The Partial Teammate: Managing Informal Collaborations in Contemporary Health Care Teams

The Harvard community has made this article openly available. Please share how this access benefits you. Your story matters

<table>
<thead>
<tr>
<th>Citable link</th>
<th><a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos:39947188">http://nrs.harvard.edu/urn-3:HUL.InstRepos:39947188</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Terms of Use</td>
<td>This article was downloaded from Harvard University’s DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos">http://nrs.harvard.edu/urn-3:HUL.InstRepos</a>: dash.current.terms-of-use#LAA</td>
</tr>
</tbody>
</table>
The Partial Teammate:
Managing Informal Collaborations in Contemporary Health Care Teams

A dissertation presented

by

Bethany Sheridan

to

The Committee on Higher Degrees in Health Policy

In partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

in the subject of

Health Policy

Harvard University

Cambridge, Massachusetts

June 2018
THE PARTIAL TEAMMATE: MANAGING INFORMAL COLLABORATIONS IN CONTEMPORARY HEALTH CARE TEAMS

Abstract

Health care teams have grown more complex and their boundaries less clear over time, leaving much of care delivery to informal collaborations between “partial” teammates – those who roles are ambiguous and informal, but who may participate substantially in care delivery. This dissertation investigates the challenges that informal members of contemporary health care teams present, and strategies for managing these roles effectively. Each paper addresses a particular role on the boundary of the traditional health care team: medical assistants working in primary care teams, medical device sales representatives providing technical assistance to surgeons, and patients using technology that could enhance their participation in care.

In Chapter 1 — with Alyna Chien, Joanna Veazey Brooks, Antoinette Peters, and Sara Singer — we used semi-structured interviews to explore thirty medical assistants’ (MAs’) experiences in primary care offices transitioning to team-based care. MAs reported stronger relationships with colleagues, more involvement with patients, a sense of ownership, and a sense of efficacy with team-based care. This work sheds light on how teams are expected to impact primary care delivery and when they are likely to be effective.

In Chapter Two — with Rob Huckman and Neal Chen — we used data from the orthopedic surgery setting to examine the impact on operative time of having medical device sales representatives physically present during a procedure. While we found no device rep effect on average, procedures took longer when a surgeon and device rep were very new to working together. This finding supports prior research on team familiarity across organizational boundaries, and has practical implications for hospital managers weighing the tradeoffs inherent
in industry-provided technical assistance services.

In Chapter Three — with Josh Gray, Anna Zink, Amy Edmondson, and Julia Adler-Milstein — we used a detailed longitudinal dataset to understand the role of provider organizations in patients’ use of an online portal. Although prior research has focused largely on patient demographic characteristics, we looked at how practices actually used portals. We found that the extent to which they used portals to communicate proactively with patients – the rate at which they posted labs/images and sent messages to their enrolled patients – was an important predictor of whether patients adopted the portal and how frequently they used it. We also found wide variation at the practice level in how often providers/staff engaged in these activities, resulting in extensive cross-practice variation in patient utilization. These findings call for a reconceptualization of portals as two-way tools, with more focus on the provider side, and provide guidance for provider organizations looking to use them effectively.

Together, these studies help advance our understanding of the challenges and opportunities that teams with unclear boundaries face in managing roles on the periphery. They also inform health care practice by providing insights into how delivery organizations can manage informal collaborations most effectively.
# Table of Contents

[Title page].................................................................................................................. i

[Copyright].................................................................................................................... ii

[Abstract]......................................................................................................................... iii

[Table of Contents]......................................................................................................... v

[Acknowledgements]......................................................................................................... vii

Chapter 1: Introduction ........................................................................................................ 1
  1.1 Partial teammates in health care .............................................................................. 1
      1.1.1 Complex care, complex teams ........................................................................ 1
      1.1.2 Defining partial team members ...................................................................... 2
      1.1.3 The unexpected centrality of partial teammates ............................................ 2
  1.2 Contributions from management theory ................................................................. 3
      1.2.1 Challenges facing complex teams .................................................................. 4
      1.2.2 Mitigating the challenges to maximize performance outcomes .................... 5
  1.3 Summary and Dissertation Aims .............................................................................. 7

Chapter 2 - Team-Based Primary Care: The Medical Assistant Perspective ............... 10
  Abstract ......................................................................................................................... 10
  2.1 Introduction ............................................................................................................... 11
  2.2 Background .............................................................................................................. 12
  2.3 Methods .................................................................................................................... 14
      2.3.1 Research Design and Sample ........................................................................ 14
      2.3.2 Data Collection ............................................................................................... 18
      2.3.3 Data Analysis .................................................................................................. 19
  2.4 Results ....................................................................................................................... 20
      2.4.1 Mechanisms ..................................................................................................... 21
      2.4.2 Facilitators and barriers .................................................................................. 27
  2.5 Discussion .................................................................................................................. 28
      2.5.1 Limitations ...................................................................................................... 29
      2.5.2 Implications for Practice ............................................................................... 30
      2.5.3 Conclusion ...................................................................................................... 32

Chapter 3 - The Impact of Medical Device Representatives on Surgical Performance: Evidence from Orthopedic Surgery ................................................................. 33
  Abstract ......................................................................................................................... 33
  3.1 Introduction ............................................................................................................... 34
  3.2 Background .............................................................................................................. 34
      3.2.1 Familiarity and the surgeon-rep relationship .................................................. 36
  3.3 Methods .................................................................................................................... 38
      3.3.1 Setting ............................................................................................................. 38
      3.3.2 Data ................................................................................................................ 39
      3.3.3 Sample ............................................................................................................ 39
      3.3.4 Variables ........................................................................................................ 40
      3.3.5 Analysis .......................................................................................................... 42
  3.4 Results ....................................................................................................................... 44
Chapter Four - Patterns in patient portal use: The unexplored provider side

Abstract .............................................................................. 54  
4.1 Background ..................................................................... 55  
4.2 Methods ......................................................................... 56  
  4.2.1 Setting and sample ....................................................... 57  
  4.2.2 Data and measures ...................................................... 58  
  4.2.3 Analysis .................................................................. 60  
4.3 Results ............................................................................ 62  
  4.3.1 Patient- and provider-side portal activity summary .......... 64  
  4.3.2 Relationship between provider-side portal use and portal adoption by patients ............... 66  
  4.3.3 Relationship between provider-side actions and portal utilization by patients ............ 67  
4.4 Discussion ....................................................................... 68  
  4.4.1 Practice implications ................................................... 70  
  4.4.2 Limitations ................................................................ 71  
  4.4.3 Conclusion .................................................................. 72  
References .............................................................................. 73  
Appendix A: Supplementary Materials for Chapter 2.......................... 86  
Appendix B: Supplementary Materials for Chapter 3.......................... 89  
Appendix C: Supplementary Materials for Chapter 4.......................... 91
Acknowledgements

I am deeply indebted to my dissertation committee – Rob Huckman, Amy Edmondson, and Sara Singer – who steered me through this process with insightful feedback, supportive words, and well-timed doses of humor. I could not have asked for a kinder or more helpful committee, adapting to my ever-evolving study ideas and career aspirations. Their collective search for the “core” holding the ideas in this dissertation together brought a generative and creative quality to every meeting. I was never at a loss for good ideas with them in my court.

I gratefully acknowledge funding support via a Harvard Business School Doctoral Fellowship.

All members of the Academic Innovations Collaboration (AIC), and especially the medical assistants who donated their time for an interview, have my endless gratitude. All were extremely thoughtful in their responses and committed to making their voices heard to improve patient care. The broader AIC evaluation team from the T.H. Chan School of Public Health also deserve my thanks for regular feedback and support.

I thank my colleagues at the Massachusetts General Hospital for access to, and a great deal of ongoing help with, an incredible data resource (Taylor Pong, Rachel Gottlieb, and all of the Hand/Upper Extremity clinical fellows), as well as Johann Blauth for arranging this collaboration. Dr. Neal Chen, a delight to work with on multiple projects, provided expert clinical guidance without which Chapter Three would not have been possible.

I also thank my research partners at athenahealth, who kindly helped me understand the data and brainstorm practice-informed research ideas – largely with no tangible incentive to do so amid busy schedules. Josh Gray, Anna Zink, and everyone on the Data Science team were especially generous. I owe them a debt of gratitude for the legwork underlying Chapter Four.
Chapter 1: Introduction

1.1 Partial teammates in health care

1.1.1 Complex care, complex teams

As scientific knowledge and technological innovation in medicine exploded over the past several decades, health care teams have grown dramatically in scale and complexity to keep up (Plsek & Greenhalgh, 2001). Today, caring for a single patient often involves dozens of people with different backgrounds, values, incentives, and level/frequency of involvement. This breadth opens opportunities for teams, but also complicates them in ways that can impede care delivery (Wynia et al., 2012). Although roles beyond physicians and nurses are now widely acknowledged as important parts of care – perhaps most clearly seen in the rise of terms like “team-based care,” “care partners,” and “allied professionals” – there is not yet a consensus as to whom these concepts include, how new and expanded roles in health care relate to traditional ones, or how to maximize their potential in service of excellent patient care.

While there is a great deal of optimism about teams as a solution to fragmented and uncoordinated care, the basic definitional groundwork remains in its early stages in the health services literature. This can lead to ad hoc, uncoordinated studies that would benefit from a unified theoretical framework and coherent research agenda. For example, an extensive literature on patient engagement, which rests on the notion of patients as partners in their own health care, intersects only occasionally with a relatively developed management literature on how firms can “co-produce” effectively with their customers, even though the underlying principles may have a great deal in common (Hardyman, Daunt, & Kitchener, 2015). Failing to consider all participants in care delivery risks overlooking some who appear to be on the periphery, but may nevertheless have a significant impact. Treating each form of teamwork-like collaboration as unique or
exceptional (e.g., pharmacists and primary physicians, health coaches and patients, cardiologists and endocrinologists, etc.) risks missing important theory-driven insights.

1.1.2 Defining partial team members

One result of increasing complexity in health care is a set of roles that lie on the edges of the traditional care team – not clearly part of it, but important and involved enough to meaningfully affect performance outcomes. While most would agree that physicians and nurses are vital members of any care team, many people working at the margins – cleaning staff, administrative staff, lab technicians, software vendors, or families, to name just a few – can also play a large, if sometimes hidden, role in care quality. Practitioners and researchers are beginning recognize the importance of these peripheral health workers to existing systems of care, and by extension, their potential to enhance improvement efforts in a health care system that is fragmented and often slow to change from the center.

What makes a team member “partial?” In complex teams, team membership may be better thought of as a spectrum than as a binary. Some teammates may more deeply involved in core service delivery than others, but still rely extensively on those more peripheral members. Research on social networks in work groups reveals several factors that determine a given role or person’s centrality within a team. Particularly relevant to the health care delivery context are the extent to which a given role (or the person in it) is accepted as important and valid by the rest of the team, particularly by those that hold the most power (usually physicians in the health care context); personal characteristics like demographics and values (Klein et al., 2004); or the degree of role formality (Ibarra, 1993).

1.1.3 The unexpected centrality of partial teammates
Although a team member’s centrality and impact on team performance may be correlated, in some ways, these “peripheral” roles are anything but peripheral in contemporary health care settings. In contexts where core team members are constantly shifting, a more consistently-present peripheral teammate may serve as the glue holding information and jumbled pieces together. For the primary care physician working at a clinic only a fraction of the time, a great deal of valuable knowledge lies in the receptionist who has worked at the clinic for years, knows the long-standing patients personally, and is deeply familiar with its operations. When medical records prove incomplete, it is often patients and families who know their history and medication lists the best. In the face of constantly-changing orthopedic surgery teams, the medical device representative may actually know “how things work here” better than rotating surgical residents. These people hold unique information, skills, and may be able to contribute to the quality of care if managed in a deliberate way.

In this dissertation, I ask two main questions: What does it mean to manage peripheral team members effectively in practice? What can we learn about teams in care delivery more generally by studying these roles on the margins?

1.2 Contributions from management theory

Health care is far from the only domain in which team boundaries have grown less clear over time. Organizations across industries increasingly use boundary spanning and fluid teams because they offer certain advantages over traditional teams, such as flexibility and diverse sources of information. Boundary-spanning teams enable roles, routines, and activities that work toward intergroup coordination – a fundamental challenge of organizations and particularly those facing high levels of uncertainty (Argote, 1982; Galbraith, 1974; Okhuysen & Bechky, 2009).
1.2.1 Challenges facing complex teams

Despite the advantages noted above, fluid teams introduce unique challenges and enhance some of the fundamental challenges that traditional teams have always faced.

By design, boundary-spanning teams are made up of people from different professional groups, departments, etc. This brings about a host of challenges. The first concerns identity management in the context of diversity. People working across disciplines often have different worldviews, languages, and perspectives that can make communication difficult without substantial translation (Bechky, 2003). This introduces frictions and inefficiencies, and it can foment conflict when differences in values or agendas come into play, as is often the case in medicine (e.g., social workers vs. doctors) (Bartunek, 2011; Hall, 2005).

Second, where groups are involved, group-based conflict and competition often follow. Enhanced by correlations between occupational and demographic groups outside the local organizational context and associated status hierarchies (Lau & Murnighan, 1998), this is rooted in a basic human tendency to create in-groups and out-groups and confer a higher value to one’s own in-group (Tajfel & Turner, 1979). Where traditional bounded teams face this challenge with respect to intergroup work, diverse groups can also face intragroup conflict based on team members’ other identities, reducing satisfaction and performance outcomes (Lichtenstein, Alexander, McCarthy, & Wells, 2004). Particularly concerning is that intragroup conflict may lead to a lack of psychological safety, the shared belief among team members that it is safe to speak up or admit error (Edmondson, 1999), which is linked to team learning and performance.

By nature, fluid teams limit the amount of time team members spend working together and getting to know each other. A large body of empirical work suggests that familiarity between team members, at least to a point that fluid teams are unlikely to reach, enhances team
performance (Cattani, Ferriani, Mariani, & Mengoli, 2013; Goodman & Leyden, 1991; Huckman, Staats, & Upton, 2012; Reagans, Argote, & Brooks, 2005). While the mechanisms explaining this relationship are not fully understood, and it is likely that several operate simultaneously, the literature suggests that positive team characteristics like cohesion, trust, accountability, psychological safety, and transactive or shared group memory are more difficult to establish under fluid team conditions (Tannenbaum et al., 2012). Unfamiliar teams may therefore have to spend more time preparing to work together or face communication lapses.

One of the major threats of fluid teams is, quite simply, chaos (Tannenbaum et al., 2012). While the idea of boundary spanning teams is partly to bring people together from different disciplines and perspectives, their roles may not be automatically clear. Task responsibilities are often overlapping or ambiguous, bringing about the potential for diminished satisfaction among individual team members, decreased team effectiveness (Hackman, 1975), and even conflict when heterogeneity already makes relationships vulnerable (De Dreu & Weingart, 2003). And fluid or temporary teams mean that members may not have time to carve out or “fall into” their roles naturally over time. This has the potential to impede motivation, as clear ownership over work and access to direct feedback about personal efforts is a key job design characteristic making work fulfilling (Hackman & Oldham, 1976).

1.2.2 Mitigating the challenges to maximize performance outcomes

Recent empirical work has focused on how fluid teams can re-establish some of the positive features of bounded teams by adopting relatively generic, replicable structures that any team can adopt quickly. Role-based coordination, in which teams always display a standard set of well-delineated roles that are independent of the person occupying those roles, offers teams a ready-made template of norms and responsibilities that new members can simply plug into,
reducing the time costs of team formation, role delineation, and group member socialization (Bechky, 2006). Similarly, combining role-based coordination with group ownership over work tasks (“team scaffolds”) has been found to enhance performance on temporary teams by creating a minimal amount of trust, pro-social motivation, and accountability between short-term teammates (Song, Tucker, & Murrell, 2015; Valentine & Edmondson, 2015).

While team composition and structures have received a great deal of research attention, team processes – the famous “black box” between team inputs and outputs – are vitally important to teams lacking clear boundaries, which may lack the enabling conditions thought to encourage productive team processes (Hackman, 1975). Even in the absence of supportive structures, fluid teams can replicate processes such as conflict management and communication by intentionally creating opportunities for them (Marks, 2016). The concept of relational coordination, in which workers solve problems, make decisions, and organize tasks together on the fly, is particularly relevant here. In the absence of clear roles and in the presence of uncertain conditions, repeated interaction in the form of routines (e.g., meetings) and explicit boundary-spanning roles can help build the relationships necessary for such spontaneous coordination across groups.

Leaders can affect how group members view themselves, and their actions can turn group identities into strengths or weaknesses by fostering either group identities or a superordinate identity bringing teams together into a whole. The literature suggests that this is a difficult balancing act and the proper allocation is a matter of debate. While empirical evidence suggests that group leaders who adopt and foster a collective identity may help their team members overcome differences in service of a higher-order goal (Bunderson & Reagans, 2011; Richter, West, Dick, & Dawson, 2006), theory suggests that when it comes to boundary spanning across
groups, the most effective leaders may adopt a “relational identity” that includes elements of the superordinate identity across groups they serve and group-specific identities (Hogg, Knippenberg, & Rast, 2012). However, the available empirical evidence seems to support only a boundary spanner’s organization identification as helpful to performance and finds that more group identification is associated with worse performance (Richter et al., 2006).

This “identity management” function for leaders and/or boundary spanners may be particularly effective in conditions where intergroup conflict is likely, and those where there is little precedent for incorporating outsiders into core work. Leader behaviors may also affect some of the inhibiting effects of status hierarchy within groups directly. Nembhard and Edmondson (2007), for example, found that inclusive physician leaders who actively invited participation and feedback were able to flatten the positive relationship between status and psychological safety as reported by their team members. Those in clear team leadership roles may have an opportunity to recognize the value of and actively manage roles on the periphery in service of better performance.

1.3 Summary and Dissertation Aims

In essence, the marginal roles considered in this dissertation present extreme cases of the opportunities and challenges typically found in boundary-spanning, fluid teams. Role ambiguity, always partly a matter of power and negotiation, becomes even more political as there is more to negotiate. Translational problems, such as differing expertise, may also be especially acute and require even more management to overcome than the already-challenging relationships between, for example, different cadres of clinicians. Thus, these marginal roles in health care teams present an opportunity to learn about complex teams precisely because they present an extreme set of circumstances.
This dissertation considers three examples of roles traditionally on the periphery of the “health care team,” all of which have long been part of the care process but not traditionally thought of as major contributors or partners in care delivery. In truth, they have played a role in care for much longer than researchers have been interested in them. Furthermore, all are arguably growing more central to care. In some cases, there are active efforts to draw them into more and more care activities. Drawing on theory and evidence around fluid and boundary-spanning teams in the broader organizational behavior literature, this dissertation introduces the partial team members as a novel concept in management theory and illustrates strategies for managing them most effectively in health care.

Chapter 2 considers the expanding roles of medical assistants in primary care. While medical assistants were always part of the care team at some level and worked for the same organization as their physician teammates, an intervention designed to make them more central to it reveals how simply formalizing existing team arrangements can improve worker satisfaction and group performance.

Chapter 3 considers the sometimes controversial role of medical device representatives in the operating room in the orthopedic surgery context. This presents a case in which the marginal team member works for a different organization entirely than the core team members, and faces financial incentives that may directly conflict with the goals of the surgical team. We find evidence that a lack of team familiarity harms performance in this context, as it does in more traditional team arrangements.

Chapter 4 considers an online technology (patient portals) that holds the potential to engage patients in their care. This presents a case in which the marginal team member is also the customer, and a role that historically has not be expected to participate meaningfully in care.
provision. We find that patients are unlikely to use portals as tools to manage their own care unless their providers/practice staff initiate contact with them by posting labs/images and initiating secure messages. This implies an active role for providers, and not just interventions targeted at patients, is needed for meaningful patient engagement to occur.
Chapter 2 - Team-Based Primary Care: The Medical Assistant Perspective

Abstract

Background: Team-based care has the potential to improve primary care quality and efficiency. In this model, medical assistants (MAs) take a more central role in patient care and population health management. MAs’ traditionally low status may give them a unique view on changing organizational dynamics and teamwork. However, little empirical work exists on how team-based organizational designs affect the experiences of low-status health care workers like MAs.

Purposes: This study aimed to describe how team-based primary care affects the experiences of MAs. A secondary aim was to explore variation in these experiences.

Methodology/Approach: In late 2014, the authors interviewed 30 MAs from nine primary care practices transitioning to team-based care. Interviews addressed job responsibilities, teamwork, implementation, job satisfaction, and learning. Data were analyzed using a thematic networks approach. Interviews also included closed-ended questions about workload and job satisfaction.

Results: Most MAs reported both a higher workload (73%) and greater job satisfaction under team-based primary care (86%). Interview data surfaced four mechanisms for these results, which suggested more fulfilling work and greater respect for the MA role: 1) relationships with colleagues, 2) involvement with patients, 3) sense of control, and 4) sense of efficacy. Facilitators and barriers to these positive changes also emerged.

Conclusion: Team-based care can provide low-status health care workers with more fulfilling work and strengthen relationships across status lines. The extent of this positive impact may depend on supporting factors at the organization, team, and individual worker levels.

Practice Implications: To maximize the benefits of team-based care, primary care leaders should recognize the larger role that MAs play under this model and support them as increasingly valuable team members. Contingent on organizational conditions, practices may find MAs willing to manage the increased workload that often accompanies team-based care.

Key words: team-based care, medical assistants, job satisfaction
2.1 Introduction

Team-based approaches to primary care are gaining popularity in response to demands for more care continuity, greater efficiency, better chronic disease management, and solutions to physician burnout (Goldberg, Beeson, Kuzel Anton J., E., & C., 2013; Schottenfeld et al., 2016). Rather than centering care on the doctor-patient encounter, team-based primary care organizations assign groups of healthcare professionals from multiple occupations to manage care for groups of patients. Compared to traditional physician-centric care models, teams can distribute clinical activities broadly among qualified staff, build relationships between team members and with patients, and implement systems for population management. Recent evidence of team-based care’s impact on patient satisfaction and specific clinical outcomes is promising (Helfrich et al., 2014; Misra-Hebert, Rabovsky, Yan, Hu, & Rothberg, 2015). We know little, however, about how it affects the health care workers who shape these outcomes.

In this paper, we explore how team-based care affects the experiences of medical assistants (MAs) in primary care. MAs are frontline health care workers typically responsible for initiating patient flow, taking patients’ vital signs, and performing clerical duties (Gray, Harrison, & Hung, 2016). With a high school diploma or 1-year postgraduate certificate as the typical entry point and national median pay under $15 per hour (Bureau of Labor Statistics, 2008), MAs generally have less formal education and income than their colleagues in other occupational groups. While many MAs are licensed and trained to perform a range of clinical tasks, such as administering vaccines, primary care organizations often limit the role to tasks that fall below their training (Taché & Hill-Sakurai, 2010). This stands to change under team-based care. To enable physicians and nurses to perform higher-level tasks, team-based practices assign new clinical and administrative responsibilities, including those related to population health.
management, to MAs (Naughton, Adelman, Bricker, Miller-Day, & Gabbay, 2013). MAs are thus asked to engage more directly with patients and manage core elements of their care.

Management research provides further practical and theoretical reasons to study the experiences of MAs. Like most of medicine, primary care is organized in an occupational hierarchy that situates physicians at the top. The risks that large status differences pose to group learning and performance are well documented in health care (Edmondson, 2003). Scholars and practitioners alike are thus interested in better understanding status dynamics and how to reduce their impact. Lower-status workers tend to hold different views of teamwork than others (Makary et al., 2006; Nembhard & Edmondson, 2006), and their views may be more accurate indicators of organizational performance (Nembhard, Yuan, Shabanova, & Cleary, 2015; Singer, Lin, Falwell, Gaba, & Baker, 2009). Therefore, MAs are well positioned to elucidate the impact of team-based care precisely because of their low status and position in the hierarchy.

In this study, we investigate how team-based care affects the MA work experience. Theory suggests that, compared to traditional organizations, team-based organizations promote a more meaningful work environment and foster stronger connections across hierarchical lines. This should especially benefit low-status workers like MAs. Yet, team-based primary care also typically means delegating more responsibilities to MAs and possibly decreasing the time they spend with other MAs. Our aim was to understand how team-based care affects the MA experience, given the role’s central position in these models of care coupled with its traditionally low status. Through interviews with MAs at nine primary care practices transitioning to team-based care, we found that this change largely improved the MA experience by making the work more fulfilling and decreasing the relevance of status and hierarchy in daily interactions.

2.2 Background
Management research finds that work is motivating and fulfilling to the extent that it meets a set of basic psychological needs (Lawrence & Nohria, 2001). Particularly relevant in health care are the need for meaning (Renn & Vandenberg, 1995), social belonging (Ellemers, Gilder, & Haslam, 2004), feelings of autonomy and competence (Gagné & Deci, 2005), and the explicit drive to attain respect without regard to hierarchical status (Leape et al., 2012). Researchers and leaders of organizations are thus interested in how jobs can be designed to meet these needs, maximizing both personal fulfillment and productivity (Hackman & Oldham, 1976). Interventions to enhance motivation, for example by connecting workers more closely with the beneficiaries of their work, have improved performance and satisfaction (Grant, 2007, 2012).

Interventions aimed at increasing motivation at work may particularly benefit low-status workers, who generally have less power and autonomy (Anderson & Brown, 2010; Magee & Galinsky, 2008), receive less respect from others (Fragale, Overbeck, & Neale, 2011), and feel less free to speak up with concerns or opinions (Nembhard & Edmondson, 2006). While there is debate over whether low-status workers are motivated by the same psychological drives (or in the same proportions) as higher-status workers (Burns, Bradley, & Weiner, 2012), research suggests that low-status workers value and benefit from a sense of meaning (Wrzesniewski, McCauley, Rozin, & Schwartz, 1997). In particular, because low-status workers are less able to shape their own jobs (Berg, Wrzesniewski, & Dutton, 2010), motivation-enhancing interventions enacted at the organization level may benefit them disproportionately.

Team-based care could be one such intervention. Organizational research has long suggested that team-based organizations provide workers with more opportunities to connect with each other across hierarchical and occupational boundaries, develop a sense of shared identity, and feel the impact of their work (Batt, 2004; Jouini, Dallery, & Nait-Abdallah, 2008;
Mohrman, Cohen, & Mohrman, 1995). Recent work in healthcare suggests that team-like structures on a small scale improve performance at least partly by increasing motivation and reducing the salience of hierarchy (Song, Tucker, & Murrell, 2015; Valentine & Edmondson, 2015). However, the effect of team-based care on low-status health care workers specifically remains virtually unexamined. Our study addresses this gap.

2.3 Methods

2.3.1 Research Design and Sample

Because research on team-based design in health care is relatively undeveloped (though not completely nascent), we used an inductive, qualitative research design that allowed us to remain open to new concepts as they emerged (Edmondson & McManus, 2007). We interviewed MAs at practices participating in a grant-funded learning collaborative called the Academic Innovations Collaborative (AIC), designed to promote the transition of primary care practices to team-based care. Our study was embedded in a broader evaluation of this program (involving co-authors on this paper). At the time of our study, the AIC was a network of 18 primary care practices in six Harvard-affiliated academic medical centers that had begun transitioning to team-based care in 2012 (Bitton et al., 2014). AIC practices varied in size (number of clinical teams), setting (community vs. hospital-based), and type of patient population served (along socioeconomic, demographic, and health characteristics). Practice representatives from multiple occupational groups (including MAs) met at local conferences called “learning sessions” three times per year to share best practices and build a learning community. Learning sessions also provided a structured curriculum to help the practices make and support their transitions.

Before the AIC, communication across professional groups was not formally structured into daily care routines. Under the AIC, all sites transitioned to team-based care and added
formal communication processes. This meant that they formally assigned all patient-facing staff to teams, assigned each team responsibility for a defined patient panel, and instituted daily team huddles and regular team meetings. Teams always included at least an MA and a provider (generally a physician), registered nurses (RNs), and allied health professionals such as pharmacists and social workers (who usually worked across teams). MAs and providers were the core team for huddles, and MAs were invited to all team meetings (on a rotating basis on some larger teams). Some teams were further subdivided into MA/physician dyads called “teamlets.”

Finally, all AIC practices introduced new population management tasks and systems for tracking performance. These tasks were generally a combination of administrative and clinical, such as identifying and following up with patients who are overdue on cancer screening tests and checking diabetic patients’ blood sugar at the start of every visit. Where licensing allowed, the practice sites also aimed to shift existing clinical tasks to staff members with lower levels of training to improve efficiency. For example, some clinical activities previously performed by the physician moved to the RN role, and tasks by RNs moved to the MA role.

We recruited MAs for interviews at nine of the 18 primary care practice sites participating in the AIC in mid-2014, about two years into the transition. One practice site was excluded from consideration because it had participated in the AIC for only 1 year. We used a purposive sampling approach to select from the remaining 17 practice sites, primarily seeking variation in MAs’ average self-reported job satisfaction (as well as year-over-year change) from the team dynamics survey issued to all staff in 2012 and 2013 (Song, Chien, et al., 2015), setting, academic medical center affiliation, and size.

At all nine practices in our sample, we were given permission to recruit MAs directly for interviews. In some cases a supervisor notified all MAs at the practice about the study and
encouraged them to participate. The first author (BS) also visited two of the practices to meet the MAs as a group before inviting them to participate, at a supervisor’s request. This was the extent of managerial involvement in the recruitment process. Next, we randomly selected one MA per clinical team (based on team member lists provided by the sites) to invite for a 30-minute interview by email. Each site had between 3 and 10 clinical teams, totaling 46 teams across all 9 sites and averaging 5.1 teams per site. However, we capped the interview total at five MAs per site to limit the time burden on the practices. If one MA chose not to participate, we reached out to another randomly-selected MA from the same team until we had either invited all MAs on that team or reached our interview maximum of 5 per practice site. Ultimately, we invited 47 MAs and achieved a sample of 30, for an overall interview participation rate of 64%. Participation rates by site ranged from 38% to 100%.

Consistent with national trends (Bureau of Labor Statistics, 2008), 90% of participants (27 of 30) were female. Eighty-three percent (25 of 30) had a tenure at the practice of two years or more and thus could comment fully on their experiences as MAs before and after the intervention. Interviewees did not receive compensation for their participation. See Table 2.1 for details on the AIC practices and sample characteristics.
Table 2.1 AIC practice site and sample characteristics

<table>
<thead>
<tr>
<th>AIC practice site characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All sites (n=17)</strong></td>
<td></td>
</tr>
<tr>
<td>Setting: Community-based (vs. Hospital-based), n (%)</td>
<td>11 (65%)</td>
</tr>
<tr>
<td>Clinical teams per practice site, mean (SD)</td>
<td>4.5 (3.1)</td>
</tr>
<tr>
<td>Mean Y2 MA job sat per practice site, mean (SD)</td>
<td>3.7 (0.7)</td>
</tr>
<tr>
<td>Mean YOY change in MA job sat per practice site, mean (SD)</td>
<td>-0.1 (1.1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practice sites not in sample (n=8)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting: Community-based (vs. Hospital-based), n (%)</td>
<td>6 (75%)</td>
</tr>
<tr>
<td>Clinical teams per practice site, mean (SD)</td>
<td>4.7 (4.2)</td>
</tr>
<tr>
<td>Mean Y2 MA job sat per practice site, mean (SD)</td>
<td>3.7 (0.8)</td>
</tr>
<tr>
<td>Mean YOY change in MA job sat per practice site, mean (SD)</td>
<td>-0.3 (1.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practice sites in sample (n=9)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting: Community-based (vs. Hospital-based), n (%)</td>
<td>5 (56%)</td>
</tr>
<tr>
<td>Clinical teams per practice site, mean (SD)</td>
<td>5.0 (2.8)</td>
</tr>
<tr>
<td>Mean Y2 MA job sat per practice site, mean (SD)</td>
<td>3.8 (0.7)</td>
</tr>
<tr>
<td>Mean YOY change in MA job sat per practice site, mean (SD)</td>
<td>0.1 (1.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MA recruitment details</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time MAs per practice site, mean (SD)</td>
<td>8.2 (3.8)</td>
</tr>
<tr>
<td>Target interviews per practice site, mean (SD)</td>
<td>3.9 (0.9)</td>
</tr>
<tr>
<td>MAs invited per practice site, mean (SD)</td>
<td>5.1 (2.3)</td>
</tr>
<tr>
<td>MAs interviewed per practice site, mean (SD)</td>
<td>3.4 (1.1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MA interviewee characteristics (n=30)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender: female, n (%)</td>
<td>27 (90%)</td>
</tr>
<tr>
<td>Tenure:</td>
<td></td>
</tr>
<tr>
<td>&lt;1 year, n (%)</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>1-2 years, n (%)</td>
<td>3 (10%)</td>
</tr>
<tr>
<td>2-5 years, n (%)</td>
<td>5 (17%)</td>
</tr>
<tr>
<td>5-10 years, n (%)</td>
<td>12 (40%)</td>
</tr>
<tr>
<td>10+ years, n (%)</td>
<td>8 (27%)</td>
</tr>
<tr>
<td>Fully dedicated to a team, n (%)</td>
<td>26 (87%)</td>
</tr>
</tbody>
</table>

AIC = Academic Innovations Collaborative
MA = medical assistant
Y2 = Year 2 of AIC initiative
YOY = Year-over-year (Year 2 mean – Year 1 mean)
job sat = job satisfaction reported on all-staff survey
2.3.2 Data Collection

We interviewed the 30 participating MAs between August and November of 2014. All recruitment and interview materials were approved by the Institutional Review Board at the Harvard T.H. Chan School of Public Health. All MAs consented to be interviewed verbally and by signing a consent form before the interview. Interviews were semi-structured and lasted an average of 27 minutes each (ranging from 13 – 49 minutes). We used an interview guide to ensure consistent structure across participants. All interviews were conducted at or near the participant’s primary care practice during work hours or lunch breaks. One (BS) or two (BS, SJS) interviewers conducted all interviews. Participants were made aware in all cases that the interviewers were independent researchers and that participant responses were confidential. All interviews were audio-recorded and transcribed for analysis.

Interview questions fell into five categories developed in advance: job responsibilities and workload, teamwork and communication, transition/implementation process, job satisfaction, and learning/growth. For each, we asked interviewees about their current experiences and if/how their experiences had changed over time. For example, on teamwork and communication, we asked “How would you describe the quality of your teamwork with physicians today? How, if at all, has this changed over the past two years?” The other question categories followed a similar structure. We also included two closed-ended questions. First, we asked participants to indicate whether their workload had increased, decreased, or stayed the same over time. Second, near the end of the interview, we asked participants to assess changes in their job satisfaction on a five-point scale from “much more satisfied” to “much less satisfied.”
2.3.3 Data Analysis

We analyzed interview data in three phases: 1) analysis of closed-ended questions, 2) open coding and inter-coder reliability assessment, and 3) refined categorization. In phase 1, we calculated response distributions to our two closed-ended questions. In phase 2, we analyzed the interview data using a thematic networks approach, ordering and linking themes across conceptual levels (Attride-Stirling, 2001). One coder (BS) openly coded nine transcripts, from which nine basic themes emerged. We then randomly selected 37 excerpts from the same nine transcripts (about 10% of excerpts assigned a code), and three other coders (JVB, ASP, SJS) matched excerpts to codes to ensure that independent coders would interpret the themes in the same ways. Fleiss’ Kappa, an inter-rater reliability coefficient that allows for more than two coders and corrects for the possibility of matches that occur by chance (Hayes & Krippendorff, 2007), indicated substantial agreement at 0.8. We thus resumed the coding process with just a single coder (BS), using NVivo software. Investigators then agreed on minor modifications to coding categories, renaming codes and dividing the code “teamwork and communication” into two: “stronger relationships with colleagues” and “more control.”

In phase 3, we divided the basic themes that had emerged in phase 2 into two categories, reflecting what appeared to be two distinct organizing themes: mechanisms linking the transition to team-based care to improved experiences (characterized by references to change over time and feelings about the outcomes of change), and facilitators and barriers to change. For example, all excerpts that fell under a code called “strong relationships with colleagues” were categorized as mechanisms, while all excerpts assigned to a code called “resources” were categorized as facilitators/barriers to implementation.
2.4 Results

Responses to the two closed-ended questions regarding changes in workload and overall satisfaction presented a puzzle that warranted further exploration. Among participants who had been at their practice sites for the entire transition, 19/26 (73%) reported facing an increased workload since the AIC had begun. See Table 2.2 for examples of changes to the MA role, including new clinical and population management responsibilities MAs reported taking on under the AIC.

<table>
<thead>
<tr>
<th>Table 2.2 Examples of changes to the MA role under the AIC intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organizational structure &amp; process changes</strong></td>
</tr>
<tr>
<td>• Joins Blue Team (2 physicians + 1 NP + 1 shared RN + 1 shared social worker)</td>
</tr>
<tr>
<td>• Pairs up with 1 Blue Team physician on Mon/Tue/Thu, Blue Team NP on Wed</td>
</tr>
<tr>
<td>• Co-locates with provider(s) in a single office</td>
</tr>
<tr>
<td>• Leads 10-minute huddles with assigned provider each day</td>
</tr>
<tr>
<td>• Attends weekly team meetings</td>
</tr>
<tr>
<td><strong>Task shifting</strong></td>
</tr>
<tr>
<td>• Performing routine foot exams and A1C checks for diabetics (previously under RN role)</td>
</tr>
<tr>
<td>• Serving as primary phone contact for providers</td>
</tr>
<tr>
<td>• Organizing forms requiring provider signatures and assigns them to appropriate provider</td>
</tr>
<tr>
<td><strong>Population Management</strong></td>
</tr>
<tr>
<td>• Managing Excel tracking system for cancer screening and HIV tests</td>
</tr>
<tr>
<td>• Reporting on performance at team meetings</td>
</tr>
<tr>
<td>• Following up with all patients in panel overdue for a cancer screening by letter + phone</td>
</tr>
<tr>
<td>• Calling patients in panel who missed appointments last week</td>
</tr>
</tbody>
</table>

Three participants reported continuing to feel overwhelmed by a high workload as of the interview, but most described a challenging period of learning and adjustment followed by some level of comfort with the workload. For the question on overall satisfaction, 23/27 (86%) participants reported being “more satisfied” or “much more satisfied” as of the interview than before team-based care was implemented. None reported a decline in satisfaction.
In our analysis of the qualitative data, four conceptual themes surfaced as mechanisms that can explain the finding that satisfaction increased in spite of a higher workload: 1) relationships with colleagues, 2) involvement with patients, 3) sense of control, and 4) sense of efficacy. Each of these seemed to provide a new source of motivation and fulfillment to the MA role and reduce the salience of status and hierarchy in MAs’ everyday interactions with colleagues. Figure 2.1 links these mechanisms into a conceptual model relating the team-based care intervention to improved job satisfaction for MAs.

**Figure 2.1 Model of medical assistant experiences under team-based care**

![Diagram](image)

### 2.4.1 Mechanisms

This section discusses each mechanism in turn and the evidence that it explains MAs’ increased job satisfaction. For each mechanism, we also identify common subthemes. While this presentation does not portray all comments from MAs, it reflects the most prominent themes.

**Relationships with colleagues**

By working in stable teams and participating in structured communication routines, MAs grew more familiar with colleagues in other roles. This deepened collegial interactions into friendships and reduced the salience of status in MAs’ everyday working lives.
*Personal connections:* Interviewees described getting to know their teammates on a personal level, which made work more fun and emotionally fulfilling.

This doctor, we’re like friends. Before, they locked themselves in their offices and we were out there [on the floor], and now we share more time. So they ask about how our days are going, even our problems. So it’s pretty good, you feel good. [Practice 14]

MAs expressed a feeling that higher-status teammates (physicians in particular) now viewed them as individuals, where they had been more anonymous before.

At breaks or lunches or in-between patients, we take a few seconds to say “How’s your mom?” or “How’s your husband?”…And that’s great. That kind of makes your day. Because somebody noticed that there was a problem, or a situation. [Practice 1]

*Psychological safety:* Interviewees also described ways in which this increased familiarity translated into permission for them to speak up without fear.

Before, you knew which doctors not to approach and which doctors you could approach. So we had some of those doctors that I felt I couldn’t approach, but now, I can approach them. I feel comfortable approaching them. [Practice 10]

I think I’m just more comfortable. Like if I have any concerns or anything I’m more comfortable going up to the provider and letting them know. I feel less pressure I guess. It’s easier for me at least. [Practice 2]

This sense of comfort even extended to drawing boundaries around work and expectations, particularly important given the increased workload.

I used to feel like I had to do everything. Now I know how to say no, even to the doctors…I guess I got comfortable saying no. [Practice 14]

By enabling MAs to spend more time with colleagues, team-based care led them to feel closer and seemed to reduce the salience of hierarchy in those relationships.
Involvement with patients

Team-based care, and the new clinical and population management responsibilities that it required, led MAs to have more direct interaction with patients. Relationships with patients were inherently meaningful, and they turned MAs into valuable sources of information for teammates.

Appreciation: MAs were now assigned to the same patients over time, seeing them at the practice repeatedly, speaking with them on the phone during outreach calls, and performing some routine screenings and procedures during visits. Many expressed a sense of emotional satisfaction and pride at having patients recognize their efforts as members of the care team.

I see patients getting more comfortable. They get to know you better. And so, I see a lot more appreciation from the patients. And a lot more appreciation when they know they can walk in and say whatever they need to feel comfortable – like “I’m going to call and I know I have my MA there” and they call and say “I want to speak to [MA Name] because every time I go there he’s right there next to me.” [Practice 7]

It has changed, and I think for good. Now that I’m assigned to a doctor and we have teams, we get to know our patients. Before I had 3 doctors. Now, my patients know me, they know I work for the doctor. Whenever they call, they ask to talk to me, which is good. They see the same face every time that they come in for an appointment. I like it more. And whenever they drop off a form for me to complete, it’s on time, we don’t lose it, and they’re very grateful. [Practice 14]

Others, particularly those who had taken on expanded roles (e.g., health coaching), saw connecting with patients as a new source of personal meaning.

I’ve been here a long time, and I know a lot of the patients, but I didn’t really feel like my role was directly helpful to them. But now, with the coaching aspect of it, I’m very happy to be involved in their care. I love it. My favorite thing to do is work 1-on-1 with the patients. And I love having the time to do that, where I can really feel that I’m making a difference with them and helping them. [Practice 8]

Access to information: Having more direct patient interaction also placed MAs in a unique position to access and relay important information between patients and providers, which made them feel more included and valuable as members of the clinical team. Even though physicians still led the process, MAs described having more information to offer about patients’ lives.
The doctors are giving us more information about the patient. And sometimes it’s not only the doctors, it’s us too because patients have that relationship with us where they are willing to let us know, and then we’re the one telling the doctors “Hey, by the way…” Like we just had a patient whose sister had passed away, and we’re like “By the way did you know that that was so-and-so’s sister?” They’re like “No way.” So we get to know things in advance as well, sometimes before the doctors do. [Practice 3]

Some even made a direct connection between their ability to offer unique information and a less hierarchical decision-making process with physicians.

It’s the MA’s responsibility to do a lot of outreach calls, patient navigation, make sure patients go to their appointments, get a report from a visit they had at another hospital. The doctor, overall, is going to make all the decisions. But you can have more input because you’re very involved with the patients…Sometimes the MAs get to know their family more than the provider does. Because they feel comfortable with you in a certain way, they show you they have a family and everything. That all involves patient care, so sometimes you get to speak more about things and have more input in the meetings. [Practice 7]

Sense of control

Team-based care added responsibilities to the MA role, but also provided MAs with more resources for managing the increased workload in the form of reliable teammates and systems (e.g., pre-labeled folders for patient forms). While many described continued challenges with the high volume of work, this was often countered by a sense that the work was more under their control and thus more manageable.

Planning: With better planning and more accessible colleagues, many MAs described a stronger sense of task ownership and a greater ability to be proactive. In particular, information and expectations communicated during morning huddles reduced the sudden demands on their time.

We’re more prepared because if [the physicians] need anything from us, we can just do it right away when we call the patients in. As opposed to a situation where the patient is in the room already, we’ve done our part, and then if [patients] need anything else the providers have to go find us. [Practice 2]
Having defined responsibilities also allowed MAs to be proactive and carve out work domains that they controlled, making interactions with providers feel more like those of two professionals with different roles than those of a boss and an assistant.

Before, they weren’t giving us responsibility to take the initiative. They felt like they had to come out and tell us everything…Now they’re more in [the room], engaged with the patients, instead of out there trying to run the show too. It’s like “I run the show out there, you run the show in here.” [Practice 10]

Being responsible for a specific set of tasks for a defined patient population also gave MAs more space to allocate their own time and led to a sense of task ownership.

[Before], they would give you the list [of patients to call], and then you would just start calling. But now you own those lists. You have the list and you can decide “Should I call about mammograms today? Should I call diabetics? Should I call about pap smears?” Before you were ordered to do that. [Practice 3]

Organization: For tasks and decisions that could not be planned in advance, defined team members and often physical proximity gave MAs a more accessible set of teammates on whom to draw and systems that kept their work ordered.

[Before], a patient would call and ask a question. [The nurse] wouldn’t know what kind of paperwork I have, and I don’t know what kind of phone calls she’s got from the patient. So [now] if I call a patient to do an outreach and they tell me they have chest pains, I can just go right to her and say, “[RN Name], so-and-so’s on the phone with me, they say they’re having chest pains. Can I transfer them to you?” It’s so simple just to have her right there and just be able to talk to her. [Practice 7]

With more resources (people and systems) for getting work done under team-based care, participants described their days as smoother and less chaotic.

I think it’s better. It’s gotten better. Now that we actually have the care teams, I think it’s easier. We have a better workflow…It’s more organized now, I think we work better since we’re divided into teams. [Practice 2]

There’s more control over what you do, and your co-workers are on your team. So I think it has improved because before you would run around, it was kind of crazy. But now it’s more organized. [Practice 3]
Sense of efficacy

MAs described a newfound sense of achievement through their personal impact on patient care and newfound voice in team and practice site improvement efforts.

Personal impact: Several MAs took pride in their personal contributions to individual patients:

I had a patient a couple years ago who was a Jehovah’s Witness…And colon cancer was in her family. After a long time of talking to her – every time she came in I would talk to her, tell her how important it was – she finally did it…She came back and went “I want to thank you because they found a polyp. And it was pre-cancerous. If I had waited another 5 years, it would have been cancer.” She thanked me left and right. And that really made me feel good. [Practice 7]

Realizing that you had to work to get the patients to do these things and now they’re doing it is a great thing. They’re coming in, they’re going to the appointments that you’re scheduling for them because they need to see these specialists and you’re working to get them in there and they actually go…[I can see it] by the patients coming in, and some patients, their attitude is better. You can just tell that their health is better because they’ve gone and gotten the healthcare that they need. [Practice 8]

MAs also noted a sense of pride that came with feeling like they were now living up to their potential, growing, and using their full skillsets:

I think [team-based care] has helped a whole lot because it gets the medical assistants more involved in their jobs versus just taking vital signs and putting patients in the room. We’re using our skills more. Before we weren’t using our skills. We were just rooming. We weren’t working to our potential. Now we’re working to our potential. [Practice 10]

Finally, having more knowledge about the patients, both from interacting with patients directly and from huddling with providers, enabled some MAs to be more patient centered.

We’re filled in more about the history of the patient. And that’s very important because if a patient comes in whose dad just got deported and he comes in with an attitude, you know not to feel like it’s with you or take it personally, but understand that he’s going through a tough time. You try to be more mindful of the patients and their needs. [Practice 3]

I’ve learned to have more patience with people. I think it’s actually seeing what people are going through. Now we know “Ok, this patient’s homeless, this is their reasoning. Ok, they have alcohol abuse.” You have a better understanding of the patients in general. There’s less judgment. [Practice 8]
Voice in systems: Beyond the impact on patient care, MAs also derived a greater sense of efficacy by using their newfound inclusion as team members to make changes at the practice site. Team meetings especially were an opportunity for them to speak up about broader issues.

Before, [the physicians] would speak to the same person all the time and act like you’re here just to answer the phone or things like that. They made people feel like that. But now, everybody’s more involved and they take everybody’s opinion in my team’s group. So when we have the meetings, everybody participates and they give opportunity to everybody. Everybody needs to bring ideas and we share ideas. And that way, I feel good because everybody counts. Everybody’s involved. [Practice 14]

The team structure also provided MAs with more opportunities to participate in quality improvement initiatives and to share innovations across the practice site.

[If I had a suggestion before], I would have had to go to my manager and it probably wouldn’t have made a big difference because the whole clinic is not going to change just because one person wants to change one thing…Teams do individual things, and if everyone sees that one team is doing something and it works, then they might do it. [Practice 7]

For many MAs, team-based care seemed to have transformed the job from a series of routine tasks to a full role that could affect patients’ lives and improve care practice-wide.

2.4.2 Facilitators and barriers

The effects of team-based care described above were common across participants and practice sites, but not all participants experienced positive change to the same extent. The interviews surfaced organizational conditions that could facilitate (when present) or impede (when absent) the implementation and sustainability of team-based care, which mirrored those found in prior implementation research (Conley, Singer, Edmondson, Berry, & Gawande, 2011). First was the need for sufficient staffing and physical space to keep the same team members working together over time and to co-locate them as a unit. Second was frequent and broad communication between management and staff to promote mutual understanding. Third was
physician commitment to team processes. For example, while some physicians championed huddles, others did not attend them at all. Finally, having a strong culture of helping among MAs became important as they grew closer to teammates and more isolated from each other – particularly when workloads became uneven across teams or cross-team coverage was needed.

2.5 Discussion

Through interviews with MAs at primary care practice sites undergoing a transition to team-based care, we found that they were generally more satisfied with their jobs after team-based care was introduced. Interview data suggest that this occurred in a few related ways. MAs found more fulfillment and meaning in their work through regular interactions with patients and colleagues. More patient involvement gave them access to unique and valuable information, which allowed them to contribute meaningfully to care decisions. The ability to plan ahead gave MAs a sense of control over their work and enough space to act autonomously. Together, these changes increased MAs’ sense of meaning and value to the practice site.

The MA experience seemed to improve despite the widespread acknowledgement that workload had increased dramatically over the same time period, indicating that the improvements were large enough to offset this development. Better organization and new systems that accompanied team-based care may explain this increased tolerance for the workload. The ability to plan, access needed information, and have consistent a set of work processes reduced the sense of chaos and disorder many had described before, making even a higher workload feel less stressful overall. The nature of the work may also explain some of this change. New responsibilities involved more variation, patient interaction, and learning than the traditional MA role had. Many participants valued having more interesting work in and of itself.
Data also suggested the importance of creating an organizational environment conducive to effective teamwork. While most MAs were more satisfied under team-based care, the extent of enthusiasm varied across interviewees. When discussing aspects of team-based care that were and were not working well, many MAs referred to implementation. Key contextual factors facilitating or impeding implementation mirrored those cited more broadly in implementation research: having sufficient resources, communicating regularly with frontline staff, securing physician support, and fostering strong connections across organizational boundaries (Weiner, 2009). However, while these facilitators and barriers were frequent themes in participants’ comments, our data did not show a clear pattern of variation in satisfaction or qualitative responses by practice site, which we had expected to find. Future research at the team and individual levels may yield more variation and point to opportunities for targeted intervention.

More primary care practices are adopting team-based models of care to become more efficient, provide more continuous and coordinated care, and manage new population health responsibilities. To our knowledge, this study is the first to examine empirically how these models affect the experiences of non-physicians, despite their growing role in primary care. Finally, this study provides empirical support to the hypothesis that team-based organizations create a more fulfilling work environment and strengthen relationships across hierarchical lines.

2.5.1 Limitations

There are limitations to what can be inferred from this study. Although we attempted to minimize bias in our sample selection and question design, we likely could not eliminate it entirely. The two practice sites that declined to participate were among those with the least satisfied MAs according to survey data. It is also possible that there was self-selection bias in which MAs agreed to be interviewed, among those invited. Second, there is the possibility of
response bias in interviews. Knowing the interviewers were affiliated with the AIC could have encouraged interviewees to speak positively about the intervention and/or their practice sites. Because we interviewed participants at or near the end of the intervention, they may have engaged in retrospective sense-making and given different responses than they would in interviews conducted throughout the intervention (Eisenhardt, 2007).

Generalizability also remains a concern. All the practice sites in our sample are located in the Boston area, affiliated with Harvard University, and part of the AIC initiative. We cannot be certain that our results would be found at other practices that did not share some key traits that these practice sites exhibited. For example, an academic affiliation may also have provided additional growth opportunities for MAs by giving them access to training and personnel resources specific to these settings. In addition, the decision to participate in the AIC initiative may have indicated a pre-existing culture of change that does not exist at all practices.

Other limitations relate to the scope of the study. While our conclusions about the MA experience may well reflect broader cultural changes at the AIC practice sites, these findings do not show how a team-based care intervention affected members other occupational groups. Other ongoing research is addressing the full impact of this intervention on team dynamics. Finally, while our data speak to the potential benefits of team-based care for MAs, they do not consider the impact on performance outcomes or costs of implementing team-based care. In particular, the finding that resources facilitate the implementation of team-based care may indicate that practices lacking these resources need to weigh the benefits against initial investments in staff, physical space, and time required for the transition. Continued systematic evaluation is needed to know if team-based care truly has the impact on quality that scholars and policymakers expect.

2.5.2 Implications for Practice
Primary care leaders and policymakers want to understand not only whether team-based care leads to improved practice performance, but also how this might occur and what will be the likely impact on clinical staff. They may have concerns that adding to MAs’ responsibilities will spur opposition and dissatisfaction because of the higher workload. Our findings suggest that, while this may be a risk, the benefits of team-based care help offset this risk. By giving MAs access to patients, information, and a more equal partnership with clinicians, team-based care can provide MAs with new sources of motivation and satisfaction.

As with all interventions aimed at changing organizational dynamics, these effects are filtered through pre-existing organizational conditions. While we found that MAs at the AIC practice sites were empowered by a shift to team-based care on the whole, they were not able to overcome all obstacles. When considering a transition to team-based care, primary care leaders and managers should consider whether key facilitating conditions are in place or whether they can establish them. These include ensuring that the practice has sufficient resources to support dedicated teams, that individual physicians are committed to team processes, that communication channels with staff are open, and that a positive culture among MAs exists.

Practice leaders should also consider and build on the important and growing role that MAs play in team-based primary care. As their role evolves, research should aim to understand the growing impact these professionals have and could have on care quality, how to recruit the right people for the role, and how to set them up for success. More frequent interactions with patients and more autonomy may, for example, require stronger interpersonal skills and the ability to build trust with physicians. In addition to creating organizational conditions that encourage teamwork, practices could hire and train for these skills. Ultimately, this may help practices achieve the full performance benefits that many hope team-based care will confer.
2.5.3 Conclusion

Primary care practices undergoing a transition to team-based care may find that this initiative increases motivation and improves relationships across hierarchical lines. MAs are one of several skilled, caring occupational groups that form health care teams. Our findings that MAs in primary care can benefit from working in teams may apply to other professional groups and settings. Team-based care offers a powerful tool for improving individual motivation, reducing hierarchical behavior, and ultimately improving performance in healthcare organizations.
Chapter 3 - The Impact of Medical Device Representatives on Surgical Performance: Evidence from Orthopedic Surgery

Abstract

Objective: To assess whether and when having medical device representatives (“device reps”) physically present in the operating room during surgery affects surgical performance.

Data sources/study setting: Detailed data on 3,587 total knee replacements (TKR), 3,838 total hip replacements (THR), and 6,646 shoulder arthroscopies performed at a large teaching hospital from 2000-2015.

Study design: We used multivariate regression models to estimate the impact of device reps on operative time, length-of-stay, and 2-year revisions controlling for characteristics related to the case, surgeon, and patient.

Data collection/extraction methods: Data were extracted from a database of clinical notes, longitudinal medical records, and billing records.

Principal findings: When a device rep and surgeon had collaborated on <2 cases in the prior year, THR and shoulder arthroscopy cases took an estimated 6.5% longer. TKR cases showed a similar trend, though it was not statistically significant. Otherwise, no difference was found if a device rep was present.

Conclusions: We found evidence of a short-term efficiency loss when a new surgeon-device rep pair began working together, but no average effect after just a few collaborations. This could inform debates over the appropriate use of industry-supplied technical support.

Key words: medical technology, team familiarity, medicine-industry relationships
3.1 Introduction

Pharmaceutical and medical device firms play a large and sometimes controversial role in American medicine (Campbell et al., 2007). Proprietary drugs or devices are involved in a substantial proportion of healthcare encounters, manufacturers sponsor medical research and education initiatives, and sales representatives are frequently present at medical facilities. Decades of research on the relationship between medicine and industry documents the potential for financial incentives and marketing to influence physician decision making (Dejong et al., 2016; Perlis & Perlis, 2016).

One of the most common and direct forms of industry-medicine interaction, however, remains surprisingly unexplored: when representatives from a medical device company (“device reps”) provide in-person technical assistance to surgical teams during procedures. Given their proximity to patient care and frequent presence in operating rooms (ORs) for some specialties, device reps could, in theory, have an impact on clinical quality. Empirically, however, it is not known whether or how device reps affect surgical efficiency and subsequent outcomes.

Using a uniquely detailed dataset covering fifteen years of orthopedic surgeries at a large academic medical center in Boston, we evaluate the average impact of having a medical device representative physically present in the OR on measures of efficiency and quality, and assess whether this impact changes as particular pairs of surgeons and device reps work together over time.

3.2 Background

From a policy perspective, ties between industry and medicine have a theoretically ambiguous impact on quality. On the one hand, even relatively weak industry links can influence physician behavior in undesirable ways (Sah & Fugh-Berman, 2013; Dana & Leowenstein, 2003; Fugh-
Evidence suggests that physicians who receive payments from pharmaceutical firms, for example, are more likely to prescribe branded drugs over cheaper generic alternatives (Lieb & Scheurich, 2014; Yeh et al., 2016). Although they have received less empirical attention than similar relationships in the pharmaceutical context, interactions between physicians and medical device manufacturers raise similar concerns (Camp, Gross, & McKneally, 2015; Tringale & Hattangadi-Gluth, 2017; Leopold, 2015; Smieliauskas, 2016).

On the other hand, some degree of collaboration is necessary to develop and benefit from high-quality medical innovations. Designing, testing, and implementing new technologies in clinical settings requires communication between their suppliers and end-users (Rosenbaum, 2015; Maisel, 2004). As medical technology grows more complex and medicine increasingly depends on it, product-specific training and assistance are being recognized as components of high-quality care (World Health Organization, 2010). That said, policymakers and managers looking to promote quality and reduce cost, while minimizing potential financial conflicts, have little empirical evidence to use when making decisions around this tradeoff.

Although interactions between the device industry and surgeons take place in multiple settings, these conflicting dynamics may be present when device reps are in the OR. The limited research available reflects mixed views from surgeons, many of whom report valuing the product support that device reps provide for troubleshooting, supply management, and training on new devices – particularly under unusual clinical circumstances or when the surgical team is relatively inexperienced, a common scenario in orthopedic surgery (Gagliardi et al., 2017). However, additional personnel of any kind can interfere with a case (Feuerbacher et al., 2012), and some surgeons voice concerns that device reps can be distracting or ineffective at times (O’Connor, Pollner, & Fugh-Berman, 2016; Moed & Israel, 2017). Professional surgical
societies have guidelines constraining what industry reps are allowed to do while in the OR (American College of Surgeons, 2016; Hayes, 2003), but the impact of these regulatory efforts in practice is unclear. In one recent survey, more than a third of device reps reported having been excessively involved in a surgery (Bedard, Moore, & Shelton, 2014).

3.2.1 Familiarity and the surgeon-rep relationship

Beyond any average effects, the impact of having a device rep in an OR may depend on the relationship between the particular device rep and the particular surgeon working on a case.

Team familiarity and performance

Teams tend to perform better as they accumulate experience working together, even after adjusting for each team member’s individual experience (Reagans, Argote & Brooks, 2005; Elbardissi et al., 2013; Huckman, Staats & Upton, 2009; Avgerinos & Gokpinar, 2016). Though the mechanisms behind this relationship are not fully understood, theory suggests that interactions over time between team members promote trust (Gulati & Sytch, 2008; Uzzi, 1997) and transactive memory or “group mind” (Wegner, 1987; Converse, Cannon-Bowers & Salas, 1993). These processes enable surgical teams to spend less time negotiating roles or explicitly coordinating their actions, and more time learning together (Kurmann et al., 2014).

Conversely, flux in team membership can disrupt efficiency and performance (Summers, Humphrey & Ferris, 2012; Vashdi, Bamberger & Erez, 2013; Finnesgard et al., 2017). This challenge pervades medicine, where shift-based work, complex rotation schedules for trainees, and physicians’ ability to work at multiple institutions limit familiarity between team members (Bedwell, Ramsay & Salas, 2012). Organizations can mitigate the downsides of unstable team membership by standardizing roles and processes (Bechky, 2006), and by designing structures
that encourage teamwork (Valentine & Edmondson, 2014). Nevertheless, even minimal amounts of familiarity can have relatively large positive effects on team performance (Xu et al., 2013).

**Surgeon-device rep collaboration**

It is not clear how a role that is both informal and crosses organizational lines, such as that of a device rep, affects the dynamics of fluid teams. Even customers and suppliers working together across organizations appear to have a team learning curve. As one example, Clark, Huckman, & Staats (2013) found that as outsourced teleradiologists worked repeatedly with the same physician customers, their image read times decreased. If device reps are providing valuable product support, collaborations between surgeons and device reps might be expected to follow a similar pattern, with performance improving as familiarity increases.

The device rep role has two properties that could make new collaborations particularly challenging. First, a surgeon’s trust in a new device rep may be limited by the latter’s sales/marketing agenda and outsider status, potentially leading to additional distractions early on. Research suggests an assessment phase in which surgeons monitor a new device rep’s competence and guard against signs of overstep, while device reps carefully study the surgeon’s habits and attempt to display their usefulness through trial and error (O’Connor, Pollner, & Fugh-Berman, 2016). Thus, there may be a longer period of adjustment in this context than is found in more traditional team collaborations.

Second, the device rep role is relatively ill-defined and informal, often overlapping with that of the scrub technician – a member of the surgical team who prepares and manages instruments during surgery. Task clarity (knowing who does what) is key to effective teamwork (Hackman, 2002), and a lack of it is one of the major risks for so-called “fluid teams” (Guzzo, 1996; Edmondson & Nemhhard, 2009) – such as OR teams – which exist for short durations and
experience rapid inflow and outflow of members (Tannenbaum, Mathieu & Cohen, 2012). Wide variability in surgeon preferences and device reps’ lack of integration into standard organizational processes may bring additional challenges to a new surgeon-device rep collaboration. Conversely, when organizational processes are not well designed, an experienced device rep could serve as a resource that compensates for those shortcomings.

3.3 Methods

3.3.1 Setting

We used retrospective data from the orthopedic surgery department at a large teaching hospital in the Boston area to assess the impact of medical device reps in the OR on surgical performance. The study window was 2000-2015. We focused on three surgical procedures: shoulder arthroscopy and two types of total joint replacement (TJR): total knee replacement (TKR) and total hip replacement (THR). These procedures were chosen because they are relatively common, standardized, and heavily dependent on the proper use of diverse and frequently-updated implants. Relevant cases were identified using procedure data from patient medical records. Revisions of prior surgeries were excluded.

The main justification offered for having a device rep present in an OR is to provide technical assistance, a service that is written into the purchasing contract between the hospital and a device manufacturing company. At this hospital, device reps were typically present in the OR at the request of the surgeon, sometimes joining on an ad hoc basis in the middle of a case. Although device reps were allowed only on the periphery – they could not enter the sterile field or touch devices after they had been removed from sterile packaging, and they had to wear scrubs identifying them as outside vendors – they could participate in certain aspects of the
surgical process. Depending on the surgeon’s needs, device reps were allowed to manage inventory, physically retrieve supplies and hand them to a circulating nurse who would pass the implant to the surgeon or scrub technician (a nurse who hands instruments to the surgeon), and provide verbal technical instruction about the implant-dependent parts of a case.

3.3.2 Data
With data extracted from operative notes, we created a structured dataset including detailed information on each surgical case occurring in the period from 2000 to 2015. This information included timestamps marking the beginning and end of each case, all team members and other staff present in the OR (including device reps), and the device implanted. These data were combined with discharge notes for each case, as well as all prior diagnoses, procedures, and demographic information extracted from the longitudinal medical record for each patient in the sample.

3.3.3 Sample
Starting with all 5,032 TKR, 4,260 THR, and 8,590 shoulder arthroscopies that occurred during the period from 2000 to 2015, we excluded cases according to several criteria. First, we excluded any cases that took place on weekends or outside standard work hours (7am - 4pm), reducing the possibility that our data included emergency procedures. Second, we excluded cases by surgeons with fewer than 30 total cases in the data. Third, we excluded all cases that took place during the year 2000 to enable a 1-year lookback window for surgeon experience and surgeon-device rep collaboration counts. Finally, we excluded cases with any missing data on patient demographics or device implant codes. All experience and collaboration counts, however, were generated using the full sample. This process resulted in the exclusion of 1,445 TKR cases (29% of original
sample), 422 THR cases (11%), and 1,944 shoulder arthroscopy cases (23%). The analysis sample consisted of 3,587 total knee replacements by 11 unique surgeons, 3,838 total hip replacements by 14 surgeons, and 6,646 shoulder arthroscopies by 16 surgeons.

3.3.4 Variables

Outcomes

The main outcome of interest was total operative time, defined as the time from when the patient entered the OR to when the patient left the OR for postoperative care. Operative time is a standard measure of quality in orthopedic surgery, where procedures are relatively standardized, have low complication rates, and have few other measurable quality indicators in the short term. Although faster operations could suggest harmful shortcuts, current evidence does not indicate reduced quality with shorter case duration in this context (Peersman et al, 2006). OR time is also an expensive and scarce resource, making inefficiency at any point in the duration of a case potentially costly (Macario, 2010). Because operative time was highly skewed, we used the natural log so it would more closely approximate a normal distribution, as is common practice in orthopedic surgery studies (Ramdas et al., 2017; Reagans, Argote & Brooks, 2005).

We also looked at the impact of device rep presence and surgeon-device rep familiarity on other measures of surgical performance. Specifically, we considered post-operative length-of-stay (LOS), measured as the number of hours between when the patient left the OR and when they were discharged from the hospital. This measure was applicable only to TJR cases, as shoulder arthroscopies were typically outpatient surgeries. We also used the natural log of LOS in a linear model, as is standard in medical research. In addition, we observed whether the patient in a given case underwent a revision surgery on the same limb within two years of the initial case. To ensure a full two-year window for observing revisions, this measure was generated only
for cases that occurred prior to 2014.

**Device rep presence and familiarity with surgeons**

Our main independent variable of interest was a simple indicator for whether or not at least one device rep was present during a given surgical case. Cases with a device rep present were further categorized according to the total number of collaborations between the device rep and the surgeon in the prior year. Unfamiliar surgeon-device rep pairs were those with no more than a single collaboration; familiar pairs were those with two or more collaborations.\(^1\) We selected this very low cut-off because our conversations with surgeons surfaced a particular concern about situations when a device rep is very new, and because the gains of team familiarity in surgery seem to accrue and then level off relatively quickly (Xu et al., 2013).

**Controls**

At this hospital, whether or not a device rep was present for a particular case was at least partly determined by the surgeon’s perceived need for technical assistance, thus creating a challenge in identifying a device rep effect. Our detailed data, however, enabled us to control for a large number of characteristics related to each case, the surgeon, and the patient.

We controlled for three measures of surgeon experience: the number of same-procedure cases using the same device, the number of same-procedure cases using a different device, and the number of different-procedure cases the surgeon had performed in the year prior to each case (based on all orthopedic surgeries performed at the hospital during the study period). To ensure we captured meaningfully broad device categories, different versions and generations of a

---

\(^1\) For cases with more than one device rep present (<5% of all cases), we calculated familiarity based on the number of prior collaborations the surgeon had had with any of the device reps present.
particular product line were grouped together for the surgeon experience calculations.

Three additional case features correlated with device rep presence were also included: case complexity, the number of other procedures performed during the same case (e.g., a rotator cuff repair that also involved biceps reattachment = one additional procedure), and whether the case was the surgeon’s first in a given day. Case complexity was determined from a keyword search on the operative notes for the word “complex,” which is routinely noted (for billing purposes) to indicate additional OR time needed when the surgeon considers a case particularly difficult for any reason, such as a comorbidity or a characteristic of the injury.

Patient controls included sex, race, age group, and score on the Charlson Comorbidity Index (CCI), a standard measure of comorbidities that has been linked to poorer clinical outcomes in orthopedic surgery (Charlson et al., 1987; Quan et al., 2011). Timing fixed effects were included, including the hour of the day in which the patient entered the OR, day of the week, month of the year, and year of the case. Finally, surgeon fixed effects were included to adjust for time-invariant differences across surgeons.

3.3.5 Analysis

We evaluated the impact of having a device rep present using the following multivariate ordinary least squares specification, where $i$ denotes the focal case:

\[
\ln(\text{OPERATIVE\_TIME}_i) = \beta_0 + \beta_1 \text{REP}_i + \beta_2 \text{OCC}_i + \beta_3 \text{SURG\_EXP}_i + \delta X_i + \theta T + \eta + \epsilon_i
\]

\text{REP}, the independent variable of interest, is a binary indicator for whether or not a device rep was present in the OR during focal case $i$. \text{SURG\_EXP} is a vector of covariates representing the three types of surgeon experience related to focal case $i$: the same-procedure cases with the same device, same-procedure cases with a different device, and cases of a
different procedure in the prior year. \( \text{OCC} \) is a vector of case-specific characteristics including complexity and the number of other procedures performed. \( \text{X} \) is a vector of characteristics of the patient undergoing surgery in focal case \( i \) (20-year age group, sex, race, and CCI), and \( \text{T} \) is a vector of timing-related covariates, including year, month of year, day of week, and the hour of day during which focal case \( i \) started. \( \theta \) represents timing fixed-effects, and \( \eta \) represents surgeon fixed-effects.

**Equation 3.2**

\[
\ln(\text{OPERATIVE\_TIME}_i) = \beta_0 + \beta_1\text{REP\_CAT}_i + \beta_2\text{OCC}_i + \beta_3\text{SURG\_EXP}_i + \delta X_i + \theta T + \eta + \epsilon_i
\]

Equation (2) is similar to the specification in Equation (1), but the independent variable of interest is decomposed into a three-level categorical variable that incorporates surgeon-rep familiarity. \( \text{REP} \) is replaced with \( \text{REP\_CAT} \), a vector of dummy variables signifying whether the case had no device rep, device rep present and familiar with the surgeon, or device rep present and unfamiliar with the surgeon.

Next, to contextualize our estimated impact of surgeon-device rep familiarity – versus surgeon familiarity with other essential team members – on operative time, Equation (3) respecifies Equation (2) with an additional dummy variable (\( \text{ST\_FAM} \)) indicating whether the scrub technician and the surgeon were familiar (vs. unfamiliar). As with surgeon-device rep pairs, surgeon-scrub technician pairs with two or more collaborations in the past year were categorized as familiar, while those with only zero or one prior collaborations were categorized as unfamiliar. \(^2\)

**Equation 3.3**

\[
\ln(\text{OPERATIVE\_TIME}_i) = \beta_0 + \beta_1\text{REP\_CAT}_i + \beta_2\text{ST\_FAM}_i + \beta_3\text{OCC}_i + \beta_4\text{SURG\_EXP}_i + \delta X_i + \theta T + \eta + \epsilon_i
\]

\(^2\) Because a scrub technician is present for every case, there was no equivalent level to “no rep present.” Therefore, we changed the reference group for \( \text{REP\_CAT} \) to “present and familiar with surgeon” to mirror the structure of the equivalent scrub technician variable.
3.4 Results

3.4.1 Sample characteristics

Table 3.1 contains descriptive statistics for each procedure-specific analysis sample. Device reps were present much more frequently in TJR cases (42% of the time for TKR, 40% for THR) than in shoulder arthroscopies (6%). By and large, this difference was attributable to the same device reps working frequently with the same surgeons, and not to a larger pool of reps for TJR cases. The average TKR lasted 158 minutes (SD = 45), THR 178 minutes (SD = 49), and shoulder arthroscopy 124 minutes (SD = 34). As expected if device reps were invited for cases when the surgeon most needed technical assistance, across all three procedures, unadjusted operative time was shortest when there was no device rep present, longer when a familiar device rep was present, and longest when an unfamiliar device rep was present. LOS followed similar patterns for TJR procedures. Consistent with other data from the orthopedic setting, revision rates were quite low (2-4%) across procedures.

Cases involving device reps tended to take place earlier in the surgeon’s daily case load, possibly due to scheduling convenience and more-predictable case timing. The presence of a device rep – particularly an unfamiliar one – was associated with less implant-specific experience for a surgeon. This pattern is understandable to the extent that device reps are requested when the surgeon is using a newer device. The familiarity component likely reflects device rep specialization by product; a new (to the surgeon) implant thus often means a new (to the surgeon) device rep. Other types of surgeon experience followed less consistent patterns, though device reps were present less frequently for cases where the surgeon had more other-device and other-procedure experience. Device reps were somewhat more likely to be present
during complex cases for TKR and THR, but not for shoulder arthroscopy. Our data showed essentially no other consistent differences in the likelihood that a device rep was present based on the patient characteristics we were able to observe.

### Table 3.1 Descriptive statistics for analysis samples by procedure

<table>
<thead>
<tr>
<th>TOTAL KNEE REPLACEMENT (TKR)</th>
<th>Category</th>
<th>No rep</th>
<th>Familiar rep</th>
<th>Unfamiliar rep</th>
<th>Total</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td></td>
<td>2,086</td>
<td>1,436</td>
<td>65</td>
<td>3,587</td>
<td></td>
</tr>
<tr>
<td><strong>Dependent variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>operative time (mins), mean (SD)</td>
<td></td>
<td>153 (41)</td>
<td>166 (48)</td>
<td>171 (49)</td>
<td>158 (45)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>postop LOS (hrs), mean(SD)</td>
<td></td>
<td>63 (40)</td>
<td>67 (36)</td>
<td>68 (32)</td>
<td>65 (38)</td>
<td>0.005</td>
</tr>
<tr>
<td>reop within 2y (%)</td>
<td></td>
<td>1.6</td>
<td>2.2</td>
<td>1.5</td>
<td>1.9</td>
<td>0.427</td>
</tr>
<tr>
<td><strong>Surgeon experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>same device, mean (SD)</td>
<td></td>
<td>72 (44)</td>
<td>63 (42)</td>
<td>37 (42)</td>
<td>68 (44)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>other device, mean (SD)</td>
<td></td>
<td>22 (32)</td>
<td>24 (33)</td>
<td>38 (46)</td>
<td>23 (33)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>other procedure, mean (SD)</td>
<td></td>
<td>166 (74)</td>
<td>166 (74)</td>
<td>139 (70)</td>
<td>166 (73)</td>
<td>0.011</td>
</tr>
<tr>
<td><strong>Case properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other procedures in case, mean (SD)</td>
<td></td>
<td>0.1 (0.4)</td>
<td>0.2 (0.4)</td>
<td>0.3 (0.4)</td>
<td>0.2 (0.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>complex case (%)</td>
<td></td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>first case of day (%)</td>
<td></td>
<td>42</td>
<td>50</td>
<td>48</td>
<td>46</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Patient characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCI (0-26), mean (SD)</td>
<td></td>
<td>3.1 (2.7)</td>
<td>3.1 (2.7)</td>
<td>3.4 (2.3)</td>
<td>3.1 (2.7)</td>
<td>0.646</td>
</tr>
<tr>
<td>sex = female (%)</td>
<td></td>
<td>59</td>
<td>60</td>
<td>68</td>
<td>60</td>
<td>0.356</td>
</tr>
<tr>
<td>race = nonwhite (%)</td>
<td></td>
<td>11</td>
<td>12</td>
<td>15</td>
<td>12</td>
<td>0.377</td>
</tr>
<tr>
<td>age &lt;40 (%)</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0.688</td>
</tr>
<tr>
<td>age 40-60 (%)</td>
<td></td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>age 60-80 (%)</td>
<td></td>
<td>67</td>
<td>66</td>
<td>60</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>age 80+ (%)</td>
<td></td>
<td>10</td>
<td>9</td>
<td>14</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL HIP REPLACEMENT (THR)</th>
<th>Category</th>
<th>No rep</th>
<th>Familiar rep</th>
<th>Unfamiliar rep</th>
<th>Total</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td></td>
<td>2,294</td>
<td>1,455</td>
<td>89</td>
<td>3,838</td>
<td></td>
</tr>
<tr>
<td><strong>Dependent variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>operative time (mins), mean (SD)</td>
<td></td>
<td>175 (48)</td>
<td>183 (51)</td>
<td>202 (49)</td>
<td>178 (49)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>postop LOS (hrs), mean(SD)</td>
<td></td>
<td>72 (49)</td>
<td>74 (52)</td>
<td>95 (105)</td>
<td>73 (52)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>reop within 2y (%)</td>
<td></td>
<td>2.7</td>
<td>2.2</td>
<td>3.4</td>
<td>2.5</td>
<td>0.590</td>
</tr>
</tbody>
</table>
### Table 3.1 (Continued)

**Surgeon experience**
- same device, mean (SD): 34 (24) 35 (25) 11 (16) 34 (24) <0.001
- other device, mean (SD): 14 (21) 13 (21) 18 (24) 14 (21) 0.082
- other procedure, mean (SD): 205 (109) 189 (91) 185 (150) 197 (104) <0.001

**Case properties**
- other procedures in case, mean (SD): 0.1 (0.3) 0.0 (0.3) 0.1 (0.3) 0.1 (0.3) 0.100
- complex case (%): 6 5 9 5 0.090
- first case of day (%): 51 54 63 52 0.041

**Patient characteristics**
- CCI (0-26), mean (SD): 2.7 (2.8) 2.8 (2.9) 2.9 (2.9) 2.8 (2.8) 0.524
- sex = female (%): 52 50 49 51 0.567
- race = nonwhite (%): 6 6 35 34
- age <40 (%) : 3 3 10 4 0.010
- age 40-60 (%) : 35 33 35 34
- age 60-80 (%) : 52 52 52 52
- age 80+ (%) : 10 11 3 11

<table>
<thead>
<tr>
<th>Category</th>
<th>No rep</th>
<th>Familiar rep</th>
<th>Unfamiliar rep</th>
<th>Total</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variable</strong></td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>operative time (mins), mean (SD)</td>
<td>6,274</td>
<td>277</td>
<td>95</td>
<td>6,646</td>
<td></td>
</tr>
<tr>
<td>reop within 2y (%)</td>
<td>122 (33)</td>
<td>140 (38)</td>
<td>145 (44)</td>
<td>124 (34)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Surgeon experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>same device, mean (SD)</td>
<td>31 (27)</td>
<td>20 (23)</td>
<td>16 (20)</td>
<td>30 (27)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>other device, mean (SD)</td>
<td>90 (54)</td>
<td>84 (56)</td>
<td>74 (60)</td>
<td>89 (54)</td>
<td>0.006</td>
</tr>
<tr>
<td>other procedure, mean (SD)</td>
<td>321 (178)</td>
<td>252 (157)</td>
<td>239 (168)</td>
<td>317 (177)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Case properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other procedures in case, mean (SD)</td>
<td>3.0 (1.3)</td>
<td>3.1 (1.4)</td>
<td>2.7 (1.5)</td>
<td>3.0 (1.3)</td>
<td>0.017</td>
</tr>
<tr>
<td>complex case (%)</td>
<td>17</td>
<td>16</td>
<td>8</td>
<td>17</td>
<td>0.068</td>
</tr>
<tr>
<td>first case of day (%)</td>
<td>41</td>
<td>52</td>
<td>63</td>
<td>41</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Patient characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCI (0-26), mean (SD)</td>
<td>1.4 (1.9)</td>
<td>1.5 (2.0)</td>
<td>1.4 (2.1)</td>
<td>1.4 (1.9)</td>
<td>0.687</td>
</tr>
<tr>
<td>sex = female (%)</td>
<td>34</td>
<td>31</td>
<td>27</td>
<td>33</td>
<td>0.332</td>
</tr>
<tr>
<td>race = nonwhite (%)</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>0.748</td>
</tr>
<tr>
<td>age &lt;40 (%)</td>
<td>25</td>
<td>16</td>
<td>24</td>
<td>25</td>
<td>0.052</td>
</tr>
<tr>
<td>age 40-60 (%)</td>
<td>48</td>
<td>54</td>
<td>47</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>age 60-80 (%)</td>
<td>26</td>
<td>29</td>
<td>28</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>age 80+ (%)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* P-values reflect chi-square test for differences in proportions, ANOVA stat (F-test) for differences in mean
3.4.2 Device rep presence and operative time

Table 3.2 provides results on the relationship between device rep presence and operative time as estimated in Equation 3.1. We found no significant effect of device rep presence on operative time for either of the TJR procedures, although there was evidence at a 10% level of significance of an increase in operative time (estimated at 2.7%, p=0.08) when a device rep was present in the case of shoulder arthroscopy.

Table 3.2: Device rep presence and operative time

<table>
<thead>
<tr>
<th></th>
<th>Dependent variable: ln(operative time)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TKR (1)</td>
</tr>
<tr>
<td>Device rep (vs. no device rep)</td>
<td>0.010 (0.009)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,587</td>
</tr>
<tr>
<td>R²</td>
<td>0.740</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.735</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>0.135 (df = 3524)</td>
</tr>
</tbody>
</table>

Note: SEs clustered by surgeon

*p<0.1; **p<0.05; ***p<0.01

Controls included but not shown: patient characteristics, surgeon experience, other case characteristics, surgeon and timing fixed effects

3.4.3 Device rep-surgeon familiarity and operative time

A different pattern emerged when we divided cases with a device rep present by the level of surgeon-device rep familiarity as in Equation 3.2. Cases with familiar surgeon-device rep pairs again did not differ from cases in which no device rep was present (Table 3.3). For cases with unfamiliar surgeon-device rep pairs, however, operative times were longer for THR and shoulder...
arthroscopy by an average of 6.4% (p < 0.001) and 6.5% (p = 0.002), respectively. Based on these estimates, we would predict an additional 11.2 minutes for the average THR and 7.9 minutes for the average shoulder arthroscopy if an unfamiliar device rep had been present. While the estimate for TKR (3.9% increase in operative time) did not reach conventional levels of statistical significance (p = 0.12), it was in the same direction as, and of similar magnitude to, the effects for THR and shoulder arthroscopy.

Table 3.3 Surgeon-rep familiarity and operative time

<table>
<thead>
<tr>
<th>Dependent variable: ln(operative time)</th>
<th>TKR (1)</th>
<th>THR (2)</th>
<th>shoulder arthroscopy (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiar device rep (vs. no rep)</td>
<td>0.008</td>
<td>0.004</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Unfamiliar device rep (vs. no rep)</td>
<td>0.039</td>
<td>0.064***</td>
<td>0.065***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.013)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,587</td>
<td>3,838</td>
<td>6,646</td>
</tr>
<tr>
<td>R²</td>
<td>0.740</td>
<td>0.637</td>
<td>0.410</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.736</td>
<td>0.631</td>
<td>0.404</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>0.134 (df = 3523)</td>
<td>0.152 (df = 3770)</td>
<td>0.203 (df = 6578)</td>
</tr>
</tbody>
</table>

Note: SEs clustered by surgeon

* p<0.1; ** p<0.05; *** p<0.01

Controls included but not shown: patient characteristics, surgeon experience, other case characteristics, surgeon and timing fixed effects

To place the magnitude of the surgeon-device rep familiarity effect in context, we compared it with the effect of familiarity between the surgeon and an indisputably vital member of the core surgical team – the scrub technician responsible for handing instruments to the surgeon – as specified in Equation 3.3. Table 4 below indicates that the impact of surgeon-device rep familiarity was at least as large as that of surgeon-scrub technician familiarity. An unfamiliar
scrub technician-surgeon pair was associated with longer operative times for TKR and shoulder arthroscopy. Chi-squared tests for differences in individual coefficients showed that the estimates for surgeon-device rep vs. surgeon-scrub technician were statistically indistinguishable for TKR (3.1% vs. 2.9%, p = 0.94) and shoulder arthroscopy (4.9% vs. 4.1%, p = 0.73). However, for THR, an unfamiliar device rep was associated with a greater slow-down in operative time than an unfamiliar scrub technician (6.0% vs. 1.9%, p=0.010).

Table 3.4: Surgeon-rep familiarity and operative time: scrub technician comparison

<table>
<thead>
<tr>
<th></th>
<th>TKR (1)</th>
<th>THR (2)</th>
<th>shoulder arthroscopy (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No device rep (vs. familiar rep)</td>
<td>−0.008 (0.008)</td>
<td>−0.004 (0.008)</td>
<td>−0.014 (0.016)</td>
</tr>
<tr>
<td>Unfamiliar device rep (vs. familiar rep)</td>
<td>0.031 (0.022)</td>
<td>0.060*** (0.011)</td>
<td>0.049** (0.022)</td>
</tr>
<tr>
<td>Unfamiliar scrub technician (vs. familiar scrub technician)</td>
<td>0.029*** (0.007)</td>
<td>0.019 (0.012)</td>
<td>0.041*** (0.010)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>TKR (1)</th>
<th>THR (2)</th>
<th>shoulder arthroscopy (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>3,585</td>
<td>3,835</td>
<td>6,645</td>
</tr>
<tr>
<td>R²</td>
<td>0.741</td>
<td>0.638</td>
<td>0.411</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.737</td>
<td>0.737</td>
<td>0.631</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>0.135 (df = 3520)</td>
<td>0.152 (df = 3766)</td>
<td>0.203 (df = 6576)</td>
</tr>
</tbody>
</table>

Note: SEs clustered by surgeon

* p<0.1; ** p<0.05; *** p<0.01

Controls included but not shown: patient characteristics, surgeon experience, other case characteristics, surgeon and timing fixed effects

3.4.4 Other performance measures

Finally, to assess whether having device reps in the OR affects measures of clinical quality, we estimated the models in Equation (2) above using two different dependent variables: (1) LOS and (2) an indicator for whether the patient had a revision procedure (i.e., reoperation) within two
years of the focal procedure. As with operative time, we log-transformed LOS because it was highly skewed in our data. Due to the binary nature of our revision procedure variable, we used a logit model. The two-year window (following a focal case) required to capture a revision procedure required us to limit our data to cases that took place from 2001 to 2013 for that analysis. We found no evidence of a device rep effect—familiar or unfamiliar—on either LOS or the likelihood of a revision procedure within 2 years (results in Appendix Tables A1 and A2).

3.5 Discussion

The role of industry in medicine is a long-debated topic, but medical device representatives remain a common and active presence in ORs across the U.S. Surprisingly little empirical work exists on just how often and when device reps are actually present, how frequently they interact with particular physicians, or how they affect clinical care. This study is among the first attempts, to our knowledge, to quantify any dimension of this phenomenon.

We found that, while device reps were more likely to be present when the surgeon was relatively inexperienced with a particular device, this result only described part of the picture. Device reps were present for total joint replacements at a much higher rate than for shoulder arthroscopies, which is surprising given that there were many more distinct and frequently-updated types of implants available in shoulder arthroscopy (30 unique families of suture anchors in our data) than in TJR (9 unique families of implants for TKR, 6 for THR). More research is needed to understand what actually drives decisions to have a device rep present during a particular surgical case.

Further, we found no evidence, on average, that device reps had an impact on operative time after controlling for a wide range of covariates. However, operative times were longer when the surgeon and device rep were very new to working together. This is consistent with a growing
literature on team familiarity in medicine, which finds that when team members accumulate experience working together, they tend to perform better even when working across traditional organizational boundaries.

The magnitude of this negative relationship between the presence of a new (to the surgeon) device rep and efficiency was greater than the impact of the same level of familiarity between surgeons and scrub technicians for the same types of cases. Although surprising given the centrality of the scrub technician role in surgery, it may partially be explained by the device rep’s unique position on a given team as an outsider and informal teammate. The device rep’s role in sales and marketing may limit the surgeon’s trust and necessitate more management early in the working relationship. A lack of clarity regarding the device rep’s role in providing technical assistance may also slow the pace of work as task responsibilities and routines are established. More research is needed to understand the micro-level dynamics of surgeon-device rep collaborations.

3.5.1 Practical implications

Our study is particularly timely in terms of its implications for practice. Recent years have witnessed a spate of articles in the popular press questioning whether device reps should be so deeply involved in clinical activity (Rubenfire, 2016; Boodman, 2016). Having largely emerged in the last three years, more rigorous academic approaches to this topic are growing as well (O’Connor, Pollner & Fughberman, 2016; Gagliardi et al., 2017; Grundy, Bero & Malone, 2016). In this nascent research context, our study is the first to address device reps in the OR using observational, detailed, quantitative data.

As part of an effort to rein in costs and reduce industry influence, hospitals such as Linda Loma University Medical Center in California have begun replacing device reps with in-house
staff or reducing the role through technology (Lee, 2016; Advisory Board Company, 2014; Gennuso, 2014). Apps and tools designed to facilitate this process have emerged on the market (e.g., NuRep, a telesurgery service). Practitioners around the country are asking whether device reps are in fact worth their costs and what the risks might be of removing or replacing them. Our study can help inform this debate as hospital managers, surgeons, and medical societies reconsider policies around product-specific technical support in the OR.

3.5.2 Limitations

Though our data offered a uniquely detailed view of surgeon-device rep collaboration in the OR, this study faced limitations. Some key variables (device rep, implant, and case complexity) were derived from unstructured portions of clinical notes, raising the possibility of missing or inaccurate data. Descriptive results and the full regression estimates show expected patterns, however, suggesting that data for the complete cases were reasonably accurate. For example, when the surgeon’s device-specific experience was lower, device reps were far more likely to be present (Table 1). In addition, complex cases and lower surgeon device-specific experience were associated with substantial increases in operative time. See Appendix Table A3 for details.

Though we used standard quality measures for the orthopedic surgery context, the available data limited our choice of outcome variables. It is not surprising that operative time showed the clearest relationship to our independent variables of interest, as it is the measure that most directly relates to the operative period during which the device rep would interact with the surgeon. In comparison, LOS and two-year revision rate may be influenced by a wide variety of factors unrelated to the interaction between a surgeon and a device rep. Revision rates for the procedures we considered are also extremely low, likely leaving too little variation to identify rep effects. Ideally, we would have linked rep presence to a wider range of outcomes, such as 10-
or 15-year failure/replacement rate or patient-reported outcomes.

The fact that our study took place within a single academic teaching hospital may limit generalizability. Thought we would expect similar surgeon-rep familiarity patterns to be present in other types of facilities, it is not clear whether that would be the case in smaller or non-teaching hospitals, or if hospitals might vary how they manage surgeon-rep interactions in a way that would affect the impact of having reps present. Future research should look at such relationships across different types of institutions, geographic settings, and payment structures.

3.6 Conclusion

We used a novel dataset and approach to explore the tradeoffs involved in one type of physician-industry relationship: the physical presence of industry representatives in the OR during surgery. We found evidence that the presence of device reps with whom surgeons were not familiar hindered efficiency slightly in the short term. More research is needed to understand under precisely what circumstances device reps actually take part in clinical activity, what they do while present, and how they affect both clinical quality and cost. As debates over the proper role of industry in health care continue, stakeholders from clinical care, policy, and industry will benefit from a stronger empirical foundation.
Chapter Four - Patterns in patient portal use: The unexplored provider side

Abstract

Research Objective: Online portals, where patients can access their own health records and message with providers, offer new channels for patients to participate in their care. However, low patient uptake has resulted in limited impact. Provider organizations may play a significant role in the extent to which patients use and benefit from portals, but have received little attention. In this study, we explore how primary care providers/practice staff use portals and how this relates to utilization on the patient side.

Study Design: We use a uniquely large and detailed dataset spanning 369,247 patients cared for by 4,036 primary care providers at 642 primary care practices across the U.S. using athenahealth, Inc.’s patient portal platform. Longitudinal utilization data on both the patient and provider sides was recorded at the patient-month level from Jan 2015 to Dec 2016.

We used descriptive statistics to characterize variation in portal activity on the practice and patient sides. We used linear fixed-effects models to predict portal adoption by patients as a function of specific provider-side actions, and to predict utilization (among adopters) as a function of provider-side actions lagged up to 4 months back.

Population Studied: Patients treated in 642 primary care practices that varied in size, U.S. region, and network type. Patients were included in the sample if they visited the practice at least once each year from 2015-2016 and opened a portal account before Jan 1, 2015.

Principal Findings: A substantial amount of variation in practice-side activity took place between practices, but this differed depending on the activity. We saw no evidence of substantial variation across individual providers within a practice. Patients at practices with higher lab/image posting rates, messaging rates, and response rates to patient messages were far more likely to use the portal.

Portal actions on the practice side were strongly associated with both portal adoption and use (among adopters) on the patient side after controlling for a wide variety of patient characteristics, health care utilization, and chronic condition diagnoses.

Conclusions: Whether and how much patients use portals may depend substantially on how their providers use them. Posting clinical data and personalized messages from providers garner more action from patients than automated messages. Practices interested in increasing portal utilization by patients should first focus on increasing use by their own providers, and prioritizing functions that interest patients.
4.1 Background

Online patient portals hold the potential to engage patients in their care and improve operational efficiency for provider organizations (Ahearn et al., 2011). While they vary by platform and provider, portals generally feature at least an online scheduling system, billing/payment interface, viewable EHR data, secure messaging with providers, online medication refill requests, and automated reminders. Spurred by the 2009 HITECH Act’s requirement that providers must have granted patients some access to their electronic health records (EHRs) and secure messaging to receive Stage 2 Meaningful Use incentive payments (CMS, 2017), portals have proliferated in recent years and are now widely adopted by provider organizations across the U.S. (Neuner et al., 2015; Furukawa et al., 2014).

Despite their promise, portals appear to have had only a minimal impact on patient engagement, operational efficiency, or clinical outcomes to date (Goldzweig et al., 2015; de Jong, Ros & Schrijvers, 2014; Ammenwerth, Schnell-Inderst & Hoerbst, 2012). While patients generally report being interested in the increased convenience and access portals offer (Wakefield et al., 2012; Jenssen, 2016; Osborn et al., 2013), only 15-30% of them actually used it as of 2017 (GEO, 2017). Uptake is particularly low among racial/ethnic minorities, low-income, and older patients (Emont, 2011; Graetz et al., 2016; Kruse et al., 2012; Sarkar et al., 2011; Ancker et al., 2011; Jhamb et al., 2015).

One reason for the gap between interest and uptake may be that portals are a relatively new concept to patients as a way to manage their care. Some report not being aware of portals available to them (Ronda, Dijkhorst-Oei & Rutten, 2014; Osborn et al., 2013), or not knowing how to enroll (Goel et al., 2011). Unaccustomed to technology-mediated interactions with health care providers, many patients voice uncertainty about what portals are for, how they work, and
how to use them effectively (Kruse et al, 2015; Luque, Keken & Fiscella, 2013).

Providers and practice organizations may play an important role in how patients use and experience portals (Wald, 2010), but have received very little research attention to date. This is surprising given that portals are explicitly built to facilitate exchanges between patients and their care providers. Patients whose physicians endorse and engage with portals report having more interest in using them (Irizarry, Dabbs & Curran, 2015; Wade-Vuturo, Mayberry & Osborn, 2013; Giardina, 2017), and some observational studies suggest this actually translates into both higher uptake and more frequent utilization (Wolcott et al, 2017; Krist et al., 2014). However, the few studies that have quantified any aspect of provider-side portal activity have generally focused on the individual provider level only, and have been limited to at most a small handful of practice organizations. This is again surprising, given that many features of portals intersect with organizational workflows and are not contained to individual provider-patient pairs.

There is no broad data on how providers actually use portals, how much variation exists across individual providers and practice organizations, or the extent to which portal-based actions on the provider side (as well as which types) are most likely to engage patients. This study seeks to close that gap by using a uniquely large, multi-practice dataset extracted from portal utilization records to answer two questions: First, what do primary care providers/practice staff do on portals, and at what level (individual provider or practice organization) does the meaningful variation take place? Second, which of these actions are most closely associated with portal adoption and utilization by patients?

4.2 Methods

Approval from the Harvard University Institutional Review Board (IRB) was obtained for this study.
4.2.1 Setting and sample

We used retrospective data from an online patient portal developed and operated by athenahealth, Inc., a cloud-based health technology company that also provides claims management services and electronic health record (EHR) software to health care delivery organizations across the U.S. The final sample consisted of 369,923 portal-registered patients distributed across 4,064 primary care providers and 642 primary care practices. The study timeframe was Jan 1, 2015 through Dec 31, 2016.

Practice selection

The sample consisted of primary care practices that were actively using all components of the athenahealth patient portal throughout the study period. Although specialty providers also use portals, continuity and frequent communication between patients and providers may be especially important in primary care settings. Chronic condition management, often touted as a core use of portals, also takes place mainly in primary care. To ensure that all practices in the sample were using a relatively uniform tool, and that they had at least a year of experience with the portal before the study began, we included only those practices that had some activity recorded for all major portal capabilities (clinical data posting and viewing, secure messaging on both sides) every month from January 2014 through December 2016.

Patient selection

Patients were selected if they were registered at a primary care practice in the sample from Jan 2015 to Dec 2016, had at least one completed visit to the practice during each year of that same time period (two total visits minimum), and were aged 20 or older as of Jan 1, 2015. To ensure a full 2 years of utilization data, patients were only included in analysis if they also
opened a portal account at any point before Jan 1, 2015. This resulted in an analytic sample of 369,923 patients. Patients were assigned to the primary care provider with whom they had the preponderance of their visits to the practice during the study window.

4.2.2 Data and measures

We relied on portal click logs, clinical document records, and secure messaging documentation to observe all portal activity (incoming from providers/practice staff and actions taken by the patient) for each patient in the sample by month for all 24 months in the study window. Utilization data were linked to patient demographic characteristics and chronic condition diagnoses using claims data. Finally, practice characteristics were obtained from operational data.

Patient-side portal activity

Patients were considered to have adopted the portal if they used it at all during the two-year study window for any of the following activities: initiating a secure message thread, viewing some type of clinical data (e.g., care summaries, lab/image results, vaccination histories, medication lists, etc.), requesting or managing appointments, requesting medication refills, or managing payments. Among adopters, utilization was recorded as a binary indicator (1 = used portal, 0 = did not use portal) by month (for 24 months in total).

Practice-side portal activity

Practices using this portal could engage in three main categories of activity: posting labs/images to the portal, reaching out to patients through secure messaging, and responding to patient-initiated secure messages.

As with patient-side portal actions, each provider-side action was aggregated up to the patient level as a binary indicator (1 = provider-side content sent/posted for patient at some point
during the study window, 0 = provider-side content not sent/posted). For patients who adopted the portal, each practice-side portal action was also recorded as a binary indicator at the patient-month level (1 = action was taken in month t, 0 = action was not taken in month t).

Secure message threads initiated by the practice were categorized as either “auto-generated” or “personalized.” Auto-generated messages were generally, from the patient perspective, form letters not clearly written by a specific individual at the practice to the specific patient. These could range in content, but examples included care summary notifications, appointment reminders, and information campaigns about preventive health. Personalized messages were any messages written by a specific provider or staff member at the practice (physician, nurse, administrative staff, etc.), customized, and sent specifically to one patient.

When a lab/image result was generated after an applicable visit, providers had the option of publishing it to the relevant patient’s portal account. Lab/images posted were recorded as a binary indicator in a given patient-month (0 = no lab/image posted, 1 = at least one lab/image posted).

Controls

*Structural practice characteristics:* We used visit volume as a proxy for practice size. Practices with under 30,000 visits per year were categorized as small practices, those with over 50,000 as large practices, and the rest as medium-sized practices. We also included an indicator for whether the practice was part of a broader multispecialty network, as opposed to a network consisting only of primary care practices.

*Patient demographics:* Patient demographic information included age, sex, race, ethnicity, self-reported primary language (English vs. other), U.S. region, geographic type (metropolitan,
Patient prior and new chronic conditions: Patient health characteristics came from EHR data. They were recorded as the presence or absence of 33 diagnoses included in the Center for Medicare and Medicaid Services (CMS) published list of common chronic and/or debilitating conditions. Prior diagnoses were determined by the presence of a relevant diagnosis code (ICD-9 or -10) on a claim within 3 years prior to Jan 2015, and new diagnoses were determined by the presence of a relevant diagnosis code (if not already included as a prior diagnoses) on a monthly basis from Jan 2015 - Dec 2016.

4.2.3 Analysis

Our first aim was to describe how providers/practice staff used the portal, and at what levels this varied for each provider-side activity. We generated descriptive statistics showing the overall rates at which patients had labs/images posted, received the two types (auto-generated vs. personalized) of secure messages, and (for patients who initiated at least one secure message) received responses to their secure messages. To assess the proportion of variation in adoption accounted for at the patient, provider, and the practice levels, we used a three-level (L1 = patient, L2 = provider, L3 = practice), fully-nested hierarchical model with varying intercepts by provider and practice, for each provider-side activity. All controls at the patient and practice levels were included to adjust for the likely possibility that patients were unevenly distributed across providers/practices by demographic and health characteristics. Intraclass correlations (ICCs), the proportion of total variance attributable to between-group variation (i.e., the correlation between units within groups), were calculated at the practice and provider (within
practice) levels. Residual variation was attributed to the patient (within provider) level.

Our second aim was to understand how actions on the provider side related to 1) patient adoption and 2) frequency/timing of use among adopters. Both involved predicting binary outcomes, but we used linear probability models rather than a logistic regressions models for computational tractability. Although the linear specification risks generating predicted probabilities greater than 1 or less than 0, our large dataset and relatively frequent outcomes (66% of patients in the sample adopted the portal, and adopters used the portal in 26% of all patient-months) make it a reasonable option for our data (Angrist & Pischke, 2009).

To model portal adoption at the patient level, data were organized by patient, and provider-side actions were converted into a binary indicator (1 = received content during the study period vs. 0 = did not receive content during the study period). We included all patient-level controls listed above (demographics and health characteristics), as well as practice fixed-effects to control for systematic variation by practice. Standard errors were clustered by practice. Next, to explore how specific provider-side actions related to patient portal use on a more granular month-to-month basis, we took the subsample of adopters (66% of the initial sample) and ran a linear model with time lags backward up to 4 months (t-1, t-2, t-3, t-4) for each provider-side action. Controls for seasonality (month and year), an indicator for the presence of a new chronic condition diagnosis, and an indicator for whether the patient had a visit to the practice, were included. Finally, we included patient fixed-effects to control for any unobserved time-invariant factors attributable to the patient that may have caused systematic differences in the probability that they used the portal in any given month. Standard errors were clustered by patient. To capture full data back to t-4, observations from the first five months of the study window (Jan - May 2015) were excluded from analysis.
4.3 Results

Table 1 below compares characteristics of the full patient sample (n = 1.2 million patients), which included all patients at a qualifying practices who were registered with the practice throughout the study period and had a visit in each of 2015 and 2016, to the analytic sample (n = 369,247 patients), which only included the subset of these patients who registered for the portal before Jan 1, 2015. Patients in both samples were distributed across 642 primary care practices and 4,036 individual primary care providers.

Both the full sample and the analytic samples were substantially less demographically diverse than the U.S. population (Census, 2010), likely due to our having included only patients at practices with a fully operational portal. Other health technologies, such as EHR systems, have also been more slowly implemented in settings that serve rural, low-income, and minority patients (Mack et al., 2016). Portal registration rates also reflected demographic disparities identified in prior research, resulting in an analytic sample that was less diverse than the original sample. Those who had opened a portal account before Jan 1, 2015 were disproportionately white, less likely to be Hispanic or Latino, more likely to be living in a metropolitan area, and dramatically more likely to be married/partnered than those in the full sample. The groups did not differ substantially in the rate at which they had commercial insurance, but patients in the analytic sample were more likely to have Medicare and less likely to have Medicaid or be uninsured, again mirroring disparities in technology adoption found consistently in prior research. Finally, portal registrants tended to be middle-aged, with both the youngest (20-40) and oldest (80+) cohorts being substantially less represented in the analytic sample than in the original sample.
Table 4.1 Characteristics of full vs. analytic samples

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample</th>
<th>Analytic sample*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>large</td>
<td>35</td>
<td>36</td>
</tr>
<tr>
<td>medium</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>small</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>Multispecialty (vs. not)</td>
<td>59</td>
<td>56</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-40</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>40-60</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>60-80</td>
<td>29</td>
<td>38</td>
</tr>
<tr>
<td>80+</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>white</td>
<td>91</td>
<td>93</td>
</tr>
<tr>
<td>asian</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>black/African-American</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>other</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Sex = female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino (vs. not)</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Geographic type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>metro</td>
<td>78</td>
<td>80</td>
</tr>
<tr>
<td>metro-adjacent</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>rural</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Married (vs. single)</td>
<td>56</td>
<td>65</td>
</tr>
<tr>
<td>Insurance status/type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>commercial</td>
<td>57</td>
<td>58</td>
</tr>
<tr>
<td>medicaid</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>medicare</td>
<td>27</td>
<td>32</td>
</tr>
<tr>
<td>military</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>uninsured</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Primary language = non-English</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>midwest</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>northeast</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>south</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>west</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Chronic condition diagnoses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>4+</td>
<td>23</td>
<td>31</td>
</tr>
</tbody>
</table>

*Patients who registered for the portal before Jan 1, 2015
4.3.1 Patient- and provider-side portal activity summary

Table 4.2 describes both patient- and practice-side portal activity. For the full analytic sample of patients, each of these is expressed as the percentage of patients who took each possible action, or received each type of content from a provider, at any point during the study window (column A). Then, for adopters only, Column B reports the percentage of patient-months (out of the 24 possible) during which each patient engaged in the activity or received each type of content from a provider.

Sixty-six percent of all patients in the analytic sample adopted the portal, and only slightly more of them (70%) received some type of content from a provider during the study window. Those who who adopted the portal used it during 26% of patient-months overall (translating to ~6.3 months out of the total possible 24), but received content from a provider in only 12% of all patient-months (~2.9 months). Viewing clinical data was by far the most common patient-side activity, with 56% of all patients doing so at some point and adopters doing so during 22% of all patient-months. Similar to secure messaging rates found in other recent studies, 25% of patients initiated a secure message with a provider. This was a rare activity among adopters, who sent messages during only 4% of all patient-months.

Auto-generated messages were the most common type of provider-side content with about half of all patients receiving one during the study period, followed closely by having a lab/image posted (46%). Adopters had labs/images posted slightly more frequently (during 7% of all patient-months vs. 5%). Personalized messages were exceedingly rare, with only 6% of patients receiving one at all, and <1% adopters receiving one in less than 1% of all patient-months.
Table 4.2 Summary of patient- and provider-side portal activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>(A) Analytic sample (n = 369,247 patients)</th>
<th>(B) Adopters only (n = 6.5 million patient-months)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient-side</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any activity</td>
<td>66%</td>
<td>26%</td>
</tr>
<tr>
<td>Managed/requested an appointment</td>
<td>49%</td>
<td>8%</td>
</tr>
<tr>
<td>Managed a payment</td>
<td>34%</td>
<td>7%</td>
</tr>
<tr>
<td>Viewed clinical data</td>
<td>56%</td>
<td>22%</td>
</tr>
<tr>
<td>Initiated a secure message</td>
<td>25%</td>
<td>4%</td>
</tr>
<tr>
<td>Requested a refill</td>
<td>11%</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Provider-side</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any activity</td>
<td>70%</td>
<td>12%</td>
</tr>
<tr>
<td>Lab/image posted</td>
<td>46%</td>
<td>7%</td>
</tr>
<tr>
<td>Auto-generated message received</td>
<td>51%</td>
<td>5%</td>
</tr>
<tr>
<td>Personalized message received</td>
<td>6%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Next, we sought to describe how provider-side portal activity varied at patient, provider, and practice levels. Table 4.3 summarizes the intraclass correlations (ICCs) associated with each activity (expressed as percentages), after adjusting for all other practice characteristics and patient characteristics listed in Table 1. ICCs measure to degree to which variation takes place across groups (i.e., the degree to which units within groups are correlated). These varied somewhat by activity, but a substantial amount of variation appeared to take place at the practice level across all of them.

Almost two-thirds (64%) of total variation in auto-generated messaging and one-third (32%) in lab/image posting occurred across practices. Personalized messaging was more idiosyncratic, with the practice level accounting for 18% of total variation (still a sizable proportion). Differences across individual providers within practices accounted for very little variation across all three activities (ranging from 1% for auto-generated messaging to 5% for
personalized messaging). Differences across patients accounted for between one-third and three-quarters all variation across activities, likely reflecting a combination of patients’ different health conditions, technological access/literacy, care patterns, and individual preferences.

Table 4.3 Breakdown of variation in provider-side portal activity*

<table>
<thead>
<tr>
<th>Practice-side activity</th>
<th>Variation across patients (within providers)**</th>
<th>Variation across providers (within practice organizations)</th>
<th>Variation across practice organizations</th>
<th>Total variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Had a lab or image posted</td>
<td>66%</td>
<td>2%</td>
<td>32%</td>
<td>100%</td>
</tr>
<tr>
<td>Received an auto-generated message</td>
<td>35%</td>
<td>1%</td>
<td>64%</td>
<td>100%</td>
</tr>
<tr>
<td>Received a personalized message</td>
<td>77%</td>
<td>5%</td>
<td>18%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Percentages refer to intraclass correlations (representing proportion of total variance) derived from nested 3-level models with varying intercepts by provider and practice (L1 = patient, L2 = provider, L3 = practice), for each provider-side activity. The unit of analysis was the patient, and each dependent variable was a binary indicator for whether or not the provider-side activity occurred at some point during the study period.

**Residual variance after accounting for cross-provider and cross-practice variance

4.3.2 Relationship between provider-side portal use and portal adoption by patients

Sixty-six percent of patients in the analytic sample adopted the portal (i.e., used it at all) during the two-year study window. Key results for the linear model predicting adoption (at the patient level) for all 369,247 patients, after controlling for patient demographic/health characteristics, are presented in Figure 4.1 (full results in Appendix Table C.1). Having at least one lab or image posted to the portal was associated with a 36 percentage-point increase (p < 0.001) in the probability of adoption. Receiving a personalized message was associated with a smaller, but still quite sizable, increase of 11 %-points (p < 0.001). Finally, auto-generated messages had the weakest relationship to adoption with only a 2 %-point (p < 0.001) increased probability for patients who received at least one such message vs. those who received none.
4.3.3 Relationship between provider-side actions and portal utilization by patients

Key results for the model predicting monthly utilization for the 66% of patients who adopted the portal are presented in Figure 4.2 (full model results are in Appendix Table C.2). These patients used the portal in 26% of all patient-months. All provider-side portal actions during a given month were strongly associated with patient activity during the same month, after controlling for other factors (including visits to the practice). However, these estimates again varied in magnitude in ways that mirrored patterns seen in adoption rates. A lab/image result posted by the practice at time $t$ had the strongest relationship to portal activity at time $t$ (27%-point increase in the probability of utilization, $p < 0.001$), followed by a personalized message received (20%-points, $p < 0.001$), and finally an automated message received (10%-points, $p < 0.001$).

Labs/images and personalized messages lagged backward up to 4 months continued to be positively associated with portal activity in focal patient-month $it$, with the magnitude of association diminishing as the time gap increased. A lab/image posted in month $t-1$ was still
associated with a 9 %-point increase in the probability of utilization in month t, though this dropped to 2 %-points (p < 0.001) at month t-2 and became almost negligible at month t-3. Personalized messages followed a similar pattern; At month t-1, receiving one was associated with a 4 %-point utilization increase in month t, 2 %-points for t-2, and essentially negligible as of t-3. For auto-generated messages, we found no evidence at all of a sustained relationship to portal utilization over time.

**Figure 4.2. Adjusted associations between practice-side portal actions and patient-side portal activity (n = 6.5 million patient-months)**

*Sample is patients who adopted the portal (n=243,703)

**Note: Error bars denoting 95% confidence intervals are included, but mostly too small to be visible due to large sample size

### 4.4 Discussion

We used a uniquely in-depth and expansive longitudinal dataset on portal utilization and outcomes from 369,247 patients at 642 primary care practices and care for by 4,036 primary care providers across the U.S. to explore detailed patterns in portal use on both the patient and provider sides. We found that practices varied extensively in the degree to which they engaged with the portal by posting labs/images and sending secure messages to their patients. This was
most true for auto-generated messaging, followed by lab/image posting and finally personalized messaging, which makes sense given that one would expect systems and workflows to influence auto-generated messaging the most, lab/image posting is likely governed by a mix of organizational policy and individual provider judgment, and personalized messaging may be determined by the preferences/habits of individual providers or practice staff. Still, that 18% of variation in even personalized messaging took place at the practice level indicates that organizations play a strong role in how portals get used.

Surprisingly, very little variation (1-5%) appeared to take place at the level of the individual provider, even with respect to personalized messaging. This runs counter to existing provider-focused work on portals (though it is scant), which has emphasized the role that specific primary care providers play in getting patients to use portals and send secure messages. In contrast, we find that individual providers vary relatively little in how they use portals once differences across their practice organizations have been accounted for. This may call for much greater attention to organizational leadership, policies, workflows, and systems when it comes to implementing new technologies, rather than focusing on individual physicians.

Finally, we found strong evidence that actions the provider side of portals are strongly associated with the likelihood that patients adopt and then use portals. While this may be intuitive, it is striking that so little prior work has considered it as a key driver. Almost all past studies have focused on differences among patients. We found confirmatory evidence of demographic disparities in portal use, even after adjusting for differences in provider-side portal activity (see Appendix Table C.1). However, the gaps in portal adoption rates between patients with and without each provider action, particularly lab/image posting, often rivaled or exceeded those seen along demographic lines.
Furthermore, all practice-side activities were not alike. Lab/image results were most strongly associated with patient-side portal adoption and use, and personalized messages more strongly associated with patient-side portal use than auto-generated ones. We found similar patterns when we looked at how patient-side portal activity varied with provider-side activity in prior months.

Our findings may help explain some of the low utilization and impact of portals to date. If patient portal use remains low, this may partly be due to a failure on the practice side to routinely engage in the activities that are most meaningful to patients. We found that only 47% of patients had a lab/image posted, and only 6% received a personalized message at any point during the two-year study window. Content that generated less interest from patients (auto-generated messages) was more consistently pushed to them, perhaps due to the lower costs of automated processes.

Though it is intuitive that providers would influence whether and how frequently patients use portals, this is a significant departure from prior literature, which almost exclusively evaluates the role of patient demographic characteristics in utilization gaps. We find that, even after controlling for demographic characteristics, provider-side portal activity is a key driver of utilization. The provider side warrants more exploration both due to its relationship to meaningful patient-side activities, and because it may yield clear actions that practices and providers can take to increase utilization on the patient side.

4.4.1 Practice implications

Organizational leaders, clinicians, and staff interested in how to use portals effectively should consider strategies that focus on their potential to facilitate communication with patients. They should also focus on applying these consistently across the organization and over time.
Although it may require more time and effort, portal-based outreach that provides information patients value, that they can act on, and that helps to build their relationships both with particular clinicians and organizations as a whole may have a larger impact.

4.4.2 Limitations

The main advantage of our dataset was that it spanned such a large number of patients and practices, included detailed portal behaviors on both the practice and patient sides, and represented real behaviors rather than perceptions. On the other hand, a lack of qualitative depth limits our ability to interpret the findings. We cannot, for example, know whether personalized messages more strongly predicted adoption and utilization than auto-generated ones because they were personalized, or if differences in timing or content accounted for this. Future studies should aim to understand more deeply why and when patients feel there is value in engaging with portal-based content.

We were also limited in our ability to interpret these findings as causal. Although we used a longitudinal dataset at the patient-month level, portal exchanges between practices and patients often take place on the order of hours or days. However, our finding that practice-side portal behaviors several months prior were still correlated with patient activity in a given month (and that similar patterns emerged across content types) is consistent with a causal effect. Future studies should assess these relationships at more granular time periods, or seek opportunities for experimental research designs.

Finally, our sample of practices and patients lacked diversity in ways that may limit generalizability. For the sake of comparability across patients and to maintain internal validity, we focused specifically on patients at practices that have already adopted portals to some extent and have opened a portal account. This sample was far more likely to be white, non-elderly, and
high-SES than the overall U.S. population (Census, 2010). We found gaps in utilization within this sample along the same demographic lines. This confirms existing concerns that portals may enhance existing disparities. Future research should focus on identifying strategies for reaching broader patient populations than current portal users.

4.4.3 Conclusion

Patient portals have the potential to engage patients and improve efficiency in health care, but these gains are unlikely to be realized at a large scale until practices use them consistently to offer information that patients value and to build relationships with patients between visits. While existing research largely focuses on the role of patient characteristics and the structural characteristics of practices, this study suggests that what practices do with portals also warrants attention. While more patient care may be moving out of the traditional office setting, provider organizations still have an enormous role to play.
References


Lieb, K., and A. Scheurich. 2014. “Contact between doctors and the pharmaceutical industry, their perceptions, and the effects on prescribing habits.” *PloS one* **9** (10): e110130.


Appendix A: Supplementary Materials for Chapter 2

Appendix A.1 Medical assistant interview guide
August – October, 2014

Introduction

Thank you for taking the time to meet with us. We’re going to ask you questions about your job as a medical assistant, and how recent changes at your practice have affected you. This should take no more than 30 minutes. We’re going to take notes and record the conversation so we can review it, but we will never share anything you say in connection with your name. You’re welcome to skip any questions that you would rather not answer. If you don’t understand any of the questions, please let us know and we will explain them. Is it ok with you to proceed?

Beginning overview questions

1. Please tell us about your role, day-to-day tasks, and responsibilities within your practice. Who are the main team members you usually work with?

2. Over the past 2 years, how (if at all) has your practice changed the way it manages work and cares for patients?

3. How much have you known, if anything, about your practice’s efforts to improve teamwork or move to team-based care?

Tasks, Roles & and Responsibilities

1. How (if at all) have your day-to-day tasks changed over the past 2 years [or since you got there if shorter], especially as your practice has moved toward team-based care?

   Probes:
   a. What kinds of new tasks do you do now that you didn’t do before?
   b. What kinds of tasks, if any, do you no longer do that you did before?
   c. In a given day, do you have more, less, or about the same amount of work as you did before?

2. [If tasks have changed], how have you adjusted to your new tasks and responsibilities?

   Probes:
   a. Have you had to learn new skills to do these new tasks and meet these new responsibilities well?
   b. Could you describe any training or tools you received, if any, to prepare you for this change in your tasks and responsibilities?
   c. Do you feel you were well prepared to do the kind of work that is being asked of you?
Teamwork and communication

1. As your practice has moved toward team-based care over the past 2 years [or since you got there], how (if at all) have your interactions with team members changed?

   Probes:
   a. Do you work with certain team members more often than you did before? Which ones?
   b. Do you work with certain team members less often than you did before? Which ones?
   c. Has the way you communicate with other team members changed (e.g., more email, more face-to-face, etc.)?
   d. How, if at all, do you interact with medical residents at your practice?
      i. [If there is a role with residents], what parts of this role do you enjoy (if any)? Are there parts you don’t enjoy?

2. How much do you feel part of the patient care team? How, if at all, has this changed over the last 2 years [or since you got there]?

   Probes:
   a. Do you feel you have a voice in team decisions about how work should be done, or parts of patient care that you participate in?
   b. How much do you feel your voice is valued within the team? Can you give an example?
   c. How well do you feel your teammates know your skills and capabilities?
   d. How well do you feel your teammates use your skills and capabilities?

Implementation

1. How involved have you been in your practice’s efforts to move toward team-based care or improve teamwork?

   Probes:
   a. Did you know about the changes before they happened?
   b. How were changes in your job (if there have been any) communicated to you?
   c. Did you have an opportunity to ask questions, voice concerns, or make suggestions related to the changes? Can you give an example of a time like that, and what happened?
   d. Did the changes turn out to be what you expected? Were there any surprises?

Overall satisfaction

1. Overall, how much more or less satisfied are you with your job since your practice started changing how work gets done, or since you started working there? [Interviewee selects response on Overall Satisfaction Question supplement]
Probes:
   a. What parts of your job do you enjoy most?
   b. What parts of your job would you most want to change?
   c. What (if anything) about your job has gotten better over time?
   d. Overall, what (if anything) about your job has gotten worse over time?

2. Overall, do you feel the changes at your practices have affected, or will affect, your career plans?

Probes:
   a. Are you considering further training or education that you were not planning on before?
   b. Do you feel like you can move up within your practice?
   c. Do you feel like you can continue learning and gaining new skills at your practice?
   d. How important is it to you to have these kinds of opportunities within your job?
## Appendix B: Supplementary Materials for Chapter 3

### Appendix Table B.1 Surgeon-device rep familiarity and post-operative LOS (hours)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>TKR</th>
<th>THR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(postop LOS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Familiar device rep (vs. no rep)</td>
<td>$-0.010$</td>
<td>$0.017$</td>
</tr>
<tr>
<td></td>
<td>$(0.025)$</td>
<td>$(0.015)$</td>
</tr>
<tr>
<td>Unfamiliar device rep (vs. no rep)</td>
<td>$-0.031$</td>
<td>$0.070$</td>
</tr>
<tr>
<td></td>
<td>$(0.040)$</td>
<td>$(0.047)$</td>
</tr>
<tr>
<td>Observations</td>
<td>3,566</td>
<td>3,804</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.327</td>
<td>0.318</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.315</td>
<td>0.306</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>$0.404$ (df = 3502)</td>
<td>$0.420$ (df = 3736)</td>
</tr>
</tbody>
</table>

Notes: SEs clustered by surgeon; $^*$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

Included but not shown: patient characteristics, surgeon experience, other case characteristics, surgeon and timing fixed effects

### Appendix Table B.2 Surgeon-device rep familiarity and revisions (logistic regression)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision operation within 2 years</td>
</tr>
<tr>
<td>TKR</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>Familiar device rep (vs. no device rep)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Unfamiliar device rep (vs. no device rep)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Log Likelihood</td>
</tr>
<tr>
<td>Akaike Inf. Crit.</td>
</tr>
</tbody>
</table>

Notes: SEs clustered by surgeon; $^*$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01
Included but not shown: patient characteristics, surgeon experience, other case characteristics, surgeon and timing fixed effects

Appendix Table B.3 Surgeon-device rep familiarity and operative time: all major controls displayed

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>TKR (1)</th>
<th>THR (2)</th>
<th>shoulder arthroscopy (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device rep (vs. no device rep)</td>
<td>0.010 (0.009)</td>
<td>0.008 (0.008)</td>
<td>0.027* (0.015)</td>
</tr>
<tr>
<td>Complex (vs. not complex)</td>
<td>0.196*** (0.021)</td>
<td>0.160*** (0.015)</td>
<td>0.114*** (0.011)</td>
</tr>
<tr>
<td>First case of day (vs. second or later)</td>
<td>0.024* (0.013)</td>
<td>0.030*** (0.009)</td>
<td>0.031*** (0.008)</td>
</tr>
<tr>
<td>Number of other procedures during case</td>
<td>0.070*** (0.007)</td>
<td>0.154*** (0.027)</td>
<td>0.060*** (0.006)</td>
</tr>
<tr>
<td>Surgeon’s same-device experience (10s of cases)</td>
<td>−0.012*** (0.003)</td>
<td>−0.017*** (0.005)</td>
<td>−0.017*** (0.002)</td>
</tr>
<tr>
<td>Surgeon’s different-device experience (10s of cases)</td>
<td>−0.010*** (0.002)</td>
<td>−0.016*** (0.005)</td>
<td>0.001 (0.003)</td>
</tr>
<tr>
<td>Surgeon’s different-procedure experience (10s of cases)</td>
<td>−0.005 (0.003)</td>
<td>−0.002 (0.002)</td>
<td>−0.002 (0.002)</td>
</tr>
</tbody>
</table>

Observations: 3,587 3,838 6,646
R²: 0.740 0.636 0.409
Adjusted R²: 0.735 0.629 0.403
Residual Std. Error: 0.135 (df = 3524) 0.153 (df = 3771) 0.203 (df = 6579)

Notes: SEs clustered by surgeon; *p<0.1; **p<0.05; ***p<0.01

Included but not shown: patient characteristics, surgeon and timing fixed effects
Appendix C: Supplementary Materials for Chapter 4

Appendix Table C.1 Full fixed-effects model by patient with practice FEs (predicting adoption)

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>lab or image posted</td>
<td>0.36***</td>
<td>0.01</td>
</tr>
<tr>
<td>automated message received</td>
<td>0.02***</td>
<td>0.00</td>
</tr>
<tr>
<td>personalized message received</td>
<td>0.11***</td>
<td>0.01</td>
</tr>
<tr>
<td>total visits (count)</td>
<td>0.0008*</td>
<td>0.00</td>
</tr>
<tr>
<td>new chronic condition diagnoses (count)</td>
<td>0.0004***</td>
<td>0.00</td>
</tr>
<tr>
<td>chronic condition diagnoses before 2015 (count)</td>
<td>-0.01***</td>
<td>0.00</td>
</tr>
<tr>
<td>age = 40-60 (vs. 20-40)</td>
<td>-0.03***</td>
<td>0.00</td>
</tr>
<tr>
<td>age = 60-80 (vs. 20-40)</td>
<td>-0.04***</td>
<td>0.00</td>
</tr>
<tr>
<td>age = 80+ (vs. 20-40)</td>
<td>-0.19***</td>
<td>0.00</td>
</tr>
<tr>
<td>region = northeast (vs. midwest)</td>
<td>-0.05*</td>
<td>0.02</td>
</tr>
<tr>
<td>region = south (vs. midwest)</td>
<td>-0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>region = west (vs. midwest)</td>
<td>-0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>race = American Indian or AK native (vs. white)</td>
<td>-0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>race = Asian (vs. white)</td>
<td>-0.02**</td>
<td>0.01</td>
</tr>
<tr>
<td>race = black/African American (vs. white)</td>
<td>-0.08***</td>
<td>0.01</td>
</tr>
<tr>
<td>race = other (vs. white)</td>
<td>-0.05*</td>
<td>0.02</td>
</tr>
<tr>
<td>primary language = non-english</td>
<td>-0.16***</td>
<td>0.02</td>
</tr>
<tr>
<td>hispanic/Latino</td>
<td>-0.05***</td>
<td>0.01</td>
</tr>
<tr>
<td>male</td>
<td>-0.02***</td>
<td>0.00</td>
</tr>
<tr>
<td>single (vs. married/partnered)</td>
<td>-0.03***</td>
<td>0.00</td>
</tr>
<tr>
<td>geo type = metro-adjacent</td>
<td>-0.02***</td>
<td>0.00</td>
</tr>
<tr>
<td>geo type = rural</td>
<td>-0.03**</td>
<td>0.01</td>
</tr>
<tr>
<td>insurance = medicaid (vs. commercial)</td>
<td>-0.10***</td>
<td>0.01</td>
</tr>
<tr>
<td>insurance = medicare (vs. commercial)</td>
<td>-0.09***</td>
<td>0.00</td>
</tr>
<tr>
<td>insurance = military (vs. commercial)</td>
<td>0.03***</td>
<td>0.01</td>
</tr>
<tr>
<td>insurance = uninsured (vs. commercial)</td>
<td>-0.07***</td>
<td>0.01</td>
</tr>
</tbody>
</table>

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.396 on 368579 degrees of freedom
Multiple R-squared(full model): 0.3055  Adjusted R-squared: 0.3042
Multiple R-squared(proj model): 0.1744  Adjusted R-squared: 0.1729
F-statistic(full model, *iid*):243.1 on 667 and 368579 DF, p-value: < 2.2e-16
F-statistic(proj model): 229.9 on 26 and 641 DF, p-value: < 2.2e-16
Appendix Table C.2 Full fixed-effects model by patient-month with patient FEs (predicting utilization)

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>lab/image posted (t)</td>
<td>0.2730***</td>
<td>0.0008</td>
</tr>
<tr>
<td>lab/image posted (t-1)</td>
<td>0.0874***</td>
<td>0.0008</td>
</tr>
<tr>
<td>lab/image posted (t-2)</td>
<td>0.0202***</td>
<td>0.0007</td>
</tr>
<tr>
<td>lab/image posted (t-3)</td>
<td>0.0092***</td>
<td>0.0007</td>
</tr>
<tr>
<td>lab/image posted (t-4)</td>
<td>0.0024***</td>
<td>0.0007</td>
</tr>
<tr>
<td>automated message sent (t)</td>
<td>0.1027***</td>
<td>0.0011</td>
</tr>
<tr>
<td>automated message sent (t-1)</td>
<td>-0.0035***</td>
<td>0.0009</td>
</tr>
<tr>
<td>automated message sent (t-2)</td>
<td>-0.0027***</td>
<td>0.0008</td>
</tr>
<tr>
<td>automated message sent (t-3)</td>
<td>-0.0013</td>
<td>0.0008</td>
</tr>
<tr>
<td>automated message sent (t-4)</td>
<td>-0.0014</td>
<td>0.0007</td>
</tr>
<tr>
<td>personalized message sent (t)</td>
<td>0.1976***</td>
<td>0.0023</td>
</tr>
<tr>
<td>personalized message sent (t-1)</td>
<td>0.0412***</td>
<td>0.0023</td>
</tr>
<tr>
<td>personalized message sent (t-2)</td>
<td>0.0187***</td>
<td>0.0022</td>
</tr>
<tr>
<td>personalized message sent (t-3)</td>
<td>0.0068**</td>
<td>0.0021</td>
</tr>
<tr>
<td>personalized message sent (t-4)</td>
<td>0.0030</td>
<td>0.0021</td>
</tr>
<tr>
<td>visit (t)</td>
<td>0.3030***</td>
<td>0.0006</td>
</tr>
<tr>
<td>visit (t-1)</td>
<td>0.0489***</td>
<td>0.0004</td>
</tr>
<tr>
<td>visit (t-2)</td>
<td>0.0171***</td>
<td>0.0004</td>
</tr>
<tr>
<td>visit (t-3)</td>
<td>0.0078***</td>
<td>0.0004</td>
</tr>
<tr>
<td>visit (t-4)</td>
<td>-0.0027***</td>
<td>0.0004</td>
</tr>
<tr>
<td>new chronic condition diagnosis(t)</td>
<td>0.0774***</td>
<td>0.0017</td>
</tr>
<tr>
<td>new chronic condition diagnosis(t-1)</td>
<td>0.0305***</td>
<td>0.0016</td>
</tr>
<tr>
<td>new chronic condition diagnosis(t-2)</td>
<td>0.0160***</td>
<td>0.0015</td>
</tr>
<tr>
<td>new chronic condition diagnosis(t-3)</td>
<td>0.0138***</td>
<td>0.0015</td>
</tr>
<tr>
<td>new chronic condition diagnosis(t-4)</td>
<td>0.0061***</td>
<td>0.0014</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3586 on 6204698 degrees of freedom
Multiple R-squared(full model): 0.3788 Adjusted R-squared: 0.3461
Multiple R-squared(proj model): 0.1845 Adjusted R-squared: 0.1415
F-statistic(full model, *iid*): 11.59 on 326601 and 6204698 DF, p-value: < 2.2e-16
F-statistic(proj model): 2.633e+04 on 25 and 326564 DF, p-value: < 2.2e-16