

**Design and Implementation of Standard Work on Care Delivery Performance:
A Quasi-Experimental Investigation**

Aravind Chandrasekaran
Fisher College of Business
The Ohio State University

Gopesh Anand
University of Illinois

Peter Ward
Fisher College of Business
The Ohio State University

Luv Sharma
University of South Carolina

Susan Moffatt-Bruce
The Ohio State Wexner Medical Center

March 2017

Design and Implementation of Standard Work on Care Delivery Performance: A Quasi-Experimental Investigation

Abstract

This research offers insights on how to carry out process change in high-contact service settings. Focusing on healthcare delivery, we investigate the effect of standard work, put in place following Lewin's theory of social change, on 30-day readmission rates and patient satisfaction. Our quasi-experimental design involved working with 40 caregivers and over 100 patients for more than two years to implement a new process for educating kidney transplant recipients before discharge from the hospital. We examine the efficacy of the new process through a difference-in-difference approach using data over three years from 702 transplant patients, including heart and liver transplant recipients from the same hospital as a control group. Our results indicate that the likelihood of 30-day readmission is about one-third lower for kidney transplant recipients (treatment) post-implementation compared with recipients of other transplants (control group) for which the discharge-education process remained unchanged. This improvement is estimated to generate average annual savings of \$133,346 for the hospital. We also find a 10% increase in overall patient satisfaction, measured using the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, for the treatment group compared with the control group. Furthermore, our first-hand observations over two years offer new theoretical insights on initiating, implementing, and sustaining process change in high-contact service settings.

Key words: employee engagement; healthcare operations; process improvement; quasi-experimental; standard work

1.0. Introduction

Researchers studying process improvement have recognized the importance of involving frontline employees in developing standardized work practices (Adler et al. 1999, Lawler 1994). Frontline employee engagement can generate mindful adherence to standardized work practices and can further lead to effective improvements of these practices (Spear and Bowen 1999). Despite a large body of literature on the overall merits of implementing process improvement (e.g., Zhang and Zia 2013, Hendricks and Singhal 1997), there is limited knowledge on how employee developed standard work¹ affects the intended outcomes (Gino and Pisano 2008). This is especially true in high-contact service settings such as healthcare, which have complex care delivery processes (Nembhard and Tucker 2011, Gittell 2002) and high process variability related to the different customer/patient needs and preferences (Hartzband and Groopman 2016, LeBaron et al. 2016).

¹ We use standard work and standardized work practices interchangeably in the manuscript.

Furthermore, there is a lack of theoretical understanding on how to make systematic changes to processes and sustain standard work in such settings (Staats et al. 2016).

In this research, we address these issues by adopting a multimethod empirical approach, which includes action research and a quasi-experiment that allows us to compare results before and after implementing new standard work for a healthcare delivery process. Our intervention is designed based on Lewin's (1947) theory of planned change, and we define standard work as a set of activities consistent in terms of content, sequence, timing, and outcome with flexibility for some customer-centric customization (Spear and Bowen 1999). We address the following research question: *What is the effect of caregiver-designed and implemented standard work on care delivery outcomes, namely occurrence of patient readmission within 30 days after discharge and patient satisfaction?*

Our study differs from existing research on process improvement in four ways. First, we observe, through participation, the implementation of standard work in a highly regulated service environment but in which providers and consumers coproduce. Second, we compare service outcomes before and after the development and implementation of the new standard work. We do so by using a quasi-experimental research design that involves a control group. We collect and compile primary and secondary data from multiple sources over a period of more than three years and control for several other factors that could have an impact on service outcomes. Third, we study how the process change affects two service outcomes: the intended process outcome and the process customer's satisfaction. We include both these outcomes because the former may not always align with the latter, especially in unwelcome but necessary services such as surgical procedures. Fourth, after close observation of the development and implementation of the standard work over more than two years (January 2014 – April 2016), we describe in detail the changes made toward delivering standardized service. These descriptions illustrate how to increase employee mindfulness in day-to-day operational processes by involving them in designing their own standard work. Overall, this study is the first to directly assess the effects of process change on process outcomes using a quasi-experimental research design and a control group. Moreover, we are also the first to combine rich observational data, spanning the period from recognizing the need for change in work practices to sustained use of newly developed practices, with quantitative secondary data tracked over the same longitudinal period.

Our empirical context is patient education and discharge instructions delivered after kidney transplant surgery. Kidney transplantation is the preferred treatment for end-stage renal diseases (Abecassis et al. 2008). Over 390,000 kidney transplants were performed between 1988 and 2016 (Health Resource Administration 2016), far outpacing other types of transplants (e.g., liver or heart) (UNOS 2016). In 2014 alone, 17,000 patients received kidney transplants in the United States, and this number continues to grow annually (HRSA 2016). These transplant recipients require prolonged periods of post-discharge care; thus, the quality of instructions delivered before discharge plays an important role in preventing readmissions and improving post-transplant

quality of life (Gordon et al. 2009). Unfortunately, more than 30% of these recipients are readmitted within 30 days of discharge because of transplant-related problems, many stemming from patients' difficulty in complying with complex post-surgical discharge instructions (Lubetzky et al. 2016). These readmissions drive up costs for the healthcare system and patients, who additionally endure preventable suffering (Axelrod et al. 2016). In this context, standardizing care (i.e., following evidence-based standards of care) is important, so that multiple caregivers, including inpatient and outpatient nurses, provide consistent information to patients and their families at different points in time. At the same time, patient-centricity (i.e., altering patient education modes based on learning styles) remains critical to ensure patients' engagement during education and discharge and, subsequently, adherence to post-discharge instructions (Damali et al. 2016). Implementing standard work for the transition process after surgery can save money and lives while increasing patient satisfaction and reducing anxiety levels. Insights gained from developing and implementing such process improvements are, moreover, readily applicable to other transplant procedures, surgeries, and bundled-payment models that include complicated post-surgical homecare (Verhaegh et al. 2014).

