, Manning, & Sacks,

2011), robust electronic health records infrastructure (Shields et al., 2011), and physicians' leadership for governance (Anderson, 2011; Shields et al., 2011).

Four studies identified barriers of the current health system to implement ACOs. These barriers include lack of the common understanding about what an ACO is (McClellan et al., 2010), lack of the knowledge and experience in establishing the organizational and legal structures required to implement accountable care payment and performance measurement reforms (McClellan et al., 2010; Shortell & Casalino, 2010), lack of the understanding about how local contextual factors influence the success of different accountable care models (McClellan et al., 2010), the dominance of solo and small group independent physician practices and the dominance of the fee-for-services reimbursement (Shields et al., 2011).

Some studies have proposed strategies to facilitate the implementation of ACOs. These strategies encourage government to have the consistency in the definitions of cost and quality measures across all participating payers (McClellan et al., 2010), offer financial and technique support for providers (Crosson, 2011; McClellan et al., 2010; Singer & Shortell, 2011), conduct ongoing activities and performance evaluation (Fisher & Shortell, 2010; McClellan et al., 2010), and implement flexible regulations on governing ACOs (Lieberman & Bertko, 2011). In summary, these studies provided early insights for providers to establish ACOs and meaningful information for policy makers to identify potential ACO participants.

Formation and Participation of ACOs

Seven studies empirically analyzed the formation of ACOs and providers' participation of ACOs. Specifically, two studies identified regional factors associated with ACOs formation. The first study conducted by Lewis et al. focused on 227 Medicare, Medicaid, and private ACOs identified by the authors as of August 2012. They found that hospital service areas with higher quality performance, higher Medicare spending per capita, fewer primary care physician groups, greater managed care penetration, and lower poverty rates were more likely to have ACOs (Lewis, Colla, Carluzzo, Kler, & Fisher, 2013). Using hospital referral region level data, Auerbach and colleagues analyzed the regional determinants of Medicare ACOs formation. They found that regional factors, including a greater fraction of hospital risk sharing (capitation), larger integrated hospital systems, and primary care physicians practicing in larger groups were associated with ACOs' formation (Auerbach, Liu, Hussey, Lau, & Mehrotra, 2013).

Other studies examined providers' participation in ACOs. Audet and colleagues found that 13 percent of the 1,672 hospitals in their survey reported participating in an ACO or planning to participate. This study indicated that hospitals participating or planning to participate in ACOs were more likely to have more bed, to be members of a multi-hospital health system, to be located in an urban area, to be teaching hospitals, and to be not-for-profit, as compared to those not exploring the ACO model (Auerbach et al., 2013). Using resource dependency theory, Yeager et al. examined the market and organizational characteristics associated with hospital ACO participation. This study concluded that hospitals operating in areas with higher level of income per capita, higher level of competition were more likely to participate in ACOs. Organizational characteristics, such as EHR implementation, health care system membership, and

hospital ownership were also related to ACO participation (Yeager, Zhang, & Diana, 2015).

Three recently studies examined individual provider or provider group's involvement in ACOs. A study by Colla et al. found that physicians are playing strong leadership and ownership roles in ACOs. Specifically, around 51% ACOs are physician-led and physicians constituted a majority of the governing board in 78% ACOs (Colla, Lewis, Shortell, & Fisher, 2014). Using data from National Survey of Physician Organizations, Shortell et al. suggested that 23.7% physician practices reported participating an ACO and other 15.7% plan to be involved in ACOs within the next 12 months. Large physician practices, physician practices affiliated with independent practice association, and physician-hospital organizations are more likely to participate in ACOs (Shortell, McClellan, et al., 2014). Finally, Smith and colleagues discussed pharmacists' participation of ACOs. This study suggested that pharmacists' involvement will benefit ACOs due to their experience in medication reconciliation, pharmacotherapy management, and care coordination (Smith, Bates, & Bodenheimer, 2013). Findings of these studies provide early evidence for policy makers to facilitate formation of ACOs.

Evaluation the Impact of ACOs

With the increasing data availability about ACOs, studies started to focus on evaluating ACOs' performance. Specifically, these studies explored whether ACOs have controlled the growth of health costs and improved the quality of health care. Using Consumer Assessment of Healthcare Providers and Systems data, McWilliams et al. found that patients' reports of timely access to care and their primary physicians' being informed about specialty care differentially improved in the ACO group after ACO

contracts began. However, these is no improvement in patients' ratings of physicians, interactions with physicians, and overall care (McWilliams, Landon, Chernew, & Zaslavsky, 2014). Kelleher et al. examined the performance of a Medicaid ACO for pediatric care. They found that the ACO reduced growth in costs compared with fee-for-services Medicaid beneficiaries. Moreover, this slowing in cost growth was achieved without diminishing the overall quality or outcomes of care (Kelleher et al., 2015). Spatz et al. analyzed the acute admission rate for heart failure patient of ACOs. Their findings indicated that risk-standardized acute admission rates of ACOs was below the national rate. However, ACO performance varied, demonstrating heterogeneity in ACOs' abilities to prevent acute admissions among patients with heart failure (Spatz et al., 2016). Nyweide and colleagues examined the performance of the Pioneer ACO program. Using Medicare claims data, they found that beneficiaries aligned with Pioneer ACOs exhibited smaller increases in total Medicare expenditures and differential reductions in utilization of different health services, with little difference in patient experience (Nyweide et al., 2015).

These studies provide early evidence for policy makers and providers to understand the quality and costs effects of ACOs. Given the rapid expansion of ACOs across the country, more studies are needed to have a thorough evaluation on the performance of ACOs.

Other Studies about ACOs

These studies broadly examined various issues about ACOs. Lewis et al. and McWilliams et al. discussed the method of assigning patients to ACOs. Specifically, Lewis and the colleagues compared the prospective method and the performance year

method (retrospective). This study concluded that performance year attribution may more fully and accurately reflect an ACO's patient population and may better position an ACO to achieve shared savings (Lewis, McClurg, Smith, Fisher, & Bynum, 2013). McWilliams et al. discussed how the inclusion of post-acute evaluation and management services as primary care affects assignment of Medicare beneficiaries to ACOs. Their study suggested that under current Medicare assignment rules, ACOs may not be accountable for an influential group of post-acute patients, which suggests missed opportunities to improve care coordination and reduce inappropriate readmissions (McWilliams, Chernew, Zaslavsky, & Landon, 2013). A taxonomy study by Shortell et al. provide a valuable framework for empirical work on ACOs. Using eight attributes of ACOs such as size, scope of services offered, and the use of performance accountability mechanisms, their study categorized ACOs into three types, including (1) larger, integrated system, (2) smaller, physician-led practices, and (3) moderately sized, joint hospital–physician and coalition-led groups (Shortell, Wu, Lewis, Colla, & Fisher, 2014).

Summary of Existing Studies

To date, the majority of studies about ACOs have focused on implementation and formation of ACOs. With the operation of the ACOs and the availability of data, recent studies have been working on evaluating the performance of ACOs. Given the rapid development of the ACO program, more studies are necessary to evaluate the performance of ACOs from different perspectives and using more robust methods. In addition, given the availability of framework for ACOs' structure and the diversity in ACOs' composition, empirical studies are needed to examine structural characteristics

associated with ACO's performance, which is essential to regulation policy and practical guidance about ACOs.

Overview of the Dissertation

The first paper of this dissertation will present a systematic review of strategies for care coordination. Although it is widely recognized that better coordination of care holds considerable potential to improve the performance of health system, there is no agreed upon definition of the term 'care coordination' or consensus as to what it entails. In addition, the best care coordination practice for one condition may not be applicable for other conditions. The confusion of the definition of care coordination caused difficulties for providers in terms of achieving effective care coordination in clinical practice. By participating in ACOs, providers are expected to collaborate each other to coordinate health care delivery. They are eager to understand the effective ways of the care coordination for health care delivery, especially for complex conditions like chronic diseases that require coordination among various providers. This first paper will summarize the critical components and best practices about care coordination. Findings will be helpful for providers interested in implementing effective care coordination activities and will inform policy makers about relevant critical activities and capabilities ACOs may need for better performance.

The second paper of this dissertation will present an empirical examination of key market and organizational characteristics associated with achieving shared savings among ACOs. To encourage providers and organizations to participate in ACOs, significant changes and flexibility have been provided by CMS in its final rule on ACO formation. The latest data about early Medicare SSP ACOs show variation in the structures of ACOs in terms of size, type of providers, and services provided. In addition, the ACO annual performance data indicated variations in shared savings achieved by

ACOs. This study will examine whether market and organizational characteristics of ACOs are associated with their ability to achieving shared savings. Findings of this study will be informative for policy makers considering ACO implementation and for providers to establish ACOs.

The third paper of this dissertation focuses on evaluating the impact of the ACO program on regional variation in Medicare spending. There is considerable variation in per beneficiary Medicare spending across regions, which may indicate the waste of health resources and the inefficiency of health care system. ACOs create potential to improve the value of health care and reduce the regional Medicare spending variation. This study will examine the association between ACO penetration and variations in Medicare spending across hospital referral regions. Findings will provide new evidence about the impact of ACO program on health costs. Findings will also contribute to the field of the strategies to reduce geographic variation in Medicare spending and improve the value of health care.

Taken together, the three papers of this this dissertation will contribute new findings about strategies to implement care coordination, market and organizational characteristics of associated with ACOs' financial performance, and the impact of ACO penetration on health care spending. All three of these papers aim to contribute new insights for the implementation and evaluation of ACOs.

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ACHIEVING EFFECTIVE CARE COORDINATION IN ACCOUNTABLE CARE ORGANIZATIONS: A SYSTEMATIC REVIEW OF STRATEGIES FOR COORDINATED CARE DELIVERY

ABSTRACT

Background: Care coordination is one of the key strategies to improve quality and control costs of health care. Various new payment and delivery innovations, such as accountable care organizations require providers work together to coordinate health care delivery. Although care coordination is of great importance, little is known about how providers implement care coordination in clinical practices.

Methods: This study conducted a systematic review of the peer-reviewed literature published between 2010-2015 using a bibliographic search of PubMed, Cochrane Collaboration's (EPOC) database, and EMBASE. To identify all relevant studies, combinations of key words "care coordination strategies (or interventions, or practices, or elements), coordinating care strategies (or interventions, or practices, or elements), coordinated care strategies (or interventions, or practices, or elements)" were searched. A hand search of the reference lists of all manuscripts identified in the initial search was performed to identify additional articles.

Findings: Forty-eight studies were included in this review. These studies mainly focused on improving quality and controlling cost for chronic conditions in primary care and hospital settings. Key care coordination interventions, including patient education, health/needs assessment, patient/family engagement, individualized plan, team meeting, risk identification, use of health information technology, and ongoing monitoring and follow-up. Many studies implemented multiple interventions were identified in the reviewed studies.

Conclusions: Health care providers and organizations have been dedicated to coordinate health care delivery. Some new strategies have been adopted to address the problems of

care coordination reported previously. However, coordinating care coordination across the continuum of health care and care coordination focusing on post-acute care settings are still needed.

INTRODUCTION

The prevalence of chronic conditions continues to grow and it is estimated that about half of American adults (approximately 117 million people) have at least one chronic disease (Centers for Medicare and Medicaid Services, 2012; Ward, 2014). Due to their complicated conditions, these patients usually receive health care from multiple providers and organizations across different settings (Bodenheimer, 2008). However, previous studies have found that health care delivery for these patients were poorly organized (Schoen, Osborn, How, Doty, & Peugh, 2009). Little coordination and collaboration were identified among these providers and organizations. This fragmented delivery system is associated with medical errors, unnecessary utilization, and increased health care spending (Cebul, Rebitzer, Taylor, & Votruba, 2008; Enthoven, 2009).

Policy makers are trying to address these quality and cost issues through improved care coordination (R. Kocher & E. Adashi, 2011; Kocher, Emanuel, & DeParle, 2010). Care coordination is defined as "deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services" (McDonald, 2010). Evidence indicated that care coordination is associated with reduced unnecessary health care utilization, improved health care quality, and lower health costs (Havens, Vasey, Gittell, & Lin, 2010; Hernandez et al., 2010; Koehler et al., 2009). Given the potential benefits of care coordination, the Patient Protection and Affordable Care Act (ACA) proposed various payment and delivery innovations, including accountable care organizations (ACOs), bundled payment programs, and patient-centered medical homes which require fundamental changes in how health care is delivered to improve care coordination

(Berwick, 2011; Mechanic & Tompkins, 2012; Nutting et al., 2011). In addition, many states and private payers also launched various care coordination initiatives to improve quality and control costs (Cantor et al., 2014).

Although these new delivery and payment models are expanding rapidly across the nation, coordinating care have been found to be a significant challenge. Studies have reported difficulties that providers are facing in achieving effective care coordination. For example, Bodenheimer assessed the quality of care coordination and suggested that failures in the coordination of care are common and can create serious quality concerns (Bodenheimer, 2008). Another study evaluated the transitions of independent primary care practices to patient-centered medical homes. They found that the implementation was more difficult for components that required fundamental changes in established routines and coordination across work groups, or that challenged traditional roles and models of practices. Specifically, integration with community services, wellness promotion, proactive population management, and team-based care presented the greatest challenges (Nutting et al., 2011). Fisher et al. predicted the challenges to the successful diffusion of ACOs and indicated the difficulties to have care coordination because "even integrated systems are finding that they need substantial time and resources to develop the informational, technical, financial, and professional capabilities required to provide and reward coordinated, longitudinal, population-based care" (Fisher, McClellan, & Safran, 2011).

Given these difficulties to coordinate care delivery, understanding how providers implement care coordination is necessary to identify patterns and gaps in their practices. Several studies have reviewed providers' care coordination practices. McDonald et al.

presented a systematic review about care coordination. Their study summarized definitions and reviewed strategies and frameworks about care coordination (McDonald et al., 2007). A second review conducted in 2013 focused on similar topics. This paper updated the McDonald's work by including relevant studies published between 2007 and 2010 (Van Houdt, Heyrman, Vanhaecht, Sermeus, & De Lepeleire, 2013). Given the increased initiatives of care coordination among providers and organizations, this study provides further update by reviewing studies about care coordination published between 2010 and 2015. Specifically, this study focused on care coordination strategies and interventions implemented by health care providers and organizations. Findings from this study will provide policy makers and providers new evidence on how health care is coordinated in clinical practice and identify gaps in coordinated care delivery.

METHODS

Inclusion/Exclusion Criteria

As a first step to identifying appropriate papers for review, a bibliographic search was conducted using similar methods by previous studies. The search began with a broad electronic search of PubMed, Cochrane Collaboration's (EPOC) database, and EMBASE. To be as comprehensive as possible, key words used in search include: *care coordination strategies (or interventions, or practices, or elements), coordinating care strategies (or interventions, or practices, or elements), coordinated care strategies (or interventions, or practices, or elements).* The search was limited to articles published between 2010 and 2015. Relevant studies were considered if they were English-language, peer-reviewed papers. Titles of all articles identified in this step were screened for potential eligibility.

Recognizing that relevant studies may have been published in journals that were not indexed in the databased used for search, a hand search of reference lists of identified papers was conducted (step 2). The retrieved articles were screened by examining the titles and abstracts. A study was included in the review if it met the following three criteria: (1) care coordination was implemented among providers; (2) had a specific study setting (such as hospitals, medical centers, or health systems); (3) discussed health care delivery.

All the paper identified in first two steps were retained for full text review. Articles were excluded if (1) it had no details about care coordination interventions; (2) it was not actually implemented in the clinical practices; (3) it did not focus on health care. Details about the search steps and the associated article numbers were reported in the figure 1.

Variable Examined

Included studies were reviewed to extract the following information: (1) study setting (e.g., hospital, physician practice, or nursing home); (2) health condition (e.g., cancer, diabetes, or infectious diseases); (3) study design (e.g., randomized clinical trial, cohort study, or cross-sectional study); (4) patient population (e.g., children, Medicare patient, or Medicaid patients); (5) Outcome variable focused (e.g., costs, readmission rate, or patient experience); (6) results of the study (e.g., positive, negative, or null effects on outcome); (7) care coordination team or key staff (e.g., who is the coordinator); (8) key care coordination strategies.

Analysis

Information regarding variables of interest was abstracted from each article. This information was tabulated to summarize the state of care coordination in the literature. Findings were input into tables to present information about each study.

RESULTS

Study Characteristics

Table 1 presents the characteristics of reviewed studies. Of 48 studies reviewed, 17 (35.42%) were conducted in primary care settings, 12 (25.00%) were conducted in hospitals, 7 (14.58%) focused on veteran's health care systems, 7 (14.58%) studies implemented care coordination in community clinics, 3 (6.25%) focused on long-term care settings, and other 2 (4.17%) studies focused on health care systems.

In terms of health conditions, 11 (22.92%) studies examined general patient group without a specific health condition focus, such as patients at high risk of readmission. Thirty-five (72.92%) studies focused on chronic conditions. Specifically, six studies focused on cancer, such as lung cancer and colorectal cancer (Alsamarai et al., 2013; Enard et al., 2015). Seven studies focused on mental health conditions (e.g., dementia and depression). Other 22 studies focused on other chronic health conditions, such as diabetes, asthma, and heart diseases. In addition, one study (2.08%) focused on reproductive health and another one (2.08%) focused on infectious diseases.

The reviewed studies broadly examined various outcomes from both the patient and the provider's perspectives. Among all 48 studies, 13 (27.08%) examined a single outcome and 35 (72.92%) examine multiple outcomes. There were 15 (31.25%) studies examined the health care utilization and 8 of them specifically focused on hospitals

readmissions. Health costs were examined in 6 (12.5%) studies. Seven (14.58%) studies examined the quality of life of patients. In addition, there were 3 (6.25%) studies examined providers' experiences. Disease-related health indicators were examined in 5 (10.42%) studies. For example, blood glucose (A1C), body mass index (BMI), and systolic and diastolic blood pressure were included as primary outcomes in a study focusing on diabetes (Collinsworth, Vulimiri, Schmidt, & Snead, 2013). Other outcomes examined in the studies include patient adherence, completion of recommended health services, and patient self-management.

Regarding the effects of care coordination, 34 (70.83%) out of 48 studies reported positive effects, meaning care coordination improved quality, reduced unnecessary health care utilization or costs, or improved patient experience. Three (6.25%) studies reported mixed results, indicating care coordination improved some aspects of outcome they examined. For example, in a study focusing on children with complex care needs, the care coordination program was associated with fewer inpatient days and decreased health costs. However, the program had no impact on parental quality of life (QOL), although it improved child QOL (Cohen et al., 2012). Another 11 (22.92%) studies found no significant impact of care coordination program on outcomes.

Care Coordination Interventions

Twenty-six (54.17%) studies reported using a care coordinator (care manager or care navigator) in those programs. Specifically, 14 of them used nurses as coordinators, 3 of them used community workers as coordinators, and other 9 studies were not clear about who served as a coordinator. Eleven (22.92%) studies reported use of care coordination team. Depending on the specific health conditions, these teams broadly

included providers necessary for health care delivery. Providers in these teams may include pharmacists, nurses or nurse practitioners, primary care physicians, specialists, and dieticians. For example, a care team for delirium patients includes internal medicine resident physicians, nurses, pharmacists, social workers, nutritionists, and physical/occupational/speech and language therapists (Yoo, Nakagawa, & Kim, 2013).

Care coordinators focused on non-clinical activities. Their responsibilities usually included: (1) engage patients and their family through telephone or email; (2) connect patients with appropriate providers or community resources; (3) follow up patients at home or in other settings; (4) schedule team meeting to review and discuss patients' conditions.

Table 2 presents the elements of care coordination interventions in reviewed studies. The reviewed studies showed various care coordination strategies and interventions adopted by providers. These strategies and interventions usually include the following elements: (1) patient education. Among 48 review studies, 12 (25.00%) of them incorporated patient education as part of the care coordination. For example, providers developed diabetes education curriculum targeting barriers to diabetes management that Hispanics commonly experience (Collinsworth et al., 2013). (2) health/needs assessment. Providers conducted assessments to identify patients' health status and health needs. Five (10.42%) studies discussed the health assessment in their care coordination interventions. (3) Patient/family engagement. In 12 (25.00%) studies, providers engaged patients through telephone or email to respond to patients' questions and concerns, or connect patients with other providers. (4) Individualized plan. Among sixteen (33.33%) studies, providers developed an individualized plan according to a

patient's health status and needs. These plans usually included specific actions and steps or the goals for the treatment. (5) Team meeting. Nine studies (18.75%) included a meeting involving providers necessary for a patient's care. Providers could review and coordinate care plans for a patient during the meeting. (6) Risk identification. Among 7 (14.58%) studies, the care coordination plans included patients' risk identification. For example, providers identified patients with high risk and developed early interventions (Daly, Douglas, Gunzler, & Lipson, 2013). (7) Use of health information technology. Twelve studies (25.00%) reported using health information technology (e.g., electronic health records) to facilities care coordination. For example, providers used a "Cancer Alert" code in the electronic health record system to identify all potential lung cancers detected using imaging (Alsamarai et al., 2013). (8) Ongoing monitoring and follow-up. Nine (18.75%) studies reported using patient monitoring and follow-up to improve care coordination. For example, providers developed ongoing monitoring and reassessment establishing a long-term relationship that provides continuous support to veterans and caregivers (Bass et al., 2013). The details of the care coordination intervention of each reviewed study were available in the appendix.

DISCUSSION

Care coordination is a key strategy to improve quality and control cost. With the expansion of new care delivery and payment models, health care providers and organizations are making efforts to deliver coordinated health care. However, little is known about strategies and interventions providers are implementing in their clinical practices. This systematic review summarized the strategies and interventions providers conducted to coordinate care delivery between 2010-2015.

The first key finding of this study is that care coordination primarily focused on primary care and hospital settings, which has significant implications to reduce unnecessary health care utilization and control costs. High quality primary care is associated with improved outcomes at lower costs (Friedberg, Hussey, & Schneider, 2010). In addition, use of primary care could also reduce hospital utilization (Kronman, Ash, Freund, Hanchate, & Emanuel, 2008). Therefore, providers are making efforts to deliver high-quality primary care services, especially for patients with chronic conditions. This review found that majority of care coordination programs have incorporated comprehensive primary care programs. Key strategies about primary care included patient counseling, patient education, health needs assessment, and care management (Boyd et al., 2014; Looman et al., 2015; Rantz et al., 2015). Many programs also combined multiple strategies together for patients with chronic conditions. Increased delivery of quality primary care would be helpful to improve health care quality and control costs.

Unnecessary hospital care utilization significantly contributes to increased health spending (Kocher & Adashi, 2011). Previous studies have found many care coordination programs tried to improve inpatient care and discharge process to reduce unnecessary inpatient services, such as hospital readmissions (Hernandez et al., 2010; Koehler et al., 2009). This review suggested that hospitals have made efforts to strengthen their connections with other health care settings to avoid unnecessary inpatient care utilization. For example, hospitals sent nurses to follow up patients in nursing facilities or at home (Coburn, Marcantonio, Lazansky, Keller, & Davis, 2012). Hospital care coordinators also connect patients with necessary social services and community resources after patients

were discharged from hospitals (Lawson, Bloom, Sadof, Stille, & Perrin, 2011). These follow-ups and connections with necessary resources could help patients access appropriate care outside hospital and avoid re-hospitalization.

The second key finding of this review is that chronic conditions are the focus of care coordination programs. Care delivery for patients with chronic conditions usually involves multiple providers and organizations. It is challenging to coordinate different aspects of care if these providers and organizations work under separate settings without collaborations (Parekh, Goodman, Gordon, Koh, & Conditions, 2011). The fragmented care delivery for chronic conditions is associated with increased health spending and increased lab and diagnostic errors (Schoen et al., 2009). This review indicated that providers were working on improving the care coordination for patients with chronic conditions, such as cancer, diabetes, and heart diseases. These efforts focused on reducing the unnecessary utilization (e.g., unplanned readmissions and emergency department visits), controlling health costs, improve quality and outcomes of health care. These chronic diseases-focused care coordination programs are important to control health spending in US health care system.

Findings of this review indicated that care coordination interventions and strategies have targeted some gaps for care coordination reported in the previous literature. Previous studies reported various barriers and difficulties providers have in coordinating health care, including overloaded primary care physicians, implementing comprehensive multidisciplinary team meetings, and inadequate communication between providers (Bodenheimer, 2008; Friedman et al., 2016; Walsh et al., 2010). Primary care physicians were stressed to deliver recommended care, engage patients, and provide

patient education. Many care coordination programs reviewed in this study used nurses as care coordinators to provide primary care, such as patient education and health needs assessment, which could reduce the workload of primary care physicians. Care coordinators also took responsibilities to schedule the weekly or monthly meetings with other providers. Providers could review patients' conditions and discuss treatment plans. These meetings also facilitated the communication among providers. In addition, some programs used technologies, such as electronic health records for providers' communication (Cady et al., 2015).

In addition, use of health information technology (HIT) to support care coordination has been reported in many studies. Care coordination highly relies on quality exchange of patient health information among providers (O'Malley, Grossman, Cohen, Kemper, & Pham, 2010). Previous studies found that providers in the US had problems to get patient information from other settings for a same patient (Bodenheimer, 2008). HIT is an essential component of care coordination as it improves the availability of health information needed for care coordination, facilitates information sharing, and increases real-time information access among providers (Hsiao, King, Hing, & Simon, 2015). Among reviewed studies, HIT has been used to send providers reminders and alters, provide decision support to physician, and facilitate communication between providers. Also, HIT is used to track patients' health status and identify potential illness and functional declines. Incorporating HIT creates more potential for improved care coordination.

Although this reviewed found that various care coordination programs have been implemented to target various health conditions in different settings, some gaps still exist

in the literature. First, very few studies explored the care coordination across the continuum of health care. Most reviewed studies focused on coordination between primary care and specialty care, hospital care and post-acute care, or the coordination within a health care setting. No studies explored the coordination across all care settings involved for patient care. This may cause quality and cost issues. Patients may expose to uncoordinated care out of the care coordination program, which may offset the benefits of care coordination. This may be because the large integrated care systems are still not pervasive in US health care system. Indeed, only one reviewed study was conducted in a large integrated health system. Developing care coordination programs across the continuum of care may have more implications to improve quality and control cost of health care.

Second, care coordination in post-acute care setting is still lacking. Only two reviewed studies discussed the coordination between hospitals and post-acute care facilities (e.g., nursing homes). In addition, these care coordination programs primarily focused on patient follow-up, such as monitoring patients' health status. However, many opportunities exist to improve care coordination between inpatient and post-acute care settings, including team-based care and transition programs, cross-continuum case-management interventions, and communication protocols for providers across settings to share both clinical and social information (Ackerly & Grabowski, 2014). These programs may be hard to implement due to the conflicting incentives between hospitals and nursing facilities (Grabowski, 2007). The new care delivery model, such as accountable care organizations may address this problem through aligned financial incentives among providers.

This study also identified some new trends in care coordination activities compared to previous studies. First, this study found that many programs were implementing multiple interventions and strategies for care coordination. However, previous studies found that most of care coordination programs were using a single intervention. Combining different interventions may better meet patients' need and create more potential for quality improvement and cost reduction. Second, health information technology was seldom used for care coordination in previous literature. The review literature in this study found that HIT has been adopted for many purposes, such as risk identification and provider communication. Use of HIT may help providers and organizations overcome barriers for care coordination reported in previous studies. Finally, more recently studies included patient or provider's experience as the outcome, whereas previous literature usually focused on costs or clinical outcomes (e.g., mortality) or utilization measures (e.g., readmission rate). Including comprehensive outcomes may be more likely to improve quality and control costs through care coordination initiatives.

In conclusion, this study summarized the care coordination strategies and interventions implemented by providers between 2010-2015. Given the considerable efforts by federal and state government and private payers to improve care coordination, future research is needed to update the results and identify challenges providers have to inform necessary policy initiatives for effective care coordination.

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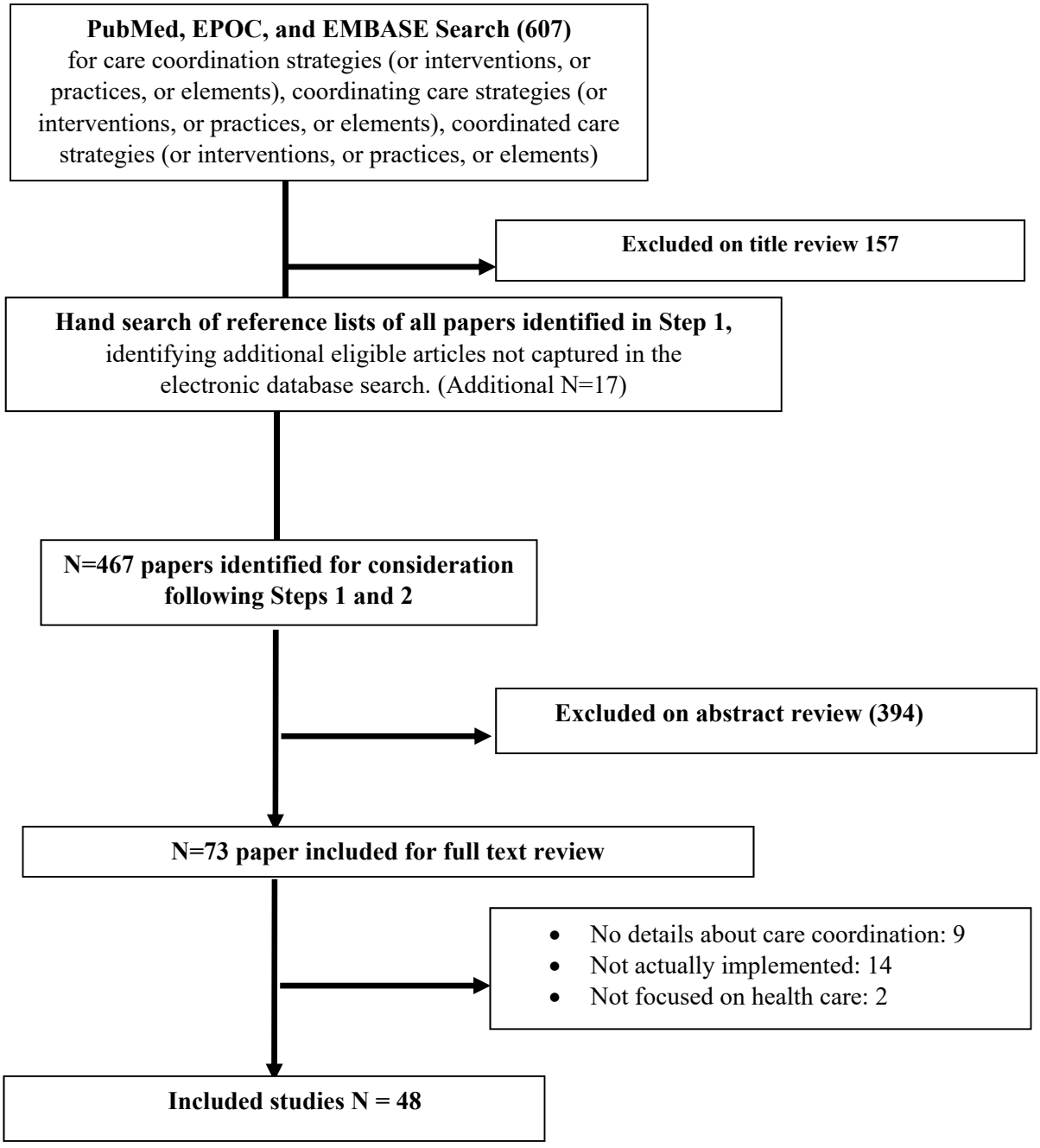

FIGURE 1 STEPS TO IDENTIFY LITERATURE

TABLE 1 CHARACTERISTICS OF THE REVIEWED STUDIES

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Alsamarai et al.	VA health system	Retrospective cohort study	Timeliness of care	Lung cancer	Veterans with lung cancer	+
Bass et al.	VA health system	Cohort study	Caregiver perceptions of unmet needs; caregiver strains; caregiver depression; support resources available	Dementia	Veterans with dementia and caregivers	+
Berry et al.	A pediatric practice	Cohort study	Ability of a pediatric clinic to meet medical home (MH) objectives; receipt of services for families of children with special health care needs	--	Children with special care needs	+
Boyd et al.	Long-term care facilities	RCT	All resident hospitalizations and subgroups classified as medical or surgical admissions	--	Residents in long-term care facilities	+
Bronstein, Gould, Berkowitz, James, & Marks	A hospital	RCT	30-day hospital readmission rate	--	Adults age 50 or older at moderate or high risk of re-hospitalization	+
Bruce et al.	Home healthcare agencies	RCT	Depression severity	Depression	Medicare population with depression	+
Cady et al.	A medical home	RCT	Family-centered care (FCC), need for care coordination help and adequacy of care coordination help received	Chronic conditions	Children with medical complexity	N
Carter et al.	A hospital	Cohort study	All-cause 30-day readmission rates	--	Patient with high risk for readmission	+

Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Coburn et al.	Seven hospitals	RCT	All-cause mortality	Coronary artery disease, heart failure, diabetes, asthma, hypertension, or hyperlipidemia	Adults aged 65 and older with one or more chronic conditions	+
Cohen et al.	Primary care medical homes	Pre and post without control	Health care utilization and expenditures, parent reports of parent- and child-quality of life (QOL), and family-centered care	Pediatrics	Children with complex care needs	M
Collinsworth et al.	Five community clinics	Pre and post without control	Mean blood glucose (A1C), body mass index (BMI), and systolic and diastolic blood pressure	Diabetes	Adults aged 18 or older with a diagnosis of type 2 diabetes	+
Coughey et al.	Communities	Retrospective cohort study	Emergency department visits, hospitalizations, and office visit claims	Asthma	Children with asthma	+
Daly et al.	An outpatient clinic	Cohort study	Health related quality of life	Stage III or IV lung, gastrointestinal or gynecologic cancer.	Adults with cancers	+
Dang et al.	An VA health system	Cohort study	Framingham risk score, systolic blood pressure, diastolic blood pressure, low-density lipoprotein (LDL) cholesterol	Coronary heart disease	Older adults with type 2 diabetes	+
						Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Dhalla et al.	Four hospitals	RCT	Composite of readmission or any hospital or death within 30 days of discharge.	--	Adults at higher risk of readmission	N
Enard et al.	A medical center	RCT	Colorectal cancer screening adherence	Colorectal cancer	Latino Medicare beneficiaries	+
Fagan et al.	Nine independent primary care practices	Retrospective cohort study	Seven disease-specific quality measures and two measures of resource use	Diabetes	Adults aged 65 and older with diabetes	N
Farmer, Clark, Drewel, Swenson, & Ge	Primary care practices	RCT	Unmet needs, patient satisfaction, and ratings of child health and family functioning	Chronic conditions expected to last for at least 12 months	Children with special care needs	+
Findley et al.	Communities	Cohort study	Health care utilization, provider perception	Asthma	Children with asthma	+
Geltman et al.	A large, integrated health system	Cohort study	Two modified HEDIS measures, use of the Vanderbilt scales	Attention-deficit/hyperactivity disorder (ADHD)	Children with ADHD	+
Green et al.	21 primary care medical centers	RCT	Colonoscopy completion after a positive colorectal cancer	Colorectal cancer	Patients aged 50-74	N

Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Haley et al.	9 primary care physician and 5 nephrology practices	Pre and post without control	Chronic kidney disease identification, referral to nephrologists, communication among primary care physicians and nephrologists, co-management processes.	Chronic kidney disease	Older than 50 years, with a diagnosis of diabetes mellitus and hypertension, and followed up by the practice for at least 12 months	+
Irvine et al.	17 hospitals and 11 community-based organizations	Pre and post without control	Care engagement and viral load suppression	HIV	HIV-infected adults	+
Jackson, Trygstad, DeWalt, & DuBard	Primary care medical homes	Cohort study	Hospital readmission	Complex chronic conditions	Medicaid beneficiaries with complex chronic medical conditions	+
Keller et al.	An academic medical center	Controlled, quasi-experimental evaluation	Hospital readmission	Infectious diseases	Outpatient parenteral antimicrobial therapy (OPAT) patients	M
Kim et al.	Communities	RCT	Use of primary and preventive care, reduce hospital admissions, and reduce emergency department visits	Disabilities	Medicaid beneficiaries aged 20-64 with disabilities	N
Lawson et al.	Six community health centers and hospital-based primary care centers	Cross-sectional study	Access to medical care, practice help and support, satisfaction with services, and parental mental and physical health.	--	Children with special care needs	+

Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Looman et al.	A pediatrics clinic	RCT	Primary caregivers' satisfaction with health services and perceived adequacy of care received relative to care needed	--	Children with medical complexity and their families	+
Masson et al.	Communities	RCT	For hepatitis A and hepatitis B: vaccination receipt of the first vaccination dose within 30 days of the date of referral	Hepatitis care	Methadone maintenance patients	+
Morando et al.	A hospital	Cohort study	30-day readmission rates; 12-month mortality and costs for management	Cirrhotic care	Patient with cirrhotic and ascites	+
Morgan et al.	A VA health system	Cohort study	Health care costs	Dementia care	Veterans with dementia	N
Ohl et al.	A VA health system	Pre and post without control	VA healthcare system performance measures for care for HIV infection and common comorbidities, patient travel time to obtain care, and patient satisfaction	HIV	Veterans with HIV infection	+
Peter et al.	A hospital	Cohort study	Health care utilization, health costs and cost-effectiveness	--	Children with complex care needs	+
Plant et al.	A hospital	RCT	P: Numbers of re-presentations or readmissions, quality of life; Other: time to re-presentation, readmission or death, length of stay, and access to hospital and community health services	Chronic illness	Adults aged 16-69 with at least one admission for a respiratory- or cardiology- related condition	N

Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Rantz et al.	A home care agency	Retrospective cohort study	Length of stay in home and community; health care costs	--	Elderly people	+
Redding et al.	Communities	Cohort study	Low birth weight	Maternal health	Women with high risk for having poor birth outcomes	+
Samus et al.	Communities	RCT	Time to transition from home, unmet needs, self-reported quality of life	Dementia care	People aged 70 and older with a cognitive disorder, community-living, English-speaking, and having a study partner available.	+
Sepers et al.	Four patient-centered medical homes	Pre and post without control	Clinical health indicators, A1C, body mass index (BMI), blood pressure, and lipids, as well as the AADE7 Behaviors	Diabetes	Patient with diabetes	+
Shaw, O'Neal, Siddharthan, & Neugaard	VA health system	Cohort study	Self-management	Heart failure	Veterans with heart failure	+
Tanner et al.	Communities	RCT	P: Total percent of unmet caregiver needs at 18 months; S: objective and subjective caregiver burden measures, quality of life, and depression	Dementia	Informal caregivers	N

Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Thomas, Krevers, & Bendtsen)	Primary care centers	Cross-sectional study	Reach: the proportion of patients receiving lifestyle promotion; effectiveness: self-reported attitudes and competency among staff; adoption: proportion of staff reporting daily practice of lifestyle promotion and referral; and implementation, of the coordinated care model	--	--	N
Treadwell & Giardino	Five medical home practices	Cohort study	Health care costs and provider satisfaction	--	Medicaid population	+
Vanderboom, Holland, Lohse, Targonski, & Madigan	A health care home	RCT	Patient-centered chronic illness care	Chronic conditions	Adults aged 55 and older with multiple chronic conditions	+
Welch et al.	An urban community healthcare center	RCT	Blood glucose, blood pressure, foot exam, eye exam, level of levels of diabetes distress, depression, and treatment satisfaction	Diabetes	Adults aged 30-85 with type 2 diabetes	+

Continued

TABLE 1 CONTINUED

Authors	Study Setting	Study Design	Outcomes	Health Conditions	Population Studied	Results
Wodarski & Green	A health services research center and a mental health system	Cohort study	Alcohol and drug use, health care utilization, overall health, crime, social connectedness	Substance abuse	Adults aged 18-56 with substance abuse	+
Wootton, Gramotnev, & Hailey	Australian VA health system	RCT	Health care costs and quality of life	Complex medical conditions (anticipated to last for at least six months, and require multidisciplinary care.)	Australian veterans with chronic or complex medical conditions	N
Yoo, Nakagawa, & Kim	A non-profit academically affiliated hospital	Cohort study	Occurrence of delirium and transition to a nursing home	Delirium	Medicare beneficiaries	M
Young et al.	23 public and private hospitals in Australia	RCT	Emergency department presentations, unplanned hospital readmissions, experience of care coordination, distress, and quality of life	Colorectal cancer	Adults with colorectal cancer	N

Notes: RCT: randomized clinical trial; VA: Veterans Affairs. In the results column, + refers to the positive results (e.g., reduced health costs, improved quality etc.), M refers to the mixed results, indicating studies found improvement in some outcomes; N means null results, indicating no significant results were reported; HEDIS: Healthcare Effectiveness Data and Information Set.

TABLE 2 CARE COORDINATION ELEMENTS IN THE REVIEWED STUDIES

Authors	Care Coordination Elements								
	Patient education	Health assessment	Patient and family engagement	Individualized health plan	Team meeting	Risk identification	HIT use	Monitoring & follow-up	Provider communication
Alsamarai et al.					1		1		
Bass et al.		1		1				1	
Berry et al.		1		1	1				
Boyd et al.	1	1							1
Bronstein et al.		1							
Bruce et al.	1	1		1		1	1		
Cady et al.	1						1	1	1
Carter et al.	1			1	1	1			
Coburn, Marcantonio, Lazansky, Keller, & Davis	1	1		1		1		1	
Cohen et al.			1	1			1		
Collinsworth et al.	1								
Coughey et al.	1	1	1						
Daly, Douglas, Gunzler, & Lipson	1		1	1	1	1			
Dang, Sanchez, Oropesa, Roos, & Florez	1					1	1	1	
Fagan et al.							1	1	1

Continued

TABLE 2 CONTINUED

Authors	Care Coordination Elements								
	Patient education	Health assessment	Patient and family engagement	Individualized health plan	Team meeting	Risk identification	HIT use	Monitoring & follow-up	Provider communication
Dhalla et al.				1	1				1
Enard et al.	1	1					1		
Farmer, Clark, Drewel, Swenson, & Ge	1		1						1
Findley et al.	1	1	1	1					
Geltman et al.							1		
Green et al.							1		
Haley et al.	1					1			1
Irvine et al.			1		1				
Jackson, Trygstad, DeWalt, & DuBard	1							1	
Keller et al.								1	
Kim et al.		1		1		1		1	
Lawson, Bloom, Sadof, Stille, & Perrin	1		1						
Looman et al.		1	1	1			1		
Masson et al.								1	
Morando et al.		1							
Morgan et al.		1		1				1	
Ohl et al.					1		1		

Continued

TABLE 2 CONTINUED

Authors	Care Coordination Elements								
	Patient education	Health assessment	Patient and family engagement	Individualized health plan	Team meeting	Risk identification	HIT use	Monitoring & follow-up	Provider communication
Peter et al.		1	1	1				1	
Plant et al.		1				1		1	
Rantz et al.	1	1	1				1		1
Redding et al.		1							
Samus et al.	1	1		1					
Sepers et al.	1	1	1						
Shaw, O'Neal, Siddharthan, & Neugaard	1		1						
Tanner et al.	1	1		1				1	
Thomas, Krevers, & Bendtsen		1							
Treadwell & Giardino		1		1				1	
Vanderboom, Holland, Lohse, Targonski, & Madigan		1		1	1				
Welch et al.	1						1	1	1
Wodarski & Green		1			1				
Wootton, Gramotnev, & Hailey		1						1	
Yoo, Nakagawa, & Kim		1							

Young et al.	1

Notes: HIT: health information technology

ANALYZING DETERMINANTS OF ACCOUNTABLE CARE ORGANIZATIONS' SUCCESS IN ACHIEVING SHARED SAVINGS

ABSTRACT

Background: Accountable care organizations (ACOs) were designed to improve quality and control costs of health care through improved care coordination. The ACO program has been implemented rapidly across the country. These is growing interests in examining the associations between ACOs' organizational forms and their performance. Previous studies indicated mixed results on organizational factors contributing to ACOs' performance in terms of quality and costs. However, there is no study examined both market and organizational characteristics associated with ACOs' financial performance using a national representative sample.

Methods: This is a cross-sectional study examining the market and organizational characteristics associated with ACOs' success in achieving shared savings. A total number of 218 ACOs participating in Medicare Shared Savings Program in 2012 and 2013 were included in the study.

Findings: Among 218 Medicare SSP ACOs established in 2012 and 2013, 51 (23.39%) of them have earned shared savings in their first performance year. Results from multivariate analyses indicated no significant associations between market characteristics and ACOs' financial performance. Among ACO-level organizational characteristics, post-acute care facility affiliation and hospital leadership were found to be associated with better financial performance. Other organizational characteristics were not associated with ACOs' financial performance.

Conclusions: Organizational factors are more important to ACOs' financial performance than market characteristics. Coordinating care with post-acute care settings and involving

hospitals in the leadership would help ACOs to earn shared savings. More research is needed to validate these findings and identify other important factors.

INTRODUCTION

Accountable care organizations (ACOs) are one of the Affordable Care Act's major policy initiatives to improve quality and control costs of health care (Berwick, 2011a). Participants of an ACO, including individual physicians, physician groups, hospitals, and other organizations are responsible for the quality and cost of care for a defined patient population. If providers are able to meet cost benchmark while satisfying quality criteria, they are eligible to share in achieved cost savings (Berwick, 2011b). The ACO program is being implemented rapidly in Medicare, Medicaid, and commercial sectors. A total number of 744 ACOs have been established as of January 2015, covering more than 20 million patients in the United States (Tu, David, Lawrence, & Ross, 2015).

The ACO model aims to improve health system through significantly transforming how care is delivered (Berwick, 2011a). In a fragmented health care system, health services are delivered by numerous freestanding providers and organizations, leading to increased costs without better quality or outcome (Cebul, Rebitzer, Taylor, & Votruba, 2008; Enthoven, 2009). The ACO model encourages providers and organizations to redesign care delivery processes and organizational structure to coordinate health care delivery. There are three core conditions providers need to consider when they form an ACO: (a) the provision of a continuum of care, (b) the capacity to develop, implement, and monitor prospectively planned budgets, and (c) sufficient beneficiary size to report comprehensive, valid, and reliable performance measurement across organizational and clinical activities (Devers & Berenson, 2009).

Health care organizations and providers may adopt various organizational forms to meet these conditions. Depending on their previous structure, connections with other

providers, and care coordination experience, an ACO could be a self-contained integrated health system with a single ownership delivering health services across the continuum of care, or a physician-led, primary care-focused practice contractually connected with other providers and organizations (Mick & Shay, 2016; Shortell, Wu, Lewis, Colla, & Fisher, 2014). Previous studies have documented variations in organizational forms among ACOs in terms of scope of services, size, hospitals' participation, inclusion of post-acute facilities, behavior health, and substance abuse therapy (D'Aunno, Friedmann, Chen, & Wilson, 2015; Lewis et al., 2014; Shortell et al., 2014; Yeager, Zhang, & Diana, 2015). For example, only half of ACOs were identified that formally include at least one post-acute service (Lewis et al., 2014).

These is growing interests in examining the associations between ACOs' organizational forms and their performance. Previous studies indicated mixed results on organizational factors contributing to ACOs' performance. Regarding health care quality, Albright et al. found that participation in the advanced payment model, having fewer specialists, and having more Medicare ACO beneficiaries per primary care provider were associated with better preventive care quality (Albright, Lewis, Ross, & Colla, 2016). In another study, D'Aunno and colleagues identifies six factors associated with better quality performance, including collaboration with hospitals, effective physician group practice prior to ACO engagement, trusted, long-standing physician leaders focusing on performance improvement, sophisticated use of information systems, effective feedback to physicians, and embedded care coordinators (D'Aunno, Broffman, Sparer, & Kumar, 2016). In terms of health care costs, Ouayogodé et al. found no organizational structure factors associated with ACOs' performance in generating cost savings (Ouayogode,

Colla, & Lewis, 2016). In addition, some researchers have extended to examine the market characteristics associated with ACOs' performance, such as competition, supply and demand of health care (D'Aunno et al., 2016; Ouayogode et al., 2016). These studies have provided valuable insights on ACOs' organizational forms and performance. However, each study was limited either by the market or ACO characteristics they examined or by the number of ACO they included in the study. To date, there is no study examined both market and organizational characteristics associated with ACOs' financial performance using a national representative sample. Given the heterogeneity of ACOs' organizational forms and market environment, more studies are needed to understand organizational and market characteristics associated with ACOs' performance.

This study examined the market and organizational characteristics associated with ACO's success in achieving shared savings. Using a comprehensive dataset on ACOs' participating providers and organizations, this study included key ACO organizational factors that have not been examined by previous studies. Findings of this study may provide new insights for policy makers and researcher to understand the ACOs' organizational forms and their performance.

THEORETICAL PERSPECTIVE

This study was conceptualized using two theories—resource dependency theory and transaction cost economics.

Resource Dependency Theory

Resource dependency theory (RDT) has been widely used to explain the strategies and performance of health care organizations (Yeager et al., 2014). RDT argues that

organization is an open system. Individual organizations usually do not possess all critical resources needed for survival and development. Therefore, organizations need to acquire resources from environment (Pfeffer & Salancik, 2003). Environment with certain characteristics, such as dense population, high costumer demand, and stable political and legislative conditions could support organizations' resource needs. On the contrary, organizations operating in environment with less munificent (e.g., low income per capita) conditions, having unpredictable changes, or having intense competitions may face challenges to obtain and sustain resources.

Three constructs were proposed to operationalize environment: munificence, dynamism, and competition (Dess & Beard, 1984). Munificence refers to the availability and accessibility of resources in environment (Dess & Beard, 1984; Sharfman & Dean, 1991). Munificence is important since an organization's development needs financial, labor, and other resources. A less munificent environment with stringent resource supply could impede organizations' ability to improve efficiency and performance. Dynamism represents the turnover, absence of pattern, or unpredictability within the environment. According to RDT, a dynamic environment may not be able to ensure the sustainability of resources needed by organizations, nor can it reduce acquisition activity by placing the value of new resource combinations in doubt (Hoskisson & Hitt, 1990). Competition is captured by the number and diversity of stakeholders (e.g., competitors, suppliers, and buyers) that decision-makers need to consider in formulating strategies (Smart & Vertinsky, 1984). A competitive environment will increase the level of uncertainty perceived by decision makers, expanding the time they need to understand the environment and possibly making them less willing to undertake new strategies.

As a new delivery and payment model, health care providers and organizations need various resources to meet the requirements and build the capacity to be a fully functioning ACO. These requirements and capacity may include pooling enough beneficiaries, updating electronic health records (EHRs) system, developing data-based tools and health information technology, recruiting physician practices, and improving care coordination ability (American Hospital Association, 2011; Fisher, Shortell, Kreindler, Van Citters, & Larson, 2012; Singer & Shortell, 2011). Achieving these task costs considerably and may be challenging to some providers. For example, the American Hospital Association estimated that it will cost $5.3 million in start-up costs and $6.3 million in ongoing (annual) costs for a single free-standing hospital, 80 primary care physicians and 250 specialists to form an ACO; and for a five-hospital (1,200 bed) system, 250 primary care physicians and 500 specialists, it will cost $12.0 million in start-up costs and $14.1 million in ongoing costs (American Hospital Association, 2011). Health care providers and organizations with sufficient financial and labor resources are more likely to accomplish these tasks and to have better performance. In addition, providers and organizations in rural areas may face environmental constrains to have a large enough beneficiary pool and find collaborators given the greater geographic separation among providers (Mackinney, Mueller, & McBride, 2011).

Primary care is one of the essential elements for the ACO model (Rittenhouse, Shortell, & Fisher, 2009). Primary care is associated with improved health care quality and reduced health costs (Friedberg, Hussey, & Schneider, 2010; Starfield, Shi, & Macinko, 2005). In addition, a strong primary care workforce is also the key for improved care coordination (Pham, O'Malley, Bach, Saiontz-Martinez, & Schrag, 2009;

Starfield et al., 2005). Given the shortage and uneven geographic distribution of primary care providers nationwide, ACOs with greater primary care capacity will be more likely to control the cost and have better financial performance.

ACOs also vary in terms of their size. Compared with small ACOs, a larger ACO may have more physicians and greater patient flow and more affiliated providers, potentially providing them a higher level of control over the resources they need to develop the capacity for care coordination, care management, and HIT update.

Therefore, this study hypothesized that ACOs operating in more munificent and less competitive market, having strong primary care capacity, having larger size are more likely to have better financial performance.

Transaction Cost Economics

Transaction cost economics (TCE) is the leading perspective to examine the strategy, structure, and performance of organizations. TCE uses transaction as the basic analytical unit. A transaction refers to an exchange of a good or service between two or more economic actors (Williamson, 1985). The central claim of the theory is that carrying out transactions is associated with costs. To improve the efficiency and performance, transactions should be handled in such a way to minimize these costs (David & Han, 2004; Williamson, 1985).

TCE assumes two essential factors existing in transaction processes: *bounded rationality* and *opportunism* (Williamson, 1981). Bounded rationality suggests that decision makers always exhibit imperfect rationality because of informational, cognitive, or temporal limits (Williamson, 1985). The existence of bounded rationality implies that

economic actors would not foresee all the contingencies associated with a contract. Therefore, changes or conflicts may happen when implementing transactions. Opportunism refers to the self-interest-seeking behaviors of economic actors. Economic actors are assumed to be primarily oriented toward their personal interests and disregard the interests of their partners. When transaction is implemented, economic actors will not reliably fulfill their promises as they signed for a contract and they will maximize their own interests.

Transactions differ in three dimensions, including *asset specificity*, *uncertainty*, and *frequency* (Carter & Hodgson, 2006; David & Han, 2004). Investments, such as human resources, physical assets, and brand labels are required for a transaction. Some investments could be reused for other purposes, while some investments are specifically made for this transaction. Asset specificity refers to the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value (Williamson, 1996). Frequency is simply how often a transaction occurs, which can be either occasional or recurrent (Diana, 2009). Uncertainty refers to unanticipated changes that could occur when implementing a transaction (Noordewier, John, & Nevin, 1990). They are hard to predict and costly to develop appropriate responses in advance. These three attributes, combined with the assumption of bounded rationality and opportunism, determine the nature of a transaction and the costs to process a transaction. For example, it could be costly for an actor to make a decision for a highly transaction-specific investment for a contract with considerable uncertainty and possible defection. He may put considerable ex-ante efforts to have a contract as comprehensive as possible which specifies any contingencies, or take ex-post safeguards to combat the threat of

opportunism. A contract which partners interact frequently could generate numerous disputes and conflicts (e.g., disputes due to opportunistic behaviors). It would be costly or even impossible to resolve every dispute through courts in a timely, knowledgeable, and efficient fashion.

To carry out a transaction efficiently, decision makers have incentives to adopt appropriate governance structure to mitigate contract hazards and economize on transaction costs. Williamson identifies three forms of transaction governance: *market*, *hybrid*, and *hierarchy* (Williamson, 1991). A market transaction occurs between individual parties without dependency relation and formal linkage, whereas a hierarchy transaction is carried out within an organization which parties have formal connections and are under control of authority (e.g., divisions of an organization). The hybrid governance stands between market and hierarchy. Parties involved in a to hybrid transaction maintain autonomy but are bilaterally dependent in a nontrivial way. The TCE perspective claims that for a specific transaction, the governance structure (i.e., hierarchy, hybrid, or market) that minimizes transaction costs is the preferred option.

Health care delivery could be organized in different ways. Patients can receive health services from many individual stand-alone providers with a series of unconnected transactions, or from an integrated organization with coordinated clinical activities. The delivery of health care in the United States is distributed across a variety of distinct and often competing entities. These entities usually have different objectives, obligations and capabilities (Cebul et al., 2008). Considerable transaction costs could be generated in this fragmented health system due to efforts to negotiate, monitor, and enforce agreement and coordinate care with other components of the delivery system (Laugesen & France, 2014;

Robinson & Casalino, 1996). Studies found that this fragmented delivery structure could lead to disrupted relationships, poor information flows, and misaligned incentives, which degrades care quality and increase costs. Close coordination between providers and organizations is required to improve quality and control costs of health care.

Accountable care organizations (ACOs) were proposed to deliver quality and affordable health care through improved care coordination. Compared to previous care delivery models (e.g., integrated delivery networks), the ACO model features in several important ways. ACOs heavily rely on health information technology to share clinical information among providers. The ACO model uses potential shared savings (or losses) to create financial incentives to encourage providers to eliminate waste and improve efficiency. In addition, all participants of an ACO need to collaborate to meet quality benchmarks, which may better align incentives of individual providers to the goal of the ACO.

Providers and organizations could take a variety of organizational forms to form an ACO. The possible organizational forms include integrated delivery systems, primary care or multispecialty medical groups, hospital-based systems, and even contractual or virtual networks of physicians, such as independent practice associations (Barnes, Unruh, Chukmaitov, & van Ginneken, 2014; Mick & Shay, 2016). In addition, ACOs may also adopt different governance models. An ACO could be physician-led, hospital-led or joint-led, each with its own merits and weaknesses (Kocher & Sahni, 2010).

From the TCE perspective, these organizational forms represent different capacities to minimize transaction costs and improve efficiency. A highly integrated ACO delivering entire continuum of care may be more likely to align providers'

incentives with the goals and priorities of the ACO, as compared with a less integrated ACO (Burns & Muller, 2008). Given the previous care coordination and integrated care experiences, a health care system-based ACO could be easier to nurture trust and a sense of shared goals between physicians and ACO administrators (Robinson & Casalino, 1996), which are more likely to economize on transaction costs associated with the changes in referral patterns, clinical protocol, and payment methods, compared to ACOs formed by providers without previous connections and collaborations. ACOs with advanced EHR use could better inform providers patient's history, condition, and needs, and the organization is better equipped to manage health services capably and effectively. Compared with hospitals, physicians may lack capacity to effectively organize themselves into groups, agree on clinical guidelines, and devise ways to equitably distribute money, all of which are required by the ACO model (Kocher & Sahni, 2010).

Therefore, this study hypothesized that more integrated ACOs, ACOs has a health care system affiliation, ACOs with advanced EHR use, and ACOs led by hospitals are more likely to have better financial performance.

METHODS

Overall Design and Study Population

This is a cross-sectional study examining market and organizational characteristics associated ACOs' performance of earned shared savings. A total number of 220 Medicare Shared Savings Program (SSP) ACOs established in 2012 and 2013 were considered in this study. Two ACOs operating in Puerto Rico were dropped since

their market characteristics were not available. Therefore, 218 Medicare SSP ACOs were included in this study.

Data Source

This study combined primary data and several secondary datasets. The financial performance data of Medicare SSP ACOs established in 2012 and 2013 are from 2013 Medicare SSP ACO Public Use File. This file includes ACOs' financial data in their first performance year. For 27 ACOs established in April 2012, the first performance year was from April 2012 to December 2013. For 87 ACOs established in July 2012, the first performance year was from July 2012 to December 2013. For 104 ACOs established in January 2013, the first performance year was equivalent to the calendar year of 2013.

All market characteristics including health resources, health demand, income per capita, and poverty rate in 2013 are from the Area Health Resource Files. The ACO-level organizational characteristics, including number of total providers, number of different types of providers (e.g., primary care physicians, specialists, or nurse practitioners), beneficiary characteristics (e.g., average age, gender, and race), ACOs' expenditure benchmark, ACO contract start date, program track status, and advanced payment status are from 2013 Medicare SSP ACO Public Use File.

The 2013 Medicare SSP ACO Provider Level Research Identifiable File was requested from the Centers for Medicare and Medicaid Services (CMS). This file contains National Provider Identifier (NPI), CMS Certification Number (CCN), and specialty code for each health care provider participating in the 218 ACOs. We identified primary care facilities, hospitals, post-acute care facilities, and health system affiliations

by cross-referencing this file with 2013 American Hospital Annual Survey, 2013 CMS Home Health Compare, 2013 Nursing Home Compare, 2013 Inpatient Rehabilitation Compare.

For EHR use, the ACO provider level file was cross-referenced with CMS Meaningful Use (MU) Public Use Files to identify eligible ACO providers who have attested the Stage 1 of MU program by 2013. Primary data were collected about ACO's leadership. Public information about composition of ACOs' governance board on each ACO's website was reviewed to identify whether an ACO is physician-led, hospital-led, or joint-led.

Define Market for ACOs

Previous studies examining organizations' external environment usually used county, Metropolitan Statistical Area, or state as an organization's market (Yeager et al., 2014). However, the service area of an ACO usually crosses these geographic boundaries. Some ACOs' service regions even cross multiple states that are not adjacent (e.g., Florida and California). This brings challenges to define the market for an ACO in this study. Data from ACO provider level file indicated that although an ACO's service areas could expand to multiple counties or states, providers of an ACO usually are highly concentrated. For 101 ACOs (46.33%), at least 85% of their providers concentrate in a single hospital referral region (HRR). This single HRR was used as the associated market and all market characteristics were measured at the HRR level for these ACOs. For other ACOs, the HRR with a plurality of providers only account for 30-40% of all participating providers. However, providers from the top three HRRs comprise 80% of providers of

these ACOs. Therefore, regions covered by these three HRRs were defined as the associated market and market variables were collapsed to this level.

Variables

Outcome Variable

The outcome of this study is ACOs' earned shared savings in their first performance year. Three different forms of this variables were tested: (1) the real value of earned shared savings in US dollars; (2) the hyperbolic sine transformed value to address the skewed distribution of the earned savings; (3) the binary variable indicating whether ACOs earned any shared savings.

Independent Variables

The market characteristics included environment munificence and competition. The munificence of environment was measured by *number of physicians per 1,000 population, number of hospital beds per 1,000 population*, *number of skilled nursing facility beds per 1,000 population*, *proportion of population age 65 or above*, *poverty rate*, and *income per capita*. All these variables were used as their 2013 value.

Competition were captured by *ACO penetration* and *ACO concentration*. *ACO penetration* is defined as proportion of Medicare fee-for-services beneficiaries enrolled in ACOs in each market. Details about the ACO penetration are available in the appendix.

ACO concentration was measured by the Herfindahl-Hirschman Index (HHI) indicating the degree of ACO beneficiaries concentrating in ACOs. Specifically, this measure was calculated using the following equation: $HHI_i = \sum_{j=1}^{n} S_j^2$, where $S_j$is the

share of beneficiaries of ACO *i* in a market, and *n* is the number of ACOs in this market. The higher value of this variable indicates a higher concentration of ACO beneficiaries.

The size of an ACO was measured by the number of providers including primary care physician (PCPs), specialists, nurse practitioners (NPs), physician assistants, and clinical nurse specialists. The primary care capacity of ACOs was captured by the *proportion of PCPs and NPs* among all providers. The integration of an ACO was measured by three binary variables, including *inclusion of a primary care facility* (i.e., rural health clinics or federally qualified health centers), *inclusion of a hospital*, *inclusion of a post-acute care facility* (i.e., skilled nursing facility, home health agency, inpatient rehabilitation center, or long-term care hospital). *Health care systems affiliation* was measured by a binary variable indicating whether an ACO involves any health care system. *Leadership* is a categorical variable with three categories: *physician-led, hospital-led, or joint-led*. *EHR implementation* is measured by the *proportion of eligible providers who attested the Meaningful Use Stage 1* by 2013.

Additional variables that may be related to an ACO's financial performance were added, including *demographic characteristics of an ACO's assigned beneficiaries* (i.e., proportion of beneficiaries over 65, proportion of female beneficiaries, and proportion of non-white beneficiaries), *beneficiary risk factors* (i.e., proportion of disabled person years and proportion of dual-eligible person years). An ACO could choose to participate in either Track 1 or Track 2 SSP program. A Track 1 ACO is not accountable for shared losses. However, a Track 2 ACO with shared losses must repay CMS. Therefore, a binary variable indicating an ACO's *track status* was added. Small, rural, or physician-only SSP ACOs could participate in the Advance Payment ACO Model which gives upfront and

monthly payments for participating ACOs to make important investments in their care coordination infrastructure (Centers for Medicare and Medicaid Services, 2013). Instead, other ACOs may not receive any shared savings until the end of a performance year. A binary variable indicating whether an ACO was in the *Advanced Payment Model* was created. Finally, a categorical variable indicating an ACO's *start date* (April 2012, July 2012, or January 2013) was added.

Analyses

A linear regression model was used for the continuous outcomes and a logit model was used for the categorical outcome. The model specification for the linear regression is:

$$y_{1i} = \alpha + \beta * S_i + \gamma * M_i + \delta * C_i + \varepsilon_i$$

The model specification for the logit regression is:

$$\mathrm{P}\,(y_{2i} = 1) = f(\alpha + \beta * S_i + \gamma * M_i + \delta * C_i + \varepsilon_i)$$

y_{1i} is the real value or transformed value of an ACO's earned shared savings; y_{2i} is a binary variable indicating whether an ACO earned any shared savings where 1 refers to an ACO earned shared savings.

S_i represents ACO-level characteristics of ACO i;

M_i represents market-level variables of ACO i;

C_i refers other control variables of ACO i.

ε_i is the error term.

i=1, 2, …, .218.

RESULTS

Descriptive Results

Table1 provides descriptive characteristics of the sample. Among 218 Medicare SSP ACOs, 51 of them earned shared savings. The average earned savings per beneficiary among those 51 ACOs was $358.03. There were no differences in market characteristics between ACOs earned shared savings and those not, except that ACOs that earned shares savings were operating in markets with lower degree of concentration.

In terms of organizational characteristics, the average size of an ACO was around 500 providers. ACOs were staffed primarily by primary care providers. More than half of ACOs' providers were primary care physicians and nursing practitioners. ACOs that earned shared savings tended to have fewer providers and had higher proportion of primary care providers. Around 20% ACOs included a rural health clinics or federally qualified health centers, and ACOs that earned shared savings were less likely to have them. Nearly half of ACOs included at least one hospital, and ACOs that earned shared savings were more likely to have an affiliated hospital. Around 25% of ACOs had affiliated post-acute care facilities and this rate was higher among ACOs that earned shared savings. About 40% of ACOs included an affiliated health system and more ACOs that earned no shared savings had a health system.

ACOs were primarily led by physicians and ACOs earned shared savings were more likely led by hospitals than those not earned savings. Regarding beneficiary characteristics, ACOs with earned shared savings had similar beneficiaries with other

ACOs. ACOs earned shared savings had higher benchmark expenditure per beneficiary, indicating the higher historical expenditure. Only 2% of ACOs chose to participate in Track 2 program. Finally, more ACOs with shared savings started the program in 2012.

Multivariate Results

Table 2 presents the results from multivariate analyses. Column (1) – (3) shows the results using earned shared saving per capita, transformed earned shared saving per capita, and whether these organizations earned any shared savings as outcomes respectively. Results from three models were consistent. First, no market characteristics were found to be associated with ACOs' financial performance. Two ACO's organizational characteristics were found to be associated with better financial performance. Specifically, all three regressions indicated that ACOs with an affiliated post-acute care facility were more likely to earn higher shared savings per beneficiary or more likely to earn any shared savings. Results from column (2) and (3) suggests that ACOs led by a hospital were more likely to have higher shared savings or more likely to earn any shared savings. Other ACO-level characteristics have no significant relationships with ACOs' earned shared savings.

Among other ACOs' characteristics, the results indicate that ACOs having more non-white beneficiaries were less likely to earn shared savings. Having higher cost benchmark per beneficiary was associated with higher earned shared savings per beneficiary. Column (3) indicates that Track 2 ACOs were more likely to earn higher shares saving, and ACOs enrolled in Advanced Payment Model were less likely to earn higher shares saving. However, these findings were not found in other two linear regressions.

DISCUSSION

Accountable care organizations were designed to control health spending while improving quality through delivering coordinated care. An increasing number of health care providers and organizations are participating in the ACO program. Previous studies indicated that ACOs vary in terms of organizational forms. There is growing interests in examining the association between ACOs' organizational structure and their performance. In addition, some studies have expanded on investigating how ACOs' market characteristics are associated with their performance. Using resource dependency theory and transaction cost economics perspective, this study analyzed the market and organizational characteristics associated with Medicare SSP ACOs' performance in earning shared savings.

Among 218 Medicare SSP ACOs established in 2012 and 2013, 51 (23.39%) of them have earned shared savings in their first performance year. Results from multivariate analyses indicated no significant associations between market characteristics and ACOs' financial performance. Among ACO-level organizational characteristics, post-acute care facility affiliation and hospital leadership were found to be associated with better financial performance. Other organizational characteristics were not associated with ACOs' financial performance.

Post-acute services, including services provided by skilled nursing facilities, home health agencies, inpatient rehabilitation facilities, and long-term care hospitals are heavily used by Medicare beneficiaries. For example, about 42% of Medicare beneficiaries discharged from prospective payment system hospitals went to a post-acute care facility in 2013. The costly post-acute care is one of the driving factors of Medicare

spending growth. Although the total Medicare spending for patients hospitalized with heart attack, congestive heart failure, or hip fracture increased by 26.7%, 37.3%, and 35.2% respectively between 1994-2009, the Medicare spending on post-acute care increased by 250.4%, 164.2%, and 99.9% among these three patient groups respectively (Chandra, Dalton, & Holmes, 2013). Previous studies suggested that the poor coordination between post-acute facilities and other settings may be the cause of the increased spending. Patients usually are discharged to a post-acute care facilities with little coordination or follow-up. This could lead to unnecessary and costly readmissions (Mechanic, 2014). In addition, acute care providers and post-acute care providers receive separate payments. Therefore, acute care providers have had little incentive to improve transition processes between acute and post-acute care settings or to support post-acute care providers when recently hospitalized patients have complications (Ackerly & Grabowski, 2014; Colla, Lewis, Bergquist, & Shortell, 2016; Mechanic, 2014). All these problems could cause unnecessary health care utilization and spending.

Inclusion of a post-acute care facility could create various opportunities for ACOs to control spending and generate shared savings. An ACO is responsible for the total spending of the assigned beneficiaries. ACO providers have incentives to improve the coordination of the whole continuum of care delivery. Formally including a post-acute care facility could give ACOs higher capacity to effectively impact the entire delivery process, as compared with ACOs without post-acute care facilities or ACOs integrating post-acute care with contractual relationships. From the transaction cost perspective, including post-acute care facilities and providers helps ACOs to minimize transaction costs associated with negotiation (e.g., develop and apply new clinical protocols among

post-acute care providers), information seeking (e.g., medical information exchange among acute-care and post-acute care settings), and assignment enforcement (e.g., ensuring quality of care in post-acute care settings). On the contrary, these transaction costs may be higher among ACOs including post-acute care facilities informally (e.g., contracts) as these facilities and providers are under different ownerships. These ACOs may face challenges to make sure these facilities and providers buy-in their new clinical protocols and interventions, sharing clinical information, and enforce care delivery process. Therefore, inclusion of post-acute care facilities and providers could better reduce the transaction costs and improve the efficiency of ACOs to deliver coordinated health care.

Previous studies reported important efforts ACOs have made to strengthen the relationship between post-acute and other care settings (Kroch et al., 2012; Silow-Carroll & Edwards, 2013). For example, some ACOs send health care professionals to post-acute care facilities after hospital discharge to review follow-up plans, answer questions, and discuss any concerns (Silow-Carroll & Edwards, 2013). In addition, ACOs hire hospital-based transition coaches working with post-acute care providers to ensure discharge protocols are met (Silow-Carroll & Edwards, 2013). Including post-acute care facilities and implementing these care coordination strategies would help ACOs to reduce unnecessary health care utilization and generate cost savings.

Leadership is one of the essential elements of the ACO model. Both this study and previous findings indicated that physicians are taking the primary leadership role among ACOs, whereas hospital or joint-leadership are limited (Colla, Lewis, Shortell, & Fisher, 2014). There are important trade-offs between physicians' and hospitals'

leadership. Physicians are real care providers and their incomes, degree of autonomy, work environments, and clinical routines are impacted by the reform. Therefore, their buy-in of the ACO model is crucial to the implementation and the success of any health care innovations (Colla et al., 2014; Kocher & Sahni, 2010). In addition, physicians are more likely to run effective outpatient and primary care practices, which are critical elements to reduce health care spending (Kocher & Sahni, 2010). On the other hand, hospitals have better financial capacity to invest in infrastructures (e.g., health information technology) required by the ACO model. Moreover, hospitals are in the center of health care delivery. They have demonstrated the ability to involve other providers and organizations to establish clinical collaboration and coordination (Kocher & Sahni, 2010). The positive relationship between hospital-leadership and ACOs' possibility to earn shared savings may indicate hospitals' advantage in building collaborations and investing in infrastructures. More research is needed to understand hospitals' leadership in ACOs.

Compared with previous studies with similar topics, this study found some different results. These differences could be due to several reasons. First, the different samples used in the studies may cause the different results. This study exclusively focused on Medicare ACOs established in 2012 and 2013. Other studies either included Medicaid or commercial ACOs, which may be different from Medicare ACOs. Second, the varying outcomes examined in these studies may account for the different results. This study examined the shared savings Medicare ACOs have achieved in their first performance year. Other studies have examined the quality or other metrics of ACOs. In summary, more research is still needed for new evidence to validate the existing results.

This study has several limitations. First, some important ACO characteristics were not included in the analyses due to data limitations. For example, previous care coordination and payment/delivery reform experience were found to be important for ACOs' performance (D'Aunno et al., 2016; Shortell et al., 2014). However, these characteristics were not available in the datasets used in this study. Second, this study only focused on ACOs' performance in their first practice year. Some market or organizational characteristics may be important if they can improve ACOs' performance over time. A study using longitudinal performance data could help identify other important characteristics. Finally, this study mainly focused on testing the correlations between market and ACO characteristics associated with ACOs' financial performance. Results may not be interpreted as causal relationships.

Given the growth of ACOs and other delivery innovations in the country, understanding characteristics associated with ACOs' performance is important for policy makers and providers to improve the quality and control costs through these organizational innovations. This study provided early examination on this issue. More research is needed to incorporate other ACO groups (e.g., Medicaid and commercial ACOs) and other potentially important factors.

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TABLE 1 DESCRIPTIVE STATISTICS OF VARIABLES

Variables	Earned shared savings		Overall (N=218)
	Yes (N=51)	No (N=167)	
Average earned savings per beneficiary	358.03 (220.17)	0.00 (0.00)	85.97 (186.98)
Market Variables			
Munificence			
Physician per 1,000 population	1.94 (0.55)	1.94 (0.53)	1.94 (0.53)
Hospital beds per 1,000 population	2.68 (0.53)	2.66 (0.62)	2.67 (0.60)
Skilled nursing facility beds per 1,000 population	4.73 (1.43)	4.74 (1.49)	5.18 (0.12)
Proportion of population age 65 or above	0.14 (0.026)	0.14 (0.021)	0.14 (0.022)
Poverty rate	0.15 (0.030)	0.15 (0.028)	0.15 (0.029)
Income per capita	47701.11 (9089.35)	47579.294 (8317.43)	47608.11 (8484.76)
Competition			
ACO penetration	0.17 (0.01)	0.16 (0.01)	0.17 (0.01)
HHI	0.52 (0.06)	0.62 (0.04)	0.60 (0.04)
Organizational Variables			
Number of providers	451.31 (70.99)	511.66 (56.93)	497.54 (46.62)
Proportion of PCPs and NPs	0.58 (0.03)	0.54 (0.02)	0.55 (0.01)
Inclusion of a primary care facility	10 (19.61%)	39 (23.35%)	49 (22.48%)
Inclusion of a hospital	28 (54.90%)	80 (47.90%)	108 (49.54%)
Inclusion of a post-acute care facility	19 (37.25%)	35 (20.96%)	54 (24.77%)
Health system affiliation	19 (37.25%)	68 (40.72%)	87 (39.91%)
Leadership			
Physician-led	37 (72.55%)	135 (80.84%)	172 (78.90%)

Hospital-led	12 (23.53%)	24 (14.37%)	36 (16.51%)
Joint-led	2 (3.92%)	8 (4.79%)	10 (4.59%)
Proportion of eligible providers who attested MU Stage 1	0.45 (0.03)	0.46 (0.02)	0.46 (0.01)
Other Control Variables			
Proportion of assigned beneficiaries over 65	0.83 (0.01)	0.83 (0.01)	0.83 (0.005)
Percentage of female	0.52 (0.007)	0.54 (0.004)	0.53 (0.003)
Percentage of non-white	0.24 (0.02)	0.23 (0.01)	0.23 (0.01)
Proportion of disabled person years	0.15 (0.01)	0.15 (0.01)	0.15 (0.005)
Proportion of dual-eligible person years	0.10 (0.02)	0.08 (0.01)	0.09 (0.08)
Cost benchmark per beneficiary	13284.27 (479.75)	11410.01 (213.19)	11848.48 (204.80)
Track 2	2 (3.92%)	3 (1.80%)	5 (2.29%)
Advanced Payment Model	8 (15.69%)	28 (16.77%)	36 (16.51%)
Start date			
April 2012	8 (15.68%)	19 (11.38%)	27 (12.39%)
July 2012	24 (47.06%)	63 (37.72%)	87 (39.91%)
January 2013	19 (37.25%)	85 (50.90%)	104 (47.71%)

Notes: ACO: accountable care organizations; HHI: Herfindahl-Hirschman Index; PCP: primary care physician; NP: nurse practitioners; MU: Meaningful Use. For continuous variables, mean values were reported and standard deviations were in the parentheses. For binary/categorical variables, numbers and percentages were reported.

TABLE 2 REGRESSION RESULTS ON MARKET AND ORGANIZATIONAL CHARACTERISTICS ASSOCIATED WITH ACOS' EARNED SHARED SAVINGS

	Earned savings per capita (1)	Earned savings per capita (transformed) (2)	P (Earned savings) (3)
Market Variables			
Munificence			
Physician per 1,000 population	-12.24 (49.11)	-0.76 (0.61)	-1.07 (0.65)
Hospital beds per 1,000 population	-10.16 (26.69)	-0.03 (0.33)	0.0001 (0.358)
Skilled nursing facility beds per 1,000 population	4.05 (12.43)	0.009 (0.15)	0.006 (0.169)
Proportion of population age 65 or above	-315.16 (572.94)	1.32 (7.11)	2.02 (6.97)
Poverty rate	522.76 (715.27)	2.92 (8.87)	5.26 (9.40)
Income per capita	0.00005 (0.0035)	0.00003 (0.00004)	0.0001 (0.0001)
Competition			
ACO penetration	-14.97 (232.10)	0.78 (2.88)	0.94 (3.07)
HHI	-2.54 (35.02)	-0.16 (0.43)	-0.32 (0.52)
Organizational Variables			
Number of providers	-0.03 (0.03)	-0.0002 (0.0004)	-0.0003 (0.0004)
Proportion of PCPs and NPs	130.89 (87.15)	1.57 (1.08)	1.78 (1.18)
Inclusion of a primary care facility	-35.98 (38.37)	-0.48 (0.476)	-0.55 (0.51)
Inclusion of a hospital	33.44 (33.09)	0.29 (0.41)	0.35 (0.44)
Inclusion of a post-acute facility	86.00 (38.93) **	1.18 (0.48) **	1.17 (0.51) **
Health system affiliation	-53.79 (39.43)	-0.48 (0.49)	-0.50 (0.56)
Leadership (compared to physician-led)			
Hospital-led	66.15 (45.85)	0.94 (0.57) *	1.10 (0.61) *
Joint-led	-23.81 (78.62)	-0.65 (0.98)	-0.78 (1.08)

Proportion of eligible providers who attested MU Stage 1	-49.30 (92.71)	0.01 (1.15)	0.06 (1.27)
Other Control Variables			
Proportion of assigned beneficiaries over 65	-959.74 (1524.85)	-6.75 (18.91)	-6.16 (21.48)
Percentage of female	294.18 (625.91)	3.28 (7.76)	2.72 (8.64)
Percentage of non-white	-440.10 (148.61) **	-3.65 (1.84) **	-4.56 (2.41) *
Proportion of disabled person years	-418.66 (1484.10)	-1.16 (18.40)	-0.16 (20.43)
Proportion of dual-eligible person years	255.45 (193.82)	0.98 (2.40)	0.39 (3.04)
Cost benchmark per beneficiary	0.031 (0.007) ***	0.0003 (0.0001) ***	0.003 (0.0001) **
Track 2	325.60 (96.32) ***	1.84 (1.19)	1.74 (1.19)
Advanced Payment Model	-47.86 (46.06)	-0.86 (0.57)	-1.02 (0.63)
Start date (Compared to April 2012)			
July 2012	-5.98 (50.17)	0.24 (0.62)	0.33 (0.65)
January 2013	-41.00 (86.85)	-0.22 (1.08)	-0.24 (1.20)

*Notes: ACO: accountable care organizations; HHI: Herfindahl-Hirschman Index; PCP: primary care physician; NP: nurse practitioners; MU: Meaningful Use. Coefficients from regression were reported and standard errors were in the parentheses. * p<0.1; ** p<0.05; *** p<0.01*

IMPACT OF ACCOUNTABLE CARE ORGANIZATION PENETRATION ON REGIONAL VARIATION IN MEDICARE SPENDING

ABSTRACT

Background: Medicare per beneficiary spending varies considerably across regions in the United States. Previous studies have found that legitimate factors, such as demographic factors and health status of beneficiaries have limited power to explain this regional difference. Evidence indicates that differences in medical practices may account for some of the previously unexplained Medicare spending variation. Policy options to reduce this variation include directly cutting payment rates in high cost regions or implementing delivery and payment reforms among providers. Accountable care organizations (ACOs) represent an innovative blend of changes targeting physicians' decisions and behaviors through clinical and financial integration. The rapid development of ACOs in the US has the potential to reduce Medicare spending variation.

Methods: A difference-in-difference design combining secondary data on regional Medicare spending, Medicare ACOs, regional health resources, and beneficiary characteristics among 306 hospital referral regions (HRRs) between 2007-2013 to examine the impact of ACO penetration on regional variation in Medicare spending.

Findings: ACO penetration was associated with reduced total Medicare spending per fee-for-services (FFS) beneficiary and Medicare inpatient spending per FFS user among HRRs with the highest Medicare spending relative to HRRs with the lowest spending. Specifically, a 10% increase in ACO penetration was associated with 1% reduction in standardized Medicare spending per FFS beneficiary and 1.3% reduction in standardized Medicare inpatient spending per FFS user among HRRs in the top spending quintile relative to HRRs in the bottom spending quintile. No significant effects were identified about ACO penetration on Medicare outpatient spending.

Conclusions: The ACO program has reduced the regional variation in total Medicare spending and Medicare inpatient spending. This finding suggests that delivery and payment innovations like ACOs could influence providers' practice patterns and improve the efficiency of the Medicare program.

INTRODUCTION

Medicare spending varies considerably across regions in the United States. For example, Medicare spending per fee-for-service (FFS) beneficiary across hospital referral regions (HRRs) ranged from $6,569 in Grand Junction, Colorado, to $15,957 in Miami, Florida in 2012 (Cassidy, 2014). Extra spending may be worthy if it translates to better quality, expanded access, or improved health outcomes. However, previous studies have found that neither quality of care nor access to care appear to be better in high spending regions (Fisher et al., 2003a, 2003b; Fowler, Gallagher, Anthony, Larsen, & Skinner, 2008). Indeed, some research indicated higher spending regions had worse quality or outcomes than low spending regions (Baicker & Chandra, 2004). This geographic spending variation without gains in population health has raised concerns because it suggests wasted of health resources and inefficiencies in the health system. Policy interventions may be needed to reduce this variation and ultimately create more value for the Medicare program.

Researchers and policy makers have attempted to understand the sources of Medicare spending variation. Demand side factors, including age, gender, race, income, and health status of beneficiaries have been widely used to explain the differences in this spending across regions (Skinner, 2012; Sutherland, Fisher, & Skinner, 2009; Zuckerman, Waidmann, Berenson, & Hadley, 2010). For example, regions with sicker beneficiaries (e.g., beneficiaries with multiple chronic conditions) have more health care demands, which gives rise to higher spending (Skinner, 2012). Market factors which vary by geographic region, such as Medicare reimbursement rates may also account for Medicare spending variation. For example, the Centers for Medicare and Medicaid

Services (CMS) pay more for providers in high cost-of-living areas (Gottlieb et al., 2010; Skinner, 2012). Therefore, these areas would have more Medicare spending than low cost ones because of the payment adjustment. In addition, the availability of health resources is also associated with health care spending (Zuckerman et al., 2010). Patients could have more health care utilization in regions with higher availability of health professionals and health facilities. However, these factors do not explain all the variation in Medicare spending. In fact, studies found that 40% - 60% of regional variation in Medicare per FFS beneficiary spending still exists after controlling for these demographic, socioeconomic, and market differences (Finkelstein, Gentzkow, & Williams, 2014; Zuckerman et al., 2010).

There is evidence that differences in medical practices may account for some of the previously unexplained variation in Medicare spending (Cutler, Skinner, Stern, & Wennberg, 2013; Fisher et al., 2003a; Newhouse et al., 2013b; Skinner, 2012). Providers have different beliefs, abilities, and practice norms due to differences in medical training (Epstein & Nicholson, 2009) or their personal experiences with different interventions (Berndt, Gibbons, Kolotilin, & Taub, 2015). Therefore, clinical practices could vary greatly even when they treat patients with the same conditions. Studies have found that providers in some regions are more likely to deliver supply sensitive care—costly health care with slight or even unknown benefits—because of providers' previous experiences, peer pressure, or financial interests (Brownlee et al., 2011; Bynum, Song, & Fisher, 2010; Skinner, 2012). Thus, regions with high concentrations of these providers may have greater spending without better quality or outcomes.

There is interest in designing policies to decrease geographic variation since this could be an opportunity for controlling overall Medicare spending and improving the value of the Medicare program (Newhouse & Garber, 2013a, 2013b). The Affordable Care Act was expected to capture some cost savings through delivery and payment innovations. CMS established the accountable care organization (ACO) program to deliver high quality and affordable health care to Medicare beneficiaries (Berwick, 2011). An ACO is a group of physicians, hospitals, and other health care providers or organizations, who work together to deliver coordinated health care to patients at lower cost without sacrificing quality (Fisher & Shortell, 2010). The development of the ACO model has important implications for controlling overall Medicare spending and reducing regional variation.

Previous studies have found that ACOs were associated with reduced Medicare costs in general (McWilliams, Hatfield, Chernew, Landon, & Schwartz, 2016; Nyweide et al., 2015). However, little is known about the effects of ACOs on reducing regional variation in Medicare spending. This study examines the association of ACO penetration and variation in Medicare spending across hospital referral regions in the US. Findings from this study may be helpful to understand the sources of Medicare spending variation and inform policy interventions to reduce the regional variation in Medicare spending.

CONCEPTUAL FRAMEWORK

The ACO model holds potential to reduce regional variation in Medicare spending through several major opportunities from both the demand and supply sides. These opportunities include increased delivery of primary care, incentives for quality

improvement and cost reduction, case management for high cost patients, standardization of clinical practices, and patient engagement.

Primary care is one of the key elements of the ACO model (McClellan, McKethan, Lewis, Roski, & Fisher, 2010; Rittenhouse, Shortell, & Fisher, 2009). Utilization of primary care is associated with better health quality and lower costs (Friedberg, Hussey, & Schneider, 2010; Starfield, Shi, & Macinko, 2005). Studies found patients who receive primary care have fewer preventable emergency department visits and hospital admissions than those who do not (Kronman, Ash, Freund, Hanchate, & Emanuel, 2008; Rodriguez, 2015). In addition, primary care clinicians use fewer tests, spend less money, and protect people from overtreatment more than subspecialists from whom patients seek routine care (Phillips & Bazemore, 2010). ACOs are putting effort into building a strong primary care capacity for quality improvement and cost reduction. ACOs are recruiting more primary care providers (PCPs) who usually have resources, information, and leadership to deliver high quality health services (Kroch et al., 2012). Some ACOs also established the infrastructure and support needed for patient-centered medical homes—a primary care focused delivery model offering a broad scope of practice, health care integration, and transition management (Silow-Carroll & Edwards, 2013). Such strong primary care capacity could prevent unnecessary hospitalizations and readmissions, and generate cost savings among Medicare beneficiaries.

The traditional fee-for-service payment structure reimburses providers based on the quantity of services they delivered. Therefore, providers have little incentive to coordinate health care and reduce unnecessary utilization. The ACO model rewards providers for providing the most appropriate and high value care to beneficiaries.

Although providers still receive fee-for-service payments during the performance year, additional bonuses can be awarded if they can meet the cost benchmark, a cost measure calculated by CMS for each ACO based on their historical data with periodic updates (Berwick, 2011). In addition, ACO providers also face possible penalties (e.g., reductions in Medicare reimbursement) if they fail to meet the assigned cost benchmark. Given the potential bonuses and losses, ACO providers could be encouraged to use more teamwork and collaboration to reduce unnecessary utilization and health costs.

Medicare spending is highly concentrated among a small number of beneficiaries with complicated conditions, such as patients with multiple chronic conditions (Thorpe & Howard, 2006; Zhang, Rathouz, & Chin, 2003). To control the costs generated by this population, providers need to identify patients with high cost potential, and design early interventions to prevent avoidable emergency room visits, hospital admissions, and readmissions (Robinson, Coughlin, & Palmer, 2014). Many ACOs have developed advanced tools to identify patients at risk for generating high costs. For example, electronic health record (EHR) systems with data mining capacity could identify and alert high costs and high risk patients to their physicians and care managers (Robinson et al., 2014; Silow-Carroll & Edwards, 2013). Some health information technology could also identify patients who do not comply with treatment, and alert providers to follow up with these patients by in-person or telephone visits to address problems (Silow-Carroll & Edwards, 2013). These strategies, including advanced use of EHRs, may contribute to avoiding unnecessary hospitalizations and other costly complications.

ACOs could also control spending through standardization of providers' clinical practice. Providers and organizations may have different treatments for patients with the

same conditions, either because they have different preferences and beliefs (Epstein & Nicholson, 2009), or simply because they are good at providing specific services (Berndt et al., 2015). Variations in medical practice are more evident if there is no professional guidelines on appropriateness for surgery (Skinner, 2012). Some providers have strong preferences to costly treatments with slight or unknown benefits. For example, providers in Sun City, Arizona are more likely to deliver intensive prostate-specific antigen tests for the elderly (Bynum et al., 2010). There is considerable controversy about the value of this test, and patients receiving this test have the risk of incontinence and loss of sexual functioning (Moyer & Force, 2012). In addition, rates of this test for men over age 80 were found to be associated with higher overall health expenditure (Skinner, 2012). The ACO model encourages providers to identify the most appropriate, evidence-based treatments for patients. ACO leaders work with providers to determine best practices, create guidelines, and standardize common clinical practices for patients in various settings (Kroch et al., 2012; Silow-Carroll & Edwards, 2013). Therefore, standardizing clinical practice across an ACO may introduce cost-effective treatments while excluding costly and ineffective treatments from routine care, leading to cost reduction.

ACOs are making important progress to engage patients and their family in care delivery (Shortell et al., 2015). Previous studies suggested that greater patient and family engagement is associated with higher quality and better outcomes of care at the same or lower costs (Carman et al., 2013; Laurance et al., 2014). The ACO model does not restrict beneficiaries' choices of providers to only ACO participants. Patients are free to select providers outside of an ACO for any services they need. Therefore, it is difficult for an ACO to track care delivery and control costs for patients receiving health care

from providers outside of the ACO network. Engaging patients and their families in the ACO network can help ACO providers coordinate care delivery through the continuum of care, creating more opportunities to adopt interventions at the point of care to improve quality and control costs. Evidence suggests that ACOs improve patient and family engagement through high-level leadership commitment, extensive provider training, use of interdisciplinary care teams, and other strategies (Shortell et al., 2015). Therefore, ACOs' success in patient engagement may help to reduce spending.

In sum, the successful implementation of these strategies or other interventions in high-cost regions have the potential to reduce Medicare spending in these regions and decrease the variation in Medicare spending.

METHODS

Data Sources

This study combines several secondary datasets on Medicare spending, the ACO program, demographic characteristics, health condition, and health resources between 2007-2013. First, the Medicare Geographic Variation Public Use files (PUFs) 2007-2013 contain Medicare spending, beneficiary characteristics, and chronic disease prevalence at the hospital referral region (HRR) level. These files include Medicare beneficiaries who have both Part A and Part B coverage and are enrolled in Medicare's fee-for-service (FFS) program. The Medicare Shared Savings Program (SSP) ACOs started from 2012. The 2013 Medicare SSP ACO provider level dataset is used to identify providers participating in SSP ACOs in 2012 and 2013. The 2013 Medicare SSP ACO Public Use File (PUF) provides the number of assigned Medicare beneficiaries of each ACO

established in 2012 and 2013. County-level health resources data were extracted from the Area Health Resource Files 2015-2016 edition. These files provide information about health care professional and facilities in each county from 2007-2013. Finally, medical care Consumer Price Indexes between 2007-2013 are downloaded from Bureau of Labor Statistics.

Variables

Outcome Variables

This study first tests the impact of ACO penetration on *standardized Medicare spending per FFS beneficiary.* Since overutilization of health care, particularly the inpatient care, is a driving factor for higher Medicare spending (Wennberg, 2005). ACOs may more focused on reducing unnecessary hospital admissions and preventable readmissions. Inpatient spending may experience a greater reduction than outpatient setting. To further clarify the effects of ACO penetration on Medicare spending, *standardized Medicare Inpatient spending per FFS user* and *standardized Medicare outpatient spending per FFS user* are also tested. These variables have been standardized by CMS to account for variation not attributed to provider or beneficiary factors, such as local wages, input prices, and teaching hospitals. Standardizing these factors allows for a fair comparison among different regions (Fisher et al., 2003a). Details about the standardization process are available on CMS's website (Centers for Medicare and Medicaid Services, 2016). These variables are further adjusted for inflation using Consumer Price Indexes. In the regressions, all outcome variables are log-transformed to adjust the skewness of their distributions.

ACO Penetration

This study uses the method proposed by Auerbach et al (Auerbach, Liu, Hussey, Lau, & Mehrotra, 2013) to estimate *ACO penetration*. This method uses the practice locations of ACOs' primary care providers (PCPs) to map the ACO beneficiaries to each region. Specifically, this method first locates PCPs of each ACO in HRRs. The total number of beneficiaries of an ACO are then mapped to HRRs in proportion to the number of PCPs of this ACO in each HRR. Finally, ACO penetration is calculated as the proportion of all ACO beneficiaries relative to the total number of Medicare FFS beneficiaries in each HRR.

The 2013 Medicare Shared Saving Program (SSP) ACO provider level dataset includes all providers participating in 2012 and 2013 SSP ACOs. First, primary care physicians defined by CMS as those practicing *internal medicine*, *general practice*, *family practice*, and *geriatric medicine* are identified among all participants. To locate the PCPs to HRRs, the ACO provider level dataset is cross-referenced with the National Plan and Provider Enumeration System to get the zip code of each PCP. These PCPs are then assigned to each HRR using the zip code-HRR crosswalk from the Dartmouth Atlas.

The number of beneficiaries CMS assigned to each ACO comes from the 2013 SSP ACO PUFs. We map the number of beneficiaries of an ACO to each HRR in proportion to the number of PCPs of that ACO in each HRR. The details of the ACO penetration estimation are available in the appendix.

Control variables

To account for time-invariant HRR specific differences in spending levels, a set of control variables are used in the analyses since they are related to Medicare spending (Skinner, 2012; Sutherland et al., 2009; Zuckerman et al., 2010). This study first controls for some other ACO-related variables. The Pioneer ACO program started in January of 2012. However, data about the individual providers participating in Pioneer ACOs are not available. To control for the effects of the Pioneer ACO program on Medicare spending, a *binary* variable is created to indicate whether a HRR has a Pioneer ACO operating through primary data collection. Specifically, information about providers' practice locations is collected from 32 Pioneer ACOs' websites. This location information is then cross-references with the zip code-HRR crosswalk to identify whether a Pioneer ACO(s) exists in each HRR.

The ACO program raised government and researchers' concerns about the possible consolidation and monopoly in health care markets (Montgomery, 2015). The integration among providers may create market power to increase price without improvement in the quality of health care. To account for the concentration of ACO beneficiaries in each HRR, an index using the following equation was created: $ACO\ Concentration_i = \sum_{j=1}^{n} S_j^2$, where $S_j$is the share of beneficiaries of ACO i in an HRR, and n is the number of ACOs in this HRR. The higher value of this variable indicates a higher concentration of ACO beneficiaries.

This study also controls for a set of HRR-level characteristics about the Medicare FFS beneficiary demographic characteristics, prevalence of chronic conditions, and health resources. Beneficiary demographic characteristics include average age, percent of female, and percent of non-whites. For chronic conditions, this study controls for the

prevalence of heart conditions (i.e., heart attack and heart failure), diabetes, chronic kidney disease, and cancer (i.e., lung cancer and colorectal cancer). Health resources variables include staffed hospital beds per capita, skilled nursing facility beds per capita, primary care physicians per capita, and specialty physicians per capita.

Estimation Strategy

This study employs a difference-in-difference (DD) model, where the unit of observation is the HRR-year, to identify the effects of ACO penetration on regional variation in Medicare spending. Specifically, we estimate

$$y_{ist} = \alpha + \beta_1 * ACOPen_{it} + \sum_{q=2}^{5} \beta_q * ACOPen_{it} * Quintile_{iq} + \beta_6 * X_{it} + \gamma_t + \lambda_i + \tau_s t + \tau_s t^2 + \varepsilon_{ist}$$

Where y_{ist} is the log-transformed Medicare spending in HRR *i* of state *s* at year *t*; $ACOPen_{it}$ represents the ACO penetration in HRR *i* at year *t*; $Quintile_{iq}$ is a dummy variable equal to 1 if HRR *i* is in the qth quintile of spending in 2007. HRRs are categorized into quintiles based on their standardized Medicare spending per FFS beneficiary in 2007. β_1 represents the effects of ACO penetration on Medicare spending among HRRs in first quintile. $\beta_2 - \beta_5$ represent the effects of ACO penetration on Medicare spending among HRRs in quintile 2 to 5 relative to the first quintile. X_{it} is a vector of control variables, including a binary variable for Pioneer ACOs, SSP ACO concentration, HRR-level Medicare FFS beneficiary characteristics, HRR-level prevalence of chronic condition, and HRR-level health resources; γ_t are the year fixed effects; λ_i are HRR fixed effects. $\tau_s t$ and $\tau_s t^2$ represent linear and quadratic state-specific annual time trends, respectively. All regressions are weighted by the number of Medicare FFS beneficiaries of each HRR. Standard errors are clustered at the state-level

to account for geographically common unexplained relationships between ACO penetration and Medicare spending. HRRs are assigned to specific states based on the location of the primary city of each HRR.

RESULTS

Sample Characteristics

Table 1 presents the summary of sample characteristics between 2007-2013. On average, the variation in standardized Medicare spending per FFS beneficiary ranged from 14% to 52% between HRRs in quintile 1 and HRRs in other quintiles. The variations in inpatient spending per FFS user ranged from 1% to 10%. The outpatient spending per FFS user was similar across HRRs in different quintiles ($1700 - $1740). The average ACO penetration among all HRRs between 2012 and 2013 is 0.073. The HRRs in quintile 3 have higher ACO penetration and ACO concentration than other HRRs. HRRs with higher costs have more hospital beds and specialties. In addition, HRRs with higher-costs have a higher prevalence of chronic diseases.

Medicare Spending Geographic Variation

Figure 1 further presents the geographic variation in standardized Medicare spending between 2007 and 2013. The HRRs in quintile 1 were used as the reference group. As compared with HRRs in quintile 1, standardized per FFS beneficiary among HRRs in other quintiles was higher, with the increase ranging from 13% (quintile 2) and 50% (quintile 5). This pattern of geographic increase was persistent between 2007 to 2011 but started to decrease after 2012. For example, the Medicare spending per FFS beneficiary among HRRs in quintile 5 was 52.6% higher than HRRs in quintile 1 in 2007,

and was 48.8% higher than HRRs in quintile 1 in 2013, representing a 3.8% reduction in variation.

ACO Penetration and Medicare Spending Geographic Variation

Table 2 presents the impact of ACO penetration on geographic variation in standardized Medicare spending per FFS beneficiary using difference-in-difference strategy. The column (1) only controls for HRR and year fixed effects. Column (2) adds all beneficiary, chronic condition, health resources, and other ACO controls. Column (3) additionally controls for ACO concentration. Column (4) adds linear state-specific annual time trends. Finally, column (5) added quadratic state-specific annual time trends. In all cases, the effects of ACO penetration in quintile 5 relative to quintile 1 are negative and significant, indicating that the ACO penetration significantly reduced the standardized Medicare spending per FFS beneficiary (β ranges from -0.13 to -0.09) among HRRs in the top quintile, as compared to HRRs in the bottom quintile. Specifically, results suggest that as compared with the HRRs in quintile 1, a 10% increase in ACO penetration is associated with a 1-1.3% reduction in total Medicare spending per FFS beneficiary in quintile 5.

Table 3 presents the difference-in-difference results about the impact of ACO penetration on geographic variation in Standardized Medicare inpatient spending per FFS user. The results indicate that ACO penetration is associated with reduced Medicare inpatient spending per FFS user (β ranges from -0.22 to -0.12) among HRRs in quintile 5 relative to HRRs in quintile 1. These results are consistent across different model specifications. Specifically, the results suggest a 10% increase in ACO penetration is

associated with a 1.2% - 2.2% reduction in Medicare inpatient spending per FFS user among HRRs in the top quintile relative to HRRs in bottom quintile.

Table 4 presents the impact of ACO penetration on geographic variation in standardized Medicare outpatient spending per FFS user. Column (1) shows that when only controlling for HRR and year fixed effects, ACO penetration is associated with reduced standardized Medicare outpatient spending per FFS user among HRRs in quintile 1 and increased standardized Medicare outpatient spending per FFS user among HRRs in quintile 3 and 4 relative to quintile 1. However, column (2) – (5) show that ACO penetration had no effects on outpatient spending changes among HRRs in quintile 2 – 5 relative to quintile 1 after adding more controls.

Robustness Checks

The key assumption for any DD strategy is that the outcome in the treatment and control groups would follow the same time trend in the absence of the treatment (Angrist & Pischke, 2008). Results will be biased if this assumption is violated.

To test whether the parallel trend assumption holds in this study, two robustness checks are implemented. The first robust check uses the method proposed by Autor (Autor, 2003). Specifically, the ACO penetration and the ACO concentration variables were added for each pre (leads) and post (lags) treatment period. For example, ACO penetration five years prior to the actual treatment assumes the ACO program started five years before the real ACOs formed. ACO penetration one-year post treatment assumes the policy only works one year after the ACO formed. The parallel trend assumption requires that all leads have insignificant effects on outcomes. Otherwise, the assumption does not hold and the estimates may be biased. A negative coefficient on a lead indicates

model partially identified of pre-trends. For example, some HRRs may have some spending-control policies before the ACO program was implemented. On the other hand, a positive coefficient on a lead may indicate some spending rising actions happened in some HRRs, like the adoption of new technology or the use of brand-name medications. Either of these pre-trends in spending may have led to increased adoption of ACOs in the HRRs.

Table 5 presents the results of the robustness check for total Medicare spending per beneficiary. The coefficients on the leads are close to zero, showing little evidence of an anticipatory response within HRRs about to have ACOs. In one year before the ACO formation, the total Medicare spending per FFS beneficiary decreased by 5 log points among HRRs in quintile 5, after which this increment went to 7 and 11 log points. A similar pattern can be observed from the robustness check for the other two models using Medicare inpatient and outpatient per user spending as outcomes. These results indicate that the model specifications are valid in this study.

This study employs a difference-in-difference strategy to address the endogeneity issue. However, controls added in the model might not eliminate all potential confounders. To test whether some other omitted factors that influence trends in both Medicare spending and ACO penetration still exist, another robustness check is implemented using veteran's hospital expenditure per inpatient day as outcome. Table 6 presents the results of this robustness check. This robustness check finds insignificant impact of ACO penetration on veteran's hospital expenditure.

DISCUSSION

Medicare spending per FFS beneficiary varies widely across regions in the US. Previous studies suggest supply side factors, such as over-supply of costly services with limited benefits, are the driving force of regional variation in Medicare spending (Cutler et al., 2013; Fisher et al., 2003a). The accountable care organization model has the potential to reduce Medicare spending variation and improve the value of the Medicare program. ACOs are being implemented rapidly in the US and studies have examined their impact on general quality and cost of health care. However, little is known about their effects on regional Medicare spending variation.

This study examines the effects of ACO penetration on variations in Medicare spending using a difference-in-difference approach. Findings indicate that ACO penetration is associated with reduced Medicare spending per FFS beneficiary and Medicare inpatient spending per FFS user among hospital referral regions (HRR) with the highest spending at baseline. Specifically, a 10% increase in ACO penetration is associated with 0.9% reduction in standardized Medicare spending per FFS beneficiary and 1.2% reduction in standardized Medicare inpatient spending per FFS user. These suggest that the variation between HRRs with the highest spending and HRRs with the lowest spending decreased due to the ACO program. However, ACO penetration is not associated with cost reduction in outpatient settings. These results are robust given that robustness checks present little evidence of an anticipatory response within HRRs about to have ACOs, and find no effect of ACO penetration on veteran's hospital expenditure.

Regional variation in Medicare spending raises both concerns about waste and inefficiency of the Medicare system and opportunities for designing policies to reduce variation and generate cost savings. However, policy responses targeting regional

variation in Medicare spending have been largely unexplored. Congress considered addressing this variation by directly cutting payment rates in high cost regions (Congressional Budget Office, 2008); however, many health services researchers opposed this policy given that it did not account for the within-region variation in providers' efficiency (Newhouse & Garber, 2013b). Essentially, the risk was that low-cost providers operating in high-cost regions could be penalized regardless of their good performance. In addition, the delivery of health care involves various decisions made by individual providers, provider groups, or health care organizations. A valid policy should target these decision-makers to encourage behavior changes. In line with this perspective, the Institute of Medicine (IOM) suggested addressing spending variation through delivery and payment reforms at the provider level, such as improved care coordination, real-time information sharing, and pay-for-performance models (Newhouse et al., 2013a).

ACOs represent an innovative blend of changes targeting physicians' decisions and behaviors through clinical and financial integration. Previous studies found that physicians in high-cost regions reported greater difficulty providing adequate continuity of care, greater difficulty communicating with other physicians, and greater difficulty obtaining services such as hospital admissions or high quality specialist referrals (Sirovich, Gottlieb, Welch, & Fisher, 2006). The clinically integrated environment of ACOs has the potential to encourage providers to share clinical data, agree on plans of care, and collaborate to achieve favorable patient outcome, which could address the care coordination challenge facing providers in high-cost regions (Newhouse et al., 2013b). ACO cost-sharing payments are distributed to participants, which allows for the alignment of financial incentives among ACO providers (Hastings, 2012). Providers with

preferences for costly but marginally beneficial care will be under pressure to change the way they treat patients and switch to cost-effective and evidence-based health care. In addition, ACO participants' behavior may be constrained by the implementation of guidelines and standardization within the ACO, which may reduce the delivery of supply sensitive care (Silow-Carroll & Edwards, 2013). The results of this study support the IOM's proposition that policies targeting individual providers, such as ACOs, could reduce Medicare spending among regions with the highest costs.

Medicare spending largely varies by regions and this study found ACOs have a significant, although slight, effect on spending. This may be related to findings from previous studies that suggested that providers face challenges in achieving effective care coordination (Barnes, Unruh, Chukmaitov, & van Ginneken, 2014). As Fisher et al. noted, even integrated systems are finding that they need substantial time and resources to develop the informational, technical, financial, and professional capabilities required to provide and reward coordinated, longitudinal, population-based care (Fisher, McClellan, & Safran, 2011). Providers may have barriers to adapting to the ACO environment, which are different from previous integrated care delivery models in many aspects. For example, ACO providers rely heavily on health information technology to share information about a patient's history, condition, and needs (Diana, Walker, Mora, & Zhang, 2015). However, providers may struggle with interoperability problems because of the disparate systems they have adopted. They also have difficulties extracting meaningful data from the EHR system for case management and quality improvement, which may not produce the efficiencies hoped for in an ACO (Premier Inc., 2014).

Greater cost savings may be achieved if providers and health systems can address these challenges and fully coordinate health care delivery within ACOs.

Findings also indicated that ACO penetration reduced Medicare inpatient spending but not outpatient spending in high-cost areas. Overutilization of health care, particularly with regard to inpatient care, is a driving factor for higher Medicare spending (Wennberg, 2005). There may be substantial room for providers to reduce unnecessary hospitalizations through aligned incentives or better primary care in high-cost regions. In fact, high-quality outpatient care has the potential to reduce hospital admissions for ambulatory-sensitive conditions, such as chronic obstructive pulmonary disease (DeCamp, 2013). To control overall spending, ACOs may be delivering more health care in outpatient settings and avoiding preventable inpatient care. Therefore, Medicare spending in outpatient settings may not change as ACOs are implemented or it may actually begin to increase over time.

This study finds no evidence that ACO penetration had effects on Medicare spending among HRRs in the three middle quintiles. Compared to HRRs with the highest Medicare spending, ACO participants in those areas may not have room for cost reduction when they have to focus on maintaining health care quality as well. These regions may also have lower efficiency than regions in the bottom quintile. All these factors may impede the wide penetration of ACOs in these regions. More research is needed to understand the sources of high Medicare spending and design polices to control Medicare spending in these regions.

This study has several limitations. First, the methodology to estimate ACO penetration may not be precise if the beneficiaries are not evenly distributed among

primary care providers. Second, this study does not incorporate the heterogeneity of how ACOs serve beneficiaries. ACOs vary widely in terms of organizational structure, composition, size, and their past care coordination experiences. Some ACOs successfully generated cost savings but others did not. ACOs with different characteristics may have different impacts on Medicare spending. Third, a binary control for Pioneer ACOs may not account for the impact of the Pioneer ACO model on Medicare spending. Detailed information is needed to account for the effects of the Pioneer ACO on Medicare spending variation.

In sum, this study presents evidence that ACO penetration reduced Medicare spending variation between HRRs with the highest spending and HRRs with the lowest spending. The ACO program is evolving, more providers are participating in ACOs, and significant changes are being made to improve the ACO model. It is necessary to further investigate this issue to better understand the effects of the ACO program on Medicare spending variation.

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TABLE 1 SUMMARY OF CHARACTERISTICS OF HRRS, 2007-2013

Variables	All HRRs	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Standardized Medicare spending per FFS beneficiary	9563.02 (1488.06)	7471.85 (526.85)	8516.03 (467.34)	9241.56 (397.12)	9895.89 (451.52)	11371.27 (1280.80)
Standardized Medicare inpatient spending per FFS user	15211.47 (1119.00)	14514.55 (755.45)	14723.96 (888.26)	14929.44 (640.10)	15297.30 (949.36)	15938.05 (1369.27)
Standardized Medicare outpatient spending per FFS user	1726.60 (229.47)	1743.44 (261.62)	1689.96 (250.22)	1744.29 (196.44)	1709.86 (214.65)	1742.93 (232.38)
ACO penetration [a]	0.073 (0.084)	0.057 (0.092)	0.075 (0.103)	0.079 (0.086)	0.073 (0.072)	0.076 (0.075)
ACO concentration [b]	0.45 (0.27)	0.51 (0.29)	0.46 (0.26)	0.50 (0.25)	0.43 (0.26)	0.37 (0.25)
Average age of all Medicare FFS beneficiaries	71.36 (1.34)	71.34 (1.14)	71.27 (1.30)	70.86 (1.40)	71.65 (1.45)	71.56 (1.24)
Percent of female among all Medicare FFS beneficiaries	55.51 (1.70)	53.98 (1.50)	54.82 (1.76)	55.66 (1.52)	56.08 (1.46)	56.15 (1.38)
Percent of nonwhite among all Medicare FFS beneficiaries	18.79 (13.63)	14.59 (14.64)	13.72 (11.71)	15.67 (10.43)	16.58 (8.15)	29.25 (15.37)
Hospital beds per 1,000 population	2.94 (0.99)	2.56 (1.13)	2.70 (0.93)	2.89 (0.87)	3.08 (1.00)	3.20 (0.90)
Skilled nursing facility bed per 1,000 population	5.26 (2.11)	4.28 (1.96)	5.18 (2.42)	5.38 (2.37)	5.89 (1.72)	5.24 (1.91)
Primary Care physicians per 1,000 population	0.74 (0.15)	0.84 (0.15)	0.71 (0.12)	0.67 (0.11)	0.78 (0.16)	0.71 (0.15)
Medical specialties per 1,000 population	0.91 (0.40)	0.86 (0.39)	0.71 (0.22)	0.76 (0.27)	1.05 (0.44)	1.02 (0.43)

Surgical specialties per 1,000 population	0.51 (0.16)	0.51 (0.17)	0.44 (0.96)	0.45 (0.12)	0.54 (0.14)	0.55 (0.19)
Prevalence of heart attack	0.89 (0.16)	0.77 (0.15)	0.86 (0.19)	0.91 (0.14)	0.93 (0.15)	0.93 (0.13)
Prevalence of chronic kidney disease	13.95 (2.37)	12.17 (2.22)	13.25 (2.12)	13.91 (2.20)	14.25 (2.00)	15.17 (2.30)
Prevalence of diabetes	26.47 (3.74)	22.17 (2.49)	24.53 (2.98)	26.58 (2.23)	27.35 (2.91)	29.21 (3.67)
Prevalence of heart failure	15.40 (2.72)	12.47 (1.58)	13.76 (1.86)	14.90 (1.50)	15.99 (2.10)	17.96 (2.49)
Prevalence of lung cancer	1.03 (0.17)	0.88 (0.12)	0.94 (0.16)	1.06 (0.14)	1.12 (0.13)	1.07 (0.17)
Prevalence of colorectal cancer	1.28 (0.20)	1.11 (0.15)	1.21 (0.20)	1.26 (0.16)	1.37 (0.18)	1.37 (0.18)

Notes: FFS: fee-for-service; HRR: hospital referral region. This table presents the mean value of characteristics of hospital referral regions between 2007-2013. a. For ACO penetration, the mean value is calculated between 2012 and 2013. b. For ACO concentration, the mean value is calculated between 2012 and 2013. Values for all other variables are reported as average between 2007 through 2013. HRRs are grouped into quintiles based on their standardized Medicare spending per FFS beneficiary in 2007. All Medicare spending variables are inflation adjusted.

TABLE 2 DIFFERENCE-IN-DIFFERENCE ESTIMATES OF THE EFFECTS OF ACO PENETRATION ON GEOGRAPHIC VARIATION IN STANDARDIZED MEDICARE SPENDING PER FFS BENEFICIARY

	(1)	(2)	(3)	(4)	(5)
Effects of ACO penetration in quintile 5 compared to quintile 1	-0.105 (0.046) *	-0.128 (0.036) **	-0.125 (0.037) **	-0.118 (0.031) ***	0.089 (0.041) *
HRR fixed effects and year fixed effects	Yes	Yes	Yes	Yes	Yes
Beneficiary, chronic condition, health resources, and Pioneer ACO controls		Yes	Yes	Yes	Yes
ACO concentration			Yes	Yes	Yes
Linear state-specific annual time trends				Yes	Yes
Quadratic state-specific annual time trends					Yes
Mean of exp (outcome)	9563.02	9563.02	9563.02	9563.02	9563.02
Number of Observations	2,142	2,142	2,142	2,142	2,142

*Notes: *** p < 0.001, ** p<0.01, * p<0.05. Coefficients indicate the percent change in Medicare spending per FFS beneficiary for a doubling in ACO penetration. ACO: accountable care organization. HRR: hospital referral region. Outcomes are inflation adjusted using medical care Consumer Price Indexes and then log-transformed in the regressions. Regressions are at the HRR-year level, weighted by the number of Medicare beneficiaries in each HRR. Beneficiary controls include average age, percent of female, and percent of non-whites; chronic condition controls include the prevalence of heart conditions (i.e., heart attack and heart failure), diabetes, chronic kidney disease, and cancer (i.e., lung cancer and colorectal cancer); health resources controls include staffed hospital beds per capita, skilled nursing facility beds per capita, primary care physicians per capita, and specialty physicians per capita. Standard errors are clustered at state-level.*

TABLE 3 DIFFERENCE-IN-DIFFERENCE ESTIMATES OF THE EFFECTS OF ACO PENETRATION ON GEOGRAPHIC VARIATION IN STANDARDIZED MEDICARE INPATIENT SPENDING PER FFS USER

	(1)	(2)	(3)	(4)	(5)
Effects of ACO penetration in quintile 5 compared to quintile 1	-0.199 (0.084) *	-0.216 (0.067) **	-0.215 (0.067) **	-0.159 (0.054) **	-0.122 (0.051) *
HRR fixed effects and year fixed effects	Yes	Yes	Yes	Yes	Yes
Beneficiary, chronic condition, health resources, and Pioneer ACO controls		Yes	Yes	Yes	Yes
ACO concentration			Yes	Yes	Yes
Linear state-specific annual time trends				Yes	Yes
Quadratic state-specific annual time trends					Yes
Mean of exp (outcome)	15211.47	15211.47	15211.47	15211.47	15211.47
Number of Observations	2,142	2,142	2,142	2,142	2,142

*Notes: *** p < 0.001, ** p<0.01, * p<0.05. Coefficients indicate the percent change in Medicare inpatient spending per FFS user for a doubling in ACO penetration. ACO: accountable care organization. HRR: hospital referral region. Outcomes are log-transformed in the regressions. Regressions are at the HRR-year level, weighted by the number of Medicare beneficiaries in each HRR. Beneficiary controls include average age, percent of female, and percent of non-whites; chronic condition controls include the prevalence of heart conditions (i.e., heart attack and heart failure), diabetes, chronic kidney disease, and cancer (i.e., lung cancer and colorectal cancer); health resources controls include staffed hospital beds per capita, skilled nursing facility beds per capita, primary care physicians per capita, and specialty physicians per capita. Standard errors are clustered at state-level.*

TABLE 4 DIFFERENCE-IN-DIFFERENCE ESTIMATES OF THE EFFECTS OF ACO PENETRATION ON GEOGRAPHIC VARIATION IN STANDARDIZED MEDICARE OUTPATIENT SPENDING PER FFS USER

	(1)	(2)	(3)	(4)	(5)
Effects of ACO penetration in quintile 5 compared to quintile 1	0.137 (0.100)	-0.011 (0.080)	-0.034 (0.086)	-0.039 (0.072)	-0.071 (0.102)
HRR fixed effects and year fixed effects	Yes	Yes	Yes	Yes	Yes
Beneficiary, chronic condition, health resources, and Pioneer ACO controls		Yes	Yes	Yes	Yes
ACO concentration			Yes	Yes	Yes
Linear state-specific annual time trends				Yes	Yes
Quadratic state-specific annual time trends					Yes
Mean of exp (outcome)	1726.60	1726.60	1726.60	1726.60	1726.60
Number of Observations	2,142	2,142	2,142	2,142	2,142

*Notes: *** p < 0.001, ** p<0.01, * p<0.05. Coefficients indicate the percent change in Medicare outpatient spending per FFS user for a doubling in ACO penetration. ACO: accountable care organization. HRR: hospital referral region. Outcomes are log-transformed in the regressions. Regressions are at the HRR-year level, weighted by the number of Medicare beneficiaries in each HRR. Beneficiary controls include average age, percent of female, and percent of non-whites; chronic condition controls include the prevalence of heart conditions (i.e., heart attack and heart failure), diabetes, chronic kidney disease, and cancer (i.e., lung cancer and colorectal cancer); health resources controls include staffed hospital beds per capita, skilled nursing facility beds per capita, primary care physicians per capita, and specialty physicians per capita; other ACO controls include Pioneer ACO existence and Shared Savings Program ACO concentration. Standard errors are clustered at state-level.*

TABLE 5 ROBUSTNESS CHECK: DIFFERENCE-IN-DIFFERENCE ESTIMATES OF THE EFFECTS OF ACO PENETRATION ON MEDICARE SPENDING WITH LEADS AND LAGS

	Total Medicare Spending	Total Medicare Spending	Total Medicare Spending
ACO Penetration$_{t+5}$	0.001 (0.018)	0.021 (0.025)	-0.044 (0.055)
ACO Penetration$_{t+4}$	-0.025 (0.023)	-0.021 (0.039)	-0.015 (0.065)
ACO Penetration$_{t+3}$	-0.020 (0.039)	-0.011 (0.052)	-0.004 (0.073)
ACO Penetration$_{t+2}$	-0.046 (0.042)	-0.035 (0.082)	-0.080 (0.096)
ACO Penetration$_{t0}$	-0.072 (0.067)	-0.154 (0.089)	0.003 (0.016)
ACO Penetration$_{t-1}$	-0.108 (0.121)	0.028 (0.163)	-0.379 (0.221)
Full Control	Yes	Yes	Yes
Mean of exp(outcome)	9563.02	15211.47	1726.60
Number of Observations	2,142	2,142	2,142

*Notes: *** p < 0.001, ** p<0.01, * p<0.05. ACO: accountable care organization. All outcomes are log-transferred in the regressions. Regressions are at the hospital referral region (HRR)-year level, weighted by the number of Medicare beneficiaries in each HRR. All regressions are controlled for the Pioneer ACO existence, Shared Saving Program ACO concentration, market characteristics, chronic conditions prevalence, year fixed effects, HRR fixed effects, linear and quadratic state specific annual time trends. Standard errors are clustered at state-level.*

TABLE 6 ROBUSTNESS CHECK DIFFERENCE-IN-DIFFERENCE ESTIMATES OF THE EFFECTS OF ACO PENETRATION ON VETERAN'S HOSPITAL EXPENDITURE PER INPATIENT DAY

	(1)	(2)	(3)	(4)	(5)
Effects of ACO penetration in quintile 5 compared to quintile 1	0.401 (0.635)	0.629 (0.637)	0.762 (0.629)	0.360 (0.566)	0.155 (0.618)
HRR fixed effects and year fixed effects	Yes	Yes	Yes	Yes	Yes
Beneficiary, chronic condition, health resources, and Pioneer ACO controls		Yes	Yes	Yes	Yes
ACO concentration			Yes	Yes	Yes
Linear state-specific annual time trends				Yes	Yes
Quadratic state-specific annual time trends					Yes
Exp (Mean of Outcome)	4667.72	4667.72	4667.72	4667.72	4667.72
Number of Observations	1,226	1,226	1,226	1,226	1,226

*Notes: *** p < 0.001, ** p<0.01, * p<0.05. Coefficients indicate the percent change in veteran's hospital spending per inpatient day for a doubling in ACO penetration. ACO: accountable care organization. HRR: hospital referral region. Outcomes are log-transformed in the regressions. Regressions are at the HRR-year level, weighted by the number of Medicare beneficiaries in each HRR. Beneficiary controls include average age, percent of female, and percent of non-whites; chronic condition controls include the prevalence of heart conditions (i.e., heart attack and heart failure), diabetes, chronic kidney disease, and cancer (i.e., lung cancer and colorectal cancer); health resources controls include staffed hospital beds per capita, skilled nursing facility beds per capita, primary care physicians per capita, and specialty physicians per capita. Standard errors are clustered at state-level.*

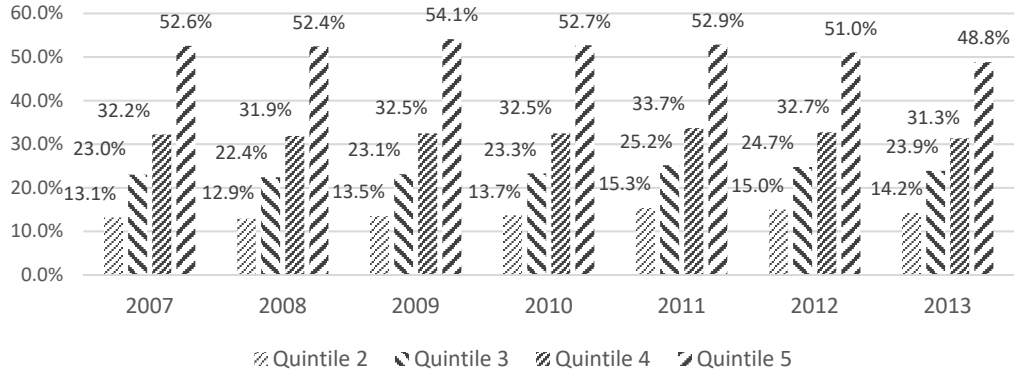

FIGURE 1 REGIONAL VARIATION IN STANDARDIZED MEDICARE SPENDING PER FFS BENEFICIARY, 2007-2013

Note: HRR: hospital referral region. HRRs are grouped into quintiles based on their standardized Medicare spending per FFS beneficiary in 2007. HRRs in quintile 1 are used as the reference group. HRRs in other quintiles are compared with the reference group to estimate the variation.

CONCLUSION

This dissertation contributes new findings to the emerging field of accountable care organizations. Specifically, the three papers of this dissertation examined the implementation and impact of accountable care organizations participating in Medicare Shared Savings Programs in 2012 and 2013. Some important questions related to ACOs have been explored using both qualitative and quantitative methods and theoretical paradigms. Findings of this dissertation provide new insight and evidence for policy makers, providers, and researchers in terms of strategies to deliver health care in ACOs, factors that may influence the financial performance of ACOs, and the impact of the ACO program on Medicare spending.

The first paper of this dissertation found that health care providers and organizations have been dedicated to coordinate health care delivery. The care coordination initiatives identified between 2010-2015 featured by their focus on chronic conditions, use of health information technology, implementation of multiple interventions for a broader scope of purposes. These experience and progress have potential to prepare providers to deliver health care in ACOs and design new interventions with other ACO participants. However, important gaps were also identified among studies. Limited evidence is available to discuss the care coordination across different health care settings. This may cause problems to deliver health care in ACOs which usually involve multiple health care settings. In addition, providers have paid little attention to post-acute care settings. Many opportunities for quality improvement and cost reduction will be gone if post-acute care is still overlooked from care coordination

activities. More research is needed to examine care coordination activities, especially those are implemented in ACOs or other payment and delivery models.

Although hundreds of ACOs have been established across the nation, factors associated with ACOs' performance are largely unexplored. The second study attempted to understand characteristics related to ACOs' earned shared savings. This study first conceptualized the research question using resource dependency theory and transaction cost perspective. The established conceptual framework identified potential market and organizational factors potential are important for ACOs' financial performance. Based on the results from quantitative analyses, it is important for ACOs to include post-acute facilities as their formal participants to have better financial performance. In addition, involving hospitals in their leadership is also important in terms of achieving shared savings. Given the tremendous Medicare spending generated by post-acute care, coordinating care between inpatient and post-acute care settings is essential to control health costs for ACOs. Including post-acute care facilities create more opportunities for ACO to influence the process of health care delivery associated with post-acute care. ACOs may also use hospitals' advantages in financial and labor resources, previous experience in care coordination and payment reform, and strong HIT capacity for efficient care delivery through hospitals' leadership. However, it is still unclear what factors are supposed to be important for ACOs' performance. More research is necessary to understand ACOs from both theoretical and empirical perspectives.

The third paper focused on an important policy issue—how to reduce the regional variation in Medicare per beneficiary spending in the US. Studies have suggested that this spending variation without gains in population health indicates the inefficiency of the US

health care system and waste of health resources. Since directly cutting the payment rate in high-spending regions may penalize efficient providers, reducing this variation through delivery and payment reform is deemed to be a better policy option. This study found that ACOs have reduced the total Medicare spending per beneficiary and Medicare inpatient spending per user between top and bottom quintile groups. These results not only indicate that ACOs are a valid option to reduce Medicare spending variation, but also inform the potential of other payment and delivery innovations to improve the value of the Medicare program. Future studies need to examine more outcomes and identify the underlying reasons for the results.

APPENDIX: ESTIMATION OF ACO PENETRATION

Overview of the Method

This study defines the ACO penetration as *the proportion of Medicare beneficiaries attributed to ACOs in each hospital referral region (HRR) among all the Medicare fee-for-services (FFS) beneficiaries in the HRR*. However, data on the geographic distribution of ACO beneficiaries are not available. We use the method proposed by Auerbach et al. to approximate the HRR locations of the ACO beneficiaries (Auerbach et al., 2012). Specifically, this method first identifies participating primary care providers (PCPs) in each ACO. PCPs are defined by CMS as those practicing *internal medicine*, *general practice*, *family practice*, and *geriatric medicine*. These PCPs then are mapped to HRRs based on their practice addresses. Finally, the total number of assigned beneficiaries of each ACO is allocated to HRRs in proportion to the geographic location of the ACO's PCPs.

The rationale of this method is that when CMS performs beneficiary assignment for ACOs, they determine whether ACO professionals participating in an ACO have provided the plurality of a beneficiary's primary care services as compared to ACO professionals in all other ACOs and individual practitioners or groups of practitioners identified by taxpayer identification numbers (TINs) that are not participating in an ACO. For an ACO, it is reasonable to assume that more assigned beneficiaries will be in the HRRs where more PCPs of this ACO are practicing.

Data Sources

ACO Providers

Medicare Shared Savings Program (SSP) ACO provider level research identifiable file 2013 was requested from the Centers for Medicare and Medicaid Services (CMS). This file provides national provider identifier (NPI) and provider specialty code for each provider participating in Medicare SSP ACOs formed in 2012 and 2013.

Provider Geographic Location

The National Plan and Provider Enumeration System (NPPES) file was downloaded from CMS. This file provides the information about zip-coded for providers.

ACO Beneficiary Number

The number of assigned beneficiaries of each ACO comes from the 2013 Medicare Shared Savings Program (SSP) ACOs Public Use File (PUF).

Zip Code-HRR Crosswalk

Zip code-HRR crosswalk was downloaded from the Dartmouth Atlas.

HRR-Level Medicare Beneficiary Number

The Medicare Geographic Variation Public Use Files (PUFs) provide total number of Medicare beneficiaries in each HRR between 2007 to 2013.

Estimate Processes

Mapping PCPs to HRRs

This study first identifies the PCPs from the ACO provider level file using the specialty codes *01 (general practice)*, *08 (family practice)*, *11 (internal medicine),* and *38 (geriatric practice)*. A total number of 31,171 PCPs were identified. The file containing these PCPs then was merged with the NPPES file using the NPI as the identifier to get zip-codes. A total number of 186 PCPs (0.6%) was not matched and therefore was

excluded from the study. This study also excluded the PCPs outside the 50 states or DC. Finally, a total number of 30,730 PCPs were identified and included in the study. These PCPs were mapped to HRRs using Dartmouth zip code-HRR crosswalk.

Allocating Beneficiaries to HRRs

The second step to estimate the ACO penetration is to allocate the total number of assigned beneficiaries of each ACO to HRRs. A challenge here is that for SSP ACOs started from 2012, the 2013 Medicare SSP ACOs PUF gives the *number of unique beneficiaries* for their first *performance year* instead of the *calendar year*. Specifically, for April 2012 starters (27 ACOs), it gives the *number of unique beneficiaries* for the 21-month period (9 months in 2012 and 12 months in 2013); for the July 2012 starters (87 ACOs), it gives the *number of unique beneficiaries* for the 18-month period (6 months in 2012 and 12 months in 2013). The *unique* here means that if a beneficiary was assigned in both 2012 and 2013, it is only counted once in the dataset.

Since the analyses will be at the HRR-year level, we need to estimate the number of assigned ACO beneficiaries for 2012 and 2013 separately for 2012 starters. To do so, we first assume the *number of unique beneficiaries* of the first performance year includes all beneficiaries assigned to an ACO in 2013. We allocated these beneficiaries to HRRs in proportion to the geographic location of the ACO's PCPs. Then we calculated the *growth rate of Medicare beneficiaries* in each HRR between 2012 and 2013 using Medicare Geographic Variation PUFs. This rate was applied to the *total number of ACO beneficiaries in each HRR of 2013* (the number of ACO beneficiaries across all ACOs in each HRR) to estimate the *change of the ACO beneficiaries in each HRR between 2012 and 2013*. This number was subtracted from the number of assigned beneficiaries of each

ACO in 2013 in proportion to the number of PCPs of this ACO among all ACO PCPs in the HRR (For example, assuming a HRR had ten more ACO beneficiaries between 2012 and 2013. There are two ACOs in this HRR, the first one has three PCPs and the second one has seven PCPs. We assigned three out of ten beneficiaries to the first ACO and the seven out ten beneficiaries to the second ACO). The number by now is the estimate of the number of assigned beneficiaries for each 2012 starters if they fully operated in 2012. However, since 2012 starters only operated for nine (April 2012 starters) or six months (July 2012 starters), we multiplied 0.75 (for April 2012 starters) or 0.5 (for July 2012 starters) to the estimated number to get the final number of assigned beneficiaries for each 2012 starter.

For ACOs started from January 2013, the performance year was completely overlapped with calendar year. We directly allocated the number of beneficiaries of each ACO to HRRs in proportion to the geographic location of the ACO's PCPs.

Estimate the ACO Penetration

In each HRR, the ACO penetration was calculated as

$$number\ of\ ACO\ beneficiaries_{it} / total\ number\ of\ Medicare\ FFS\ beneficiaries_{it}$$

References

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