We observed and analyzed the design and implementation of standard work for education and training of patients prior to their discharge after kidney transplant surgery. A team of 32 caregivers, which included discharge nurses, surgeons, social workers, and their supervisors, redesigned the standard work for patient education and training, incorporating inputs from 15 transplant patients. This redesign also served as the first such systematic clinical process improvement effort, marking the start of an initiative for ongoing continuous improvement of this and other processes across the hospital. To assess the effects of the process change, we used patient-level data from 702 patients who had undergone transplant surgeries between January 2013 and April 2016, combining it with in-depth observations throughout the period. Our analysis revealed that the newly designed and implemented standard work resulted in more engaged patients, better-coordinated care, and ultimately, improved patient health outcomes at lower costs. Specifically, the likelihood of readmission was one-third lower for transplant recipients after our implementation (treatment group) compared with patients in a different, comparable transplant process (control group) that were not part of any change in standard work. On average, this amounted to a 25% reduction in overall readmission rates for the treatment group after the intervention, resulting in a conservative estimate of \$133,346 annual savings for the hospital. We also found that patients in the treatment group rated the overall quality of their experience 10% higher on the HCAHPS survey. During the same period, the control group experienced a decline of 11% in these scores. The implementation of the process change that we describe can guide the deployment of similar process improvements in healthcare as well as other service and manufacturing contexts. Furthermore, the insights from tracking process and customer outcomes throughout the deployment process, and comparing before- and after-change outcomes are applicable to process improvement initiatives in all operations management contexts.

2.0. Theoretical Background and Hypotheses

We apply Lewin's theory of facilitating social and organizational change (Burnes 2004, Lewin 1947) to the context of implementing change in standard work. This theory recognizes the existence of two counteracting forces that restrain and drive change in organizations. Forces for stability, which are operationalized in our context through compliance with standard work, enable coordination of operations and support organizational learning (LeBaron et al. 2016, Gittel 2002). While on the one hand, maintaining stability can be a challenge, on the other hand, stability can be carried too far, and inertial tendencies can result in preserving existing practices despite reasons for change (de Holan and Phillips 2004, Van de Ven 1986). To drive desirable change, periods of stability need to be punctuated by actions for updates in work practices that then need to be successfully adopted and sustained until the next cycle of change. However, we have limited understanding on how stability and change can be simultaneously sustained, especially in high contact settings such as healthcare.

In our empirical context, guiding the caregiving team in developing new standard work involved not only making changes to the discharge education process but also putting in place a system for further such cycles of changes in the process and for similar implementations in other processes. The process for patient education and discharge after kidney transplant surgery is extremely complex, as it covers more than 45 different patient-education topics covered in the four days prior to discharge. These topics range from medication protocols, signs and symptoms of rejections, doctor visits, and dietary modifications, to infection prevention, lab compliance, wellness requirements, and fluid intake. Patients must absorb an overload of information, which can increase their anxiety, which is usually already high having experienced extensive pre-transplant medical care, and the surgery for the transplant. The discharge education process is also rife with uncertainty. Patients, families, and caregivers may experience interruptions necessitating adjustments to the standardized delivery of education. Also, process regulations and mandates may change, warranting changes to the content of education.

Following Lewin's theory, we propose that changes to standard work, made by the caregiving teams, are likely to result in successful outcomes for the patients (Schein 1996). The implementation of new standard work consists of the three stages of "unfreezing, changing, and refreezing." The "unfreezing" of current practices involves creating an environment in which employees feel psychologically safe to recognize threats and opportunities for their work practices and feel encouraged to share ideas for changes with the group (Siemsen et al. 2007). In our context, "unfreezing" involves nurses and physicians understanding the deficiencies in the care delivery processes and sharing ideas to improve these processes. Following "unfreezing," the stage of "changing" calls for exploring different work practices to come up with new and improved work practices. This stage calls for resources, including organizational infrastructure and employee time, for systematic learning (Anand et al. 2009). In our context, the caregivers who deliver discharge education explore new practices for their current work. The dual purpose of the subsequent stage of "refreezing" is to overcome

any resistance against the changes and to sustain the changes, preventing a return to old work practices (Naveh and Erez 2004). The new work practices created at the group level in the “changing” stage are standardized and serve as restraining forces to target adherence by individuals in their day-to-day work. With the iterative nature of this framework, the caregivers following the standard work (in the “frozen” stage) are simultaneously considering opportunities for improving the work practices to bring to the attention of the group (for “unfreezing” and “changing”).

While previous studies of process improvement address a single stage of such a cycle, a comprehensive application and study of the iterative stages is missing in the literature. For example, Staats et al.’s (2016) study of compliance with handwashing focused on the immediate and individual impacts of electronic monitoring. They explicitly left factors for sustaining results and impacts of coworker behavior to future research, and called for using longer duration field experiments to study such questions. While the Staats et al. (2016) paper focused on the effectiveness of frozen work practices, Nembhard and Tucker (2011) focused on deliberate learning activities (DLAs) used for changing existing work practices. While their study found DLAs to result in collaboration among healthcare workers and an initial dip in performance before turning around, they called for future research to investigate these phenomena over a longer duration and based on in-depth observation. Our study answers the calls of such researchers by studying systematic unfreezing, changing, and refreezing work practices with close observation and metrics at each stage and over an extended period.

Using an integrated approach to make work practice changes in healthcare settings following the three stages suggested by Lewin (1947) is likely to result in caregivers complying with newly developed standard work resulting in better patient outcomes. Based on these arguments, we propose the following two hypotheses regarding the relationship between standard work and patient outcomes.

H1: Standard work implementation in kidney transplant discharge education that follows an iterative process of unfreezing, changing, and freezing work practices will reduce the likelihood of patients getting readmitted within 30 days after surgery.

H2: Standard work implementation in kidney transplant discharge education that follows an iterative process of unfreezing, changing, and freezing work practices will positively impact patient satisfaction during the hospital stay.

Previous studies applying Lewin’s three-stage framework to manage organizational change (Huang and Mas-Tur 2016, Burnes 2004) have primarily focused on minimizing employee-introduced variation by developing best practices and standardizing processes in one specific area. Most of these studies have applied the framework to static contexts as in instituting a prescribed protocol or best practice (Shirey 2013), and, as such, neither account for the mindful execution of standard work by employees doing the work nor for the proactive search focusing on opportunities for further change. In addition, these studies have often failed to acknowledge the challenges posed by the power differences among the people (e.g., physicians and nurses) attempting these changes (Denis et al. 1996). In the following section, we present some of the unique challenges faced by healthcare organizations implementing changes to work practices that have remained relatively unexplored in research. We devised actions to counter these challenges during our implementation. By

describing these countermeasures, we also offer new theoretical insights on how to apply Lewin's theory to high contact and dynamic settings.

3.0. Understanding the three stages of process change in standard work implementation

The intervention described in this research consists of the implementation of the initiation, discovery, implementation, and sustainment of work practices. However, within the three stages of Lewin's framework, we relied on extant empirical research in organizational learning to design our intervention. While we selected a single approach for each inhibiting or facilitating factor anticipated in the implementation, alternative approaches could be adopted. Thus, we offer the actions that we included in our intervention within the three stages of the process change as propositions. Furthermore, these inhibiting and facilitating factors shed light on specific factors to consider in attempting process change, especially in high-contact work environments.

Unfreezing

Despite the focus on standardization in process improvement, there is limited evidence on how to implement new standard work, especially in high contact service contexts. Decrees from upper management have proven inadequate for instituting improvement in healthcare standard work (Cosgrove 2013, Gawande and Lloyd 2010). This is because adopting new standard work does not automatically lead to employee acceptance. Repenning and Sterman (2001), when studying process improvement initiatives, succinctly argue, "You can't buy a turnkey six sigma quality program. Rather [successful implementation requires that] it must be developed from within" the unit (p. 65). However, the question of how to increase buy-in for standard work changes among skeptics remains unanswered in the literature. A common refrain from employees, when proponents of process improvement in service operations try to sell it by discussing its success in other contexts, is that each context is different; thus, the changes that worked elsewhere would not work well in the current "unique" context.

To address this challenge in our standard work implementation, we involved the entire care team, including the physicians, nurses, social worker, and information technology (IT) specialists, in a discovery phase designed to study the existing work practices and to collect data about the functioning of those practices in that unit. This approach, consisting of service providers studying the current state of their own service delivery process, can augment their understanding of the gaps in service quality and help "unfreeze" and initiate change. Thus, we propose:

Proposition 1: Self-evaluation of the limitations in current work practices, conducted by the people doing the work, will help unfreeze current processes and drive process change in high-contact service settings.

Changing

Researchers have pointed out that implementations of new standard work often result in an initial decline in performance before generating improvements (Adler and Clark 1991, Nembhard and Tucker 2011). For instance, in a study of lean implementation in automobile plants, Netland and Ferdows (2016) found that

plant productivity worsened initially before improving. An underlying reason for such initial decline is the unplanned variations introduced by the newly developed processes (Knott and McKelvey 1999). In healthcare, such decline in performance can be detrimental to the success of the overall implementation of new processes, as caregivers may react to it by showing little commitment toward the change and even dismissing it as a management fad (Repenning and Sterman 2002). Existing literature has provided little guidance on how organizations can design process implementation initiatives to prevent or mitigate the effect of such initial performance declines.

We argue, based on existing literature on organizational learning, that involving caregivers in designing standard work can result in mindful execution of work processes (Laureiro-Martinez et al. 2015, Adler et al. 1999). By participating in process design, the caregivers doing the work gain a better understanding of the relationships between steps in their work processes and the outcomes of such processes (Zollo and Winter 2002). They are able to better take care of the teething problems, separating such problems from ones that need further investigation for improving the process. Participating in standard work design also allows them to design in some flexibility in the use of standard work that can be useful to mitigate the effect of unplanned variations. These arguments suggest the following regarding the role of the care team during new process implementation:

Proposition 2: In high-contact service settings, employee-driven change management is more likely to result in mindful integration of new standard work, reducing any initial dip in performance.

In high-contact service settings, developing new processes also can benefit from appropriate inputs from the customers. This is especially true with respect to delivering discharge instructions. Studies show that patients have different learning styles (e.g., visual versus verbal) and are more likely to retain post-discharge information when caregivers deliver instructions that align with their learning styles (Clancy 2009). Unfortunately, patients are also considered as “end products” of the care delivery process, and there are mixed evidences on the efficacy of incorporating their input in the design of care delivery processes (Tinetti and Basch 2013). Research shows that caregivers discourage the idea of using patient input, dismissing them to have inadequate knowledge of the care delivery process (Buckley et al. 2013). However, finding a way to include input from patients during the development of new standard practices can enable them to appreciate a care team’s efforts and provide impetus for employees toward mindful adherence of standard work practices (Cukor et al. 2016). This suggests:

Proposition 3: Carefully managed involvement of customers in identifying improvements in high contact service settings is useful in building customer centricity into standard work.

Refreezing

Research shows that adherence to standard work can be challenging to sustain over time, especially in high contact service settings (Ton and Huckman 2008, Knott 2001). Take, for example, Staats et al. (2016)’s observation that, even after caregivers established handwashing routines under monitoring, compliance rates dropped soon after monitoring was discontinued. Deterioration in standard work is primarily due to less-than-

mindful process execution, which affects the standardized aspects of processes. Barring a few descriptive studies from Spear and Bowen (1999) and Adler et al. (1999), however, there is a dearth of guidance and empirical support on how to sustain employee engagement in process improvement initiatives and adherence to standard work.

We believe that middle-management support is a critical element to sustaining standard work in these settings. The role of top management in change management has long been recognized in the literature (Naveh and Erez 2004, Lapré and Van Wessenhove 2001, Hackman and Wagemen 1995). Similarly, scholars have recognized frontline employee empowerment and a risk-taking culture as critical requirements (Siemsen et al. 2007, Nembhard and Edmondson 2006, Powell 1995). In the context of healthcare process improvement, considerable weight also is placed on top management commitment (Tucker and Singer 2015), and frontline employee engagement (Tucker 2007). However, the role of middle managers (e.g., nurse managers) in process change has not been explored beyond the importance of aligning their views with broad organizational goals (King et al. 2001). As the conduit between frontline employees and top management, middle managers' contributions typically become muddled in reconciling top- and bottom-rank views (Nonaka 1988). We suggest that middle managers play a critical role in sustaining standard work and process improvement in the healthcare context as described in the following proposition:

Proposition 4: Involving midlevel managers in standard work design and in post-change monitoring activities supports refreezing and sustaining adherence to new standard work in high-contact service settings.

4.0. Research Design

Tracking healthcare process change-related outcomes can present difficult methodological issues. Simply comparing performance outcomes before and after affecting a change ignores other unrelated but potentially salient factors. To overcome these issues, we use a difference-in-difference (DID) approach and employ a comparison group not subjected to the standard work changes to understand its effectiveness on patient outcomes.

4.1. Kidney Transplant Discharge Process and Research Site

Data for our study comes from a major research hospital, Apollo Medical Center, in the Midwest United States. Apollo (a fictitious name for the review process) is a multispecialty hospital with nearly 1,500 beds and more than 45,000 patient admissions in 2015. It is ranked among the top 50 best U.S. hospitals in several specialties, including cancer, cardiology, nephrology, diabetes, and endocrinology.

---- Insert Table 1 and Figure 1 ---

The comprehensive transplant center at Apollo conducts an average of 200 kidney transplants per year. Table 1 provides summary statistics on the kidney transplant patient volumes along with other information for the 2013–2016 fiscal years. Figure 1 outlines the process of discharging a kidney transplant patient. As seen in

the figure, some discharge instructions may start before patient admission (e.g., pre-surgery), yet critical discharge information on medications, diet, and rejection symptoms depend on surgical outcomes and cannot, therefore, be offloaded from post-surgery to a different point (e.g., pre-surgery). Outpatient coordinators, responsible for delivering care starting 48 hours after discharge and lasting for the rest of the patient's life, also repeat some of these instructions. For the purpose of this study, we curtailed the outpatient coordinator's role to the first 30 days after discharge, given our focus on minimizing 30-day readmission rates (Garnick et al, 1995). We also compared the kidney transplant discharge process from two other kidney transplant centers (one in the Midwestern and another in the Southern United States) and found that the processes used across these sites were very similar.

4.2. Study Design

Our research design included observing patient education and other activities in the hospital related to post-surgery care; we conducted these observations from January 2014 to April 2016. We obtained approval from Apollo's Institutional Review Board (IRB) to collect data through interviews, structured surveys of caregivers and patients, and from hospital records. The research team worked with senior leadership (i.e., the nursing and medical directors), middle management (i.e., nurse managers), and frontline employees (i.e., nurses) to change the discharge education and post-discharge transition processes and to lay down the groundwork for an ongoing process improvement initiative. Investigators included the chief quality and patient safety officer, physician director, and nursing director for Apollo's kidney transplant unit. The research team, consisting of the authors of this paper, interacted with the entire transplant team, consisting of 24 nurses (15 inpatient and 9 outpatient), 12 transplant surgeons and nephrologists, and inpatient and outpatient nurse managers. We also interacted with social workers, patient council staff, and information technology (IT) administrators to understand other features (e.g., patient handbook, medication lists, and electronic medical records [EMR]) that potentially affect care delivery, specifically post-transplant patient education. In addition, we also solicited and got input from 15 transplant patients. Appendix A1 summarizes the key personnel from the medical center who are part of our study.

--- Insert Figure 2 here ---

4.3. Unfreezing: Pre-Study and Its Role in Driving Change

Figure 2 shows the design of our complete study. As indicated, in Phase 1 (January 2014–June 2014), the *pre-implementation period*, we made field observations on the current discharge process and interacted with all caregivers and some patients. Two researchers and a graduate student shadowed all caregivers during their delivery of discharge instructions to patients. Following the tenets of the Toyota Production System for standardizing processes (Spear and Bowen 1999), we took note of the content, sequence, and timing of discharge instructions. We also collected qualitative and quantitative data from 87 kidney transplant patients to

ascertain the relationship between care quality and patient outcomes (see Appendix A2 for the type of data collected during Phase 1). Using this data, we examined the relationships among standardized and patient-centric aspects of the discharge process and 30-day readmission outcomes. Findings from that study published in a medical journal (reference deleted for review) indicated that a lack of standard work was associated with increases in patient anxiety levels and readmissions. These findings generated an awareness of the need to make changes in the post-transplant education process used at the unit.

Prior to collecting current-state evidence from this unit and presenting results of the study, physicians and nurses indicated minimal urgency to make any change. Specifically, the surgical team in our study was not persuaded by past studies showing the need to standardize discharge, even if those studies involved a randomized control design, a popular medical approach to establish causality. In the words of the chief surgeon at Apollo:

“You know, based on my previous work at a different medical center, I can tell that processes cannot be compared across sites. So it is hard to transfer findings from another medical center to us. Apollo is one of the largest ones in the world with a lot of complexity and bureaucracy. Issues that exist elsewhere may not exist here and vice versa.”

Conducting a randomized control design to show the efficacy of process change would be extremely difficult given its resource requirements. Regardless, the hospital team was highly skeptical of the transferability of results from any such previous studies because of the differences in context. On the other hand, the caregiving team exhibited minimal resistance to, and more acceptance of, the results from the pre-implementation study conducted in their unit. Although the study was nonrandomized, it was conducted in their own workplace and involved their patients. Consequently, the caregivers trusted the data and results based on studying their own patients and processes and were willing to acknowledge problems with the existing patient-discharge process. Showing the problems that exist in one’s own context through such a pre-study appears to be an important approach to initiating change in high contact service setting, as stated in Proposition 1. As we did not try out any alternative method for unfreezing, we cannot make any comparison of the method used in our intervention with any other, and we leave to future research to study and compare alternative methods.

4.4. Implementation: Employee-Driven Change and Managing Initial Trade-offs

Phase 2 of the intervention, the *implementation period*, started in July 2014 and ended in March 2015. During this time, we conducted six mini-workshops with 32 caregivers consisting of 24 nurses, four physicians, a social worker, two information technology support staff members, and a patient relations officer. As part of these mini-workshops, we conducted a value stream mapping analysis (Rother and Shook 2003), which included mapping the current state of the entire process of post-transplant care, including post-transplant education and post-discharge coordination of care, followed by envisioning and agreeing upon a map of the target future state.

A number of important insights surfaced from these mini-workshops. First, participants widely agreed that patients were overwhelmed by the amount of discharge instructions (see Appendix A3 for a list of topics covered in these instructions). The caregiving team realized that several of these instructions (e.g., on topics such as gardening, dental health, and eye appointments) were non-critical to patients' immediate well-being and, thus, could be given at a later point of time by the outpatient team. This would distribute the information, reduce overload, and make communication timelier, enabling better absorption and recall of the information among patients, leading to better adherence. Participants in the Phase 2 mini-workshops also recognized variations among caregiving team members in when and how education and training were delivered to patients. The inpatient nursing manager commented on the value of these mini-workshops:

“This process of breaking down discharge instructions was an eye-opener. We were able to visualize the inconsistencies that are inadvertently created from our actions. Most of the time, the instructions and the teaching guidelines were passed on to us and we had no clear input on the process of delivering them.”

As an example of variations, consider the evidence-based standard of care requiring patients to drink at least three liters of water every day (Gordon et al. 2009). In our Phase 1 shadowing of care-delivery by researchers, we had noted variations in how the caregiving team delivered this specific instruction. While one nurse recommended the patient drink “a lot of fluids,” another nurse suggested “two liters of water,” while a third suggested “100 ounces of water.” We also noted varying levels of empathy in caregiver–patient interactions. Caregivers in some instances rushed through instruction delivery due to a variety of circumstances (e.g., in one instance, a nurse delivering post-discharge instructions was called away to assist for a biopsy). We discussed and debated these inconsistencies in the Phase 2 mini-workshops. As a result, the caregiving team took upon the charge of creating a new standardized patient education process incorporating additional feedback from two patient focus groups (described later) conducted in parallel with the Phase 2 caregiver mini-workshops.

Under the research team's guidance, the caregiving team used a standard-work design approach (Toussaint and Berry 2013, Spear and Bowen 1999) to identify specific activities in the discharge process, breaking the activities into content, sequence, timing, and outcome. They also adopted a two-part patient-education approach, with inpatient nurses giving the most essential post-surgery instructions during the hospital stay (Part I Instructions) and outpatient nurses giving other post-discharge instructions (Part II Instructions) approximately 48 hours after discharge (see Appendix A3 for the new list of topics). An important part of the new process is that outpatient nurses are now required to meet the patient and the inpatient coordinators prior to discharge to initiate a formal handoff process. This is aimed at reducing errors that can occur as a result of unmindful handoffs (LeBaron et al. 2016). The new standardized discharge work process, as seen in Figure 3, provides specific instructions on content, sequence, timing, and outcome. For example, nurses are to recommend patients drink “three liters” and demonstrate with a jug (content), give the instructions before

addressing signs of rejection (sequence), spend about a minute on the activity (timing), and confirm the patient understood the instructions (output). Specifying standard work in terms of content, sequence, timing, and outcome by the caregiving team led to mindful execution of new standard work, and perhaps resulted in minimizing any decline in performance in the initial stages of the change (as indicated by the statistical analysis results described later), supporting Proposition 2.

We also conducted two patient focus groups in September and December 2014 in parallel with the caregiver mini-workshops. The parallel conduct of these patient focus groups enabled an interchange of questions across both forums while maintaining some separation. This combination helped consider aspects that warrant either more strict standardization or more flexibility-in-use for caregivers in the design of standard work. We invited to the focus group meetings 15 patients who had undergone a transplant within the last six months. Family members providing post-discharge care accompanied most patients. Through these workshops, the caregiving team integrated patient needs and preferences in designing the care delivery process. For the focus groups, we ensured diversity among patients in terms of age, gender, donor type (cadaveric kidney versus living donor), pre-existing conditions, socioeconomic status, and education level. The first patient focus group meeting was used to obtain feedback on the topics included in the two parts of the discharge work (i.e., the contents of Part I and II instructions). It is important to note that patient-feedback was primarily used to inform sequencing, not content, which was determined based on evidence-based best practices. The second patient focus group discussed outcomes and instruction delivery aspects (e.g., use of visuals, teach-back standards) and helped resolve inconsistencies in the delivery. For example, patients noted the confusion that arose when inpatient nurses used a medication's chemical name (e.g., "Cyclosporine") while outpatient nurses used its generic name (e.g., "Neoral"). We worked to resolve such issues through the caregiver mini-workshops being conducted in the same period and then rolled out a training program for all the nurses on the delivery of new instructions.

In general, having patient input in parallel offered insights that were not otherwise considered by the caregiving team. As an example, data from the focus groups suggested that some patients preferred visuals for discharge instructions while others preferred detailed explanations through narratives. This information was then used by the caregiving team, which developed both visual and conversational teaching (teach-back) techniques to accommodate the variation among patients. In line with proposition 3, having patient feedback through parallel workshops offered newer insights into improvement opportunities. Figure 2 represents the activities that constituted the research team's intervention that was completed by April 2015.

4.5. Refreezing: Sustaining Standard Work

Phase 3 represents the *post-implementation period*. The research team observed the delivery of new discharge instructions, interacted with patients, and collected qualitative feedback on the new design during this

phase. We also facilitated activities for institutionalizing continuous improvement of the discharge process by helping the caregivers set up daily (inpatient) and weekly (outpatient) huddles to address day-to-day issues and further improvements (Provost et al. 2015). These huddles are standup meetings of about 10 minutes and focus on solving problems and sharing best practices. In the past, this hospital unit had started similar huddle-meetings on two separate occasions and both efforts had been short-lived. In 2011, senior management had implemented huddles (top-down) but the initiative had lasted only a few months, apparently due to a lack of buy-in from the frontline caregivers. Later, in 2012, morning shift frontline caregivers had initiated huddles (bottom-up) to solve discharge-related problems, but even these were discontinued after a few months, reportedly due to lack of management support and resources.

This time around, with input from our research team, frontline nurses designed and developed the huddles with support from middle and top management. In fact, outpatient and inpatient nurse managers (i.e. middle management) made this a part of their weekly and bi-weekly routines. They created a structure to facilitate the huddles (less than 10 minutes), monitored them, and offered problem-solving support. This gave rise to a weekly, Monday meeting between the inpatient and outpatient manager that the nursing director (senior management) also attended. Managers in these meetings shared information on patients and the discharge process, and updated each other on huddles in their respective units. The use of these huddles organically created a tiered management structure that now allows important frontline issues to cascade through middle management to senior management, and this appears to have helped sustain standard work adherence as well as process improvement, supporting Proposition 4. Figure 3 provides an overview of the elements of the discharge process after the standard work implementation. It also shows the tiered management structure that originated from these changes. The huddles that began in May 2015 were still being regularly conducted after 22 months of the initial implementation in February 2017.

Appendix A4 provides details on the huddles and the role of middle management. When attending these huddles, we found nurse managers to be pivotal in ensuring frontline nurses had the necessary resources. They also met with the nursing director (senior leadership) on a weekly basis to communicate information from across the hospital. All the changes and improvements to the discharge process made during these huddles were tweaks to the newly designed standard work (i.e., nothing changed with respect to the content of the discharge process). Overall, we were able to develop a “learning community” (Brown and Duguid 1991) at the medical center through our intervention². Our study ended in April 2016 with the collection of interview and survey data from more than 80 patients who underwent transplant after the deployment of the new discharge process in June 2015. In order to enable a comparison, we used the same questions for our interviews and

² As an example, the caregiving team has begun work on a follow-up project focusing on the role of former transplant patients in mentoring new transplant recipients on how to manage post-discharge anxiety and psychological stress.

survey that we had used in Phase 1. We include these data to analyze the impact of our intervention and the resulting process changes.

--- Insert Figure 3 here ---

5.0. Patient and Process Data

5.1 Treatment Group: Kidney Transplant Discharge Process

The intervention in our study was the redesign of the education and training process for patients after kidney transplant surgeries. The research team had access to various forms of secondary data related to before and after the process redesign intervention, as well as primary data collected during the intervention. These multiple sources of data enabled us to triangulate our findings. The first author in this study was a constant participant throughout the process redesign intervention. The first author attended all meetings with caregivers and patients, shadowed with nurses and physician leadership before and after the intervention, and reviewed patients' medical and other information. Overall, the research team conducted more than 50 semi-structured interviews with patients and caregivers before, during, and after the intervention. These interviews enabled us to gather rich and detailed data on the process and its context. We also collected data from patients and caregivers on various aspects of healthcare delivery (pre- and post-intervention). The patient surveys were used to collect information on communication with physicians, consistency of processes, level of empathy in care delivery, and clarity of discharge instructions.

During 2013–2016, 571 patients underwent kidney transplants at the Apollo Medical Center (See Table 2). Of those, 304 patients received cadaveric kidneys (53%) while 267 received them from living donors (47%). 40% of patients were female, and the average age of all patients was 50.3 years. We conducted statistical tests to compare the averages for different descriptive characteristics for our sample with averages for data obtained from the National Kidney Foundation for all transplants conducted in the United States during the study period. Average readmission rates observed in our sample were 40%, not significantly different from the national average ($p>0.25$). Differences in other demographic and donor-type statistics also were non-significant ($p>0.30$). In addition to readmissions, we also had access to data from the HCAHPS patient satisfaction survey for the hospital unit. Scores from this survey have become a critical target of hospital administrators' improvement efforts since the Centers for Medicare and Medicaid Services (CMS) reimbursements and penalties have been tied to HCAHPS scores through its value based purchasing (VBP) program (Chandrasekaran et al. 2012). We aggregated HCAHPS monthly scores at the patients' post-surgery hospital unit level where post-surgery education and training was delivered. Given the importance of these scores for reimbursements, we also looked at monthly changes to the overall survey measure from our intervention.

5.2. Control Group – Other Transplant Recipients

Although we collected pre- and post-intervention data from the kidney transplant process, other hospital-level activities—EMR implementation, hospital-wide training programs, and health system design

changes—occurring during the period could have also impacted patient outcomes. Thus, assessing the efficacy of our intervention solely based on a pre- vs. post-intervention analysis would be problematic. One approach to control for characteristics unobservable to the researcher that may influence outcomes (Imbens and Woolridge 2009) would be to collect data from another hospital’s kidney transplant site that did not undergo this intervention. However, such an approach would not resolve the potential impact of internal hospital improvement initiatives that could additionally affect patient outcomes. Another approach would be collecting data from another transplant process within the same hospital and using it as a control group, adjusting for patient and other transplant characteristics. We adopted this latter approach as such a comparison provides a stronger test of the intervention, given commonalities between discharge processes, organizational culture, and incentives.

Through discussions with the chief medical officer, and quality and patient safety officers at Apollo, we identified the heart and liver transplant processes as our control group. Patients undergoing heart and liver transplants experience similar outpatient questions as kidney transplant recipients (Dew et al. 2007). The post-transplant education delivery process, moreover, shares many commonalities with the kidney transplant process, as shown in Figure 1. At Apollo, an internal quality and patient-safety committee had streamlined all three processes prior to our study. It is important to note that the heart and liver units only experienced routine hospital-wide quality and safety efforts at Apollo, also applied to the kidney unit, and did not undergo other initiatives such as our intervention, during our period of study. For these reasons, we collected patient and process data for all heart and liver transplant patients for the same period (January 2013–April 2016). During this period, 62 heart transplants and 103 liver transplants were conducted at Apollo. Table 2 provides details on the patient and process characteristics for this control group.

5.3 Variables

30-day Readmission. The first dependent variable of interest is whether the patient was readmitted to the Apollo or any other hospital within 30 days after being discharged from Apollo. The 30-day readmission rate is a performance measure included in the VBP and readmission reduction programs of CMS (CMS 2016). The overall readmission rates for our sample were consistent with the national averages for the treatment and control groups.

Overall Quality Rating. For our second dependent variable, we collected unit-level HCAHPS scores, which assess overall quality using a scale of 0-10 (10 being the best) as perceived by the patients during their stay. Consistent with previous studies (Senot et al. 2016, Chandrasekaran et al. 2012), we used the percentage of patients who answered “always” (scores 8, 9 and 10) as a measure of overall quality, and adjusted them for factors such as education, self-rated health, primary language, age, socioeconomic status, and delay in survey

response (see hcapsonline.org for more details). We obtained these scores for the treatment and control group units for each month during our study period³.

Implementation Phases. In our study, we specifically focused on differences in readmissions and HCAHPS scores between the treatment group (kidney) and control group (heart and liver) across three different time periods. T3 is a binary variable representing transplants at both treatment and control units between May 2015 and April 2016. It is used to test the performance differences across units' post-implementation period (i.e., Phase 3). There were 167 kidney transplants (used to measure treatment effect), 37 liver, and 30 heart transplants (used as control group) during this time period. T2 captures all transplants performed between July 2014 and March 2015 across both the units, which helps test their performance differences during the implementation period (i.e., Phase 2). This period saw 147 kidney, 15 heart, and 22 liver transplants. T1 captures all transplants performed between Jan 2014 and June 2014, which we use to investigate the differences during pre-implementation period (i.e., Phase 1). During this period, there were 74 kidney, 14 liver, and seven heart transplants.

Patient Controls. Our analyses controlled for several patient-level factors that can potentially impact readmissions and HCAHPS scores. Our discussions with the medical team helped identify the following controls: patient age, length of stay, gender, type of transplanted organ⁴ (living vs. cadaveric), and patient ethnicity (African-American, Caucasian, and others). We also controlled for pre-existing conditions such as diabetes, transplanted organ function (graft function) upon discharge (Lubetzky et al. 2016), and 30-day mortality. Finally, we added dummy variables to control for the year and quarter of transplant for readmission analyses, and year and month dummies for overall quality ratings (HCAHPS scores) analyses.

Process Controls. In addition to patient characteristics, other process changes in both the treatment and control units could affect the discharge process. Our conversations with hospital leadership suggested several related measures which we controlled for in the analyses. VBP is a binary variable that captures the effect of the October 2013-launched CMS program, which can affect the discharge process across both the treatment and control groups. In addition, we included the following three factors: EMR implementation (*EMR*) that put caregivers through additional training; outpatient EMR glitches and integration issues at the outpatient facilities for both groups (*Integration*); and transition of care for the kidney unit (*Transition*), reflecting the June to August 2015 period when the outpatient clinic moved between facilities. We also checked the turnover levels for nurses, physicians, and surgeons during our study period, and found them to be minimal. For the analyses of the overall quality rating, we controlled for the number of transplants conducted by the corresponding units since a larger number of transplants during a given month could affect the participation rates in the HCAHPS surveys.

³ All kidney transplant recipients stayed in Unit A while all liver and some heart transplants patients stayed in Unit B after surgery.

⁴ All of our heart and liver transplants were cadaveric organs

Finally, we verified with the surgical team that patients were readmitted if they had electrolyte abnormalities and/or organ dysfunctions. These criteria remained the same throughout our study period, minimizing concerns of administrative changes that could have impacted our results. Table 2 presents the definitions, and means and standard deviations for all variables used in our analyses.

--- Insert Table 2 here ---

6.0. Analyses

From the 736 patients in our sample, we deleted 34 patients who had multiple transplants due to rejections that occurred during their post-surgery hospital stay, and which lasted for more than 30 days after the initial procedure. Thus, the final sample for analyses included 702 patients (563 kidney, 48 heart, and 91 liver).

We used a difference in difference (DID) approach to estimate the causal effects of the change in patient-education standard work on readmission outcomes. Studying the DID of readmissions between kidney transplant and other transplant recipients over time allowed us to control for unobservable performance-influencing characteristics (Imbens and Wooldrige 2009). Several other researchers recommend using this approach when dealing with non-randomized experiments (Dimick and Ryan 2014). The new standard work implementation constitutes our experimental treatment or intervention that resulted in an exogenous shock to the transplant discharge process beginning in January 2014. This approach accounts for differences in baseline readmission rates across the two transplant groups and mitigates the effects of any ongoing hospital improvement efforts independent of our intervention.

Before using the DID approach, we first examined whether readmission rates between kidney and other transplant groups exhibited a parallel trend prior to our intervention (Abadie 2005). We analyzed quarterly readmission rates between the treatment and control group for the period from January 2013 to June 2014. During this period, there were 367 kidney, 29 heart, and 64 liver transplants. Comparing the readmission slopes for the two groups—kidney versus other—suggests the coefficients were not statistically different ($\chi^2 = 4.41$, $p = 0.35$). Thus, any post-implementation reduction in readmission would indicate the presence of treatment effects.

6.1. Effect of New Standardized Discharge Process Implementation on 30-day Readmission Rates

We investigated the post-discharge change in patient outcomes by examining readmission trends in the treatment and control group. We estimated the following relationship at the patient level for the three time periods:

$$\text{logit (Readmission)}_{i,j,t} = \beta_0 + \beta_1 Txp_{ij} + \beta_2 Tt_{s=1,2,3} + \beta_3 Txp_{ijt} * Tt + \theta_{jt} + \alpha_j + \delta X_{ijt} \text{ --- (1)}$$

In equation (1), i indexes each patient, j indexes each transplant type, and t indexes time in year and quarter periods. Txp_{ij} captures the type of transplant patient (kidney, heart or liver), $Tt_{S=1,2,3}$ represents the three phases of intervention (1 - pre-, 2 - during, 3 - post-implementation). $Txp_{ijt} * Tt$ captures interaction between transplant type and time, while T_{aj} represents time invariant transplant controls. X_{ijt} represents patient-level controls and θ_{jt} represents time-variant process controls for the transplant groups. We used logistic regression and interacted the treatment group dummy variable with the three phases to investigate readmission trends during the implementation process. As a verification check, we used the diff command in STATA 14 and controlled for all covariates in Table 3; the results were consistent.

---Insert Table 3 here ---

Table 3 shows the results of this analysis. In terms of patient controls, we find that female patients have a 52% higher likelihood of readmission compared to male patients ($\beta=0.45, p<0.01$, Odds Ratio [OR] = 1.52). Increase in length of stay during surgery is positively associated with the occurrence of readmission ($\beta=0.06, p<0.01$, OR = 1.06). Delayed graft functioning of the organ is associated with increase in readmission rates ($\beta=0.56, p<0.01$, OR = 1.76). Heart transplant recipients, meanwhile, has a lower likelihood of readmission compared to other transplant groups ($\beta=-0.72, p<0.05$, OR = 0.49), while there is no difference in readmission rates between the kidney and liver group. Interestingly, pre-existing diabetic conditions, donor type, age, and patient ethnicity are not associated with readmission likelihood.

In terms of process controls, we find several interesting trends. First, the EMR implementation period for both treatment and control groups ($\beta=1.07, p<0.05$, OR = 2.92) and the month of transition for the treatment group ($\beta=1.15, p<0.05$, OR=3.17) are associated with increased readmission rates. Our qualitative interviews with caregivers suggested that EMR training sessions severely affected care delivery coordination, potentially causing readmissions to spike. Similarly, our conversations also suggested transitioning the outpatient unit for the treatment caused several delayed hand-offs with the inpatient care teams, which could have increased readmissions as indicated by our results. The control group units did not transition during our study. Finally, the likelihood of 30-day readmission is higher ($\beta=1.13, p<0.05$, OR = 3.04) after the launch of CMS' VBP reimbursement program. The variance inflation factor in all our models was well below the threshold value of 10 (Hair et al. 2010).

Model 1 provides the results for the likelihood of readmission in T3 (post-implementation). As seen from Model 1, the coefficient of the interaction term between T3 and Kidney is negative and significantly associated with readmissions ($\beta=-1.15, p<0.05$, OR=0.32). This suggests that kidney transplant patients' likelihood of readmission within 30 days is lower post-implementation compared to the control group (heart and liver) and to the pre-implementation period, supporting H1. Specifically, post-implementation odds of readmission within 30 days are 0.32 times lower compared to the control group and previous time periods. To

better understand this effect, we created a conditional effects plot (Figure 4) using the margins command in STATA. Here, the predicted probabilities of readmission for the control group remain essentially the same before and after T3, while changes to the discharge process drop the predicted probability by 25% in the treatment group ($p < 0.05$).

To assess the effectiveness of our intervention, we also calculated the net savings in terms of bed occupancy rates and operating costs. We could obtain direct costs (e.g., room and board, labs, medical supplies, and pharmacy) and indirect costs (e.g., lab equipment, patient services, salaries, and benefits) data for every readmission that occurred during the study period. See Appendix A5 for details. The hospital readmission reduction program (HRRP) currently penalizes 30-day readmissions for heart attack, heart failure, and pneumonia conditions, and does not apply to the transplant population (see cms.gov). As a result, hospitals are currently reimbursed for transplant readmissions. Nevertheless, our data show that total kidney transplant readmissions decreased from 37.29% in pre-implementation and implementation periods (T1 and T2) to 31.93% during the post-implementation period (T3). This equates to a raw readmission reduction of 5.35%, or about nine fewer readmissions among T3's 167 kidney patients. The average total cost for a readmitted patient was about \$14,804, making total cost savings through reductions to be about \$133,236 in this period. This is a conservative estimate, and moreover, does not account for other intangible benefits such as increased transplant activity at the hospital by avoiding readmissions, and improved patient quality of life after discharge.

--- Insert Figure 4 here ---

Models 2 and 3 show the likelihood of readmission during T2 (implementation period) and T1 (pre-implementation). It is important to note that these regressions were run comparing the discharge process of the treatment group (kidney) with the control group (heart and liver) and pre-phase characteristics (pre-T2 and pre-T1), which explains different sample sizes for both these regressions ($n = 487$ patients for T2 and $n = 308$ for T1). It is also important to note that some of process controls (e.g., *Move* and *Transition*) occurred after T2, and were therefore dropped in the pre-implementation and implementation models. *VBP*, meanwhile, launched just prior to T1, thus was dropped from this analysis. Results of Models 2 and 3 highlight several important observations: The treatment group's likelihood of readmission during these two periods is no different than that of the control group and pre-phase time periods ($p > 0.20$). This suggests that the benefits of our intervention can only be seen after the discharge process is fully implemented. Nevertheless, we also find no deterioration in performance during these periods compared to the control group, as expected based on the prior literature (Fedrows 2015, Tyre and Orlikowski 1994). Performance across both the treatment and control group, however, is worse than the other time periods. That is, the coefficient of T2 is significantly associated with readmissions ($\beta = 1.12$, $p < 0.10$, $OR = 3.07$) suggesting the likelihood of readmission within 30 days is significantly higher during this period. Without a DID approach, we would have incorrectly concluded

performance deteriorated during our study. We do not find this effect for T1. Finally, we also find that the patient controls and time-relevant process controls remain consistent across all three phases, suggesting their effects are consistent during the study period.

6.2. Effect of Standardized Discharge Process Implementation on Overall Quality of Care

We also had access to monthly HCAHPS data for both the kidney transplant unit (Unit A) and the liver⁵ unit (Unit B) in the hospital. Appendix A shows HCAHPS monthly trends for the overall quality rating for both the units. It is important to note that these units were located in different buildings in the hospital and had no common caregivers. This reduced the possibility of carry-over learning effects between the two groups that would have impacted our study. We estimated the following relationship between the implementation phases and the overall quality ratings at the unit level.

$$Overall\ Quality\ Ratings\ i, t = \beta_0 + \beta_1 Txpi + \beta_2 Tt_{s=1,2,3} + \beta_3 Txpit * Tt + \theta jt + \alpha j + \dots \dots \dots (2)$$

In equation (2), i indexes the transplant type and t indexes time in year and months periods. $Txpi$ captures the type of transplant patient ($i = 1$ kidney; $i = 0$ heart or liver), $Tt_{s=1,2,3}$ represents the three phases of the intervention (1- pre-, 2- during, and 3- post-implementation). $Txpit * Tt$ captures transplant type and time interaction, while Taj represents time invariant transplant controls and θjt represents time-variant process controls for the transplant groups.

--- Insert Table 4 here ---

Testing the HCAHPS scores between the two units, we find the coefficients to be statistically similar ($\chi^2 = 1.48, p = 0.23$) pre-intervention, indicating that the slopes are similar across the groups. Between January 2013 and April 2016, raw overall quality scores at the kidney unit increase 10% while those at the liver unit decrease 11%. Table 4 gives the DID analyses to test the effect of intervention across all three phases between the control and treatment group. Similar to our earlier analyses, we included all process-level controls (e.g., VBP, EMR, etc.) along with relevant time intervals (e.g., T3, T2, and T1) when comparing the two units, hence the difference in the number of months. Models 4, 5, and 6 provide results for post-implementation, implementation and pre-implementation periods, respectively.

⁵ We did not include the unit in which heart transplant patients stayed because that unit also had patients who had undergone other cardiac procedures, and as such, might not adequately reflect true HCAHPS scores related to transplants. Additionally, there were a few beds in the liver unit that were dedicated for heart transplant patients, given the similarities in post-transplant care and education.

--- Insert Figures 5 and 6 here ---

As seen from the results for Model 4, the interaction term between T3 and the kidney unit is positively associated with the overall quality ratings ($\beta=0.10, p<0.05$). This suggests overall HCAHPS scores for the kidney unit improved post-intervention compared to the control group and previous time periods, supporting H2. To better understand this result, we graphed the conditional effects plot, as shown in Figure 5. As seen from the plot, overall quality scores after accounting for other covariates increase 6% for the kidney unit after T3 compared to the pre-implementation period. They decrease 7% in the liver unit during the same time. This provides evidence of the effectiveness of our intervention on improving overall HCAHPS scores.

As seen from the results for Model 5, T2 is negative and significantly associated with HCAHPS scores ($\beta= -0.08, p<0.01$), suggesting overall HCAHPS scores were lower compared to the previous time periods. The interaction between T2 and kidney transplants is also negative and significantly associated with HCAHPS ($\beta= -0.08, p<0.10$), suggesting scores in this unit were lower compared to the control group and other time periods. To better understand this result, we graphed the conditions effects plot, as shown in Figure 6. As seen from the plot, overall quality scores after accounting for other covariates decrease for both units during T2. However, the kidney unit shows a 17% reduction in HCAHPS scores while those in the liver unit only decline 7% in the same period. This suggests HCAHPS scores decline before realizing significant post-implementation benefits.

As indicated by the regression results for the T1 pre-implementation period in Model 6, both the main effect of T1 and the interaction with the kidney group are not associated with HCAHPS scores, suggesting overall quality was no different between the two groups or the pre-intervention period.

6.3. Robustness Checks

We performed robustness checks to confirm our empirical results. First, we changed the time window for assessing the effects of standard work implementation from the 12-month period (April 2015–April 2016) of our analyses to a smaller, nine-month window (July 2015–April 2016). This scenario allows caregivers a three months' lag to adjust to new routines before assessing results. We found the results from these revised analyses to be consistent with the original results.

Second, the nature of our process-change intervention required that researchers be embedded in the work at the research site. This close involvement enabled us to validate through discussions and observations some of the findings from our quantitative data analyses. Based on the qualitative data we collected, we gained rich insights that explained some statistical results, such as the HCAHPS score reduction during standard work implementation. We also could identify relevant controls (e.g., EMR implementation times and transition of outpatient care) for our quantitative analyses.

More importantly, our conversations with caregivers helped supplement findings from our quantitative analyses by suggesting a set of additional models we later tested. Observing one of the outpatient huddles and fielding follow-up questions from transplant recipients unearthed continuity-of-care differences between living donor organ and cadaveric organ recipients. A living donor recipient typically is better prepared and intrinsically motivated to take care of the organs given the connection with the living donor. Post-recovery dynamics also differ significantly among the two groups as living-donor recipients often contact the donor, making recipients better equipped to handle the post-discharge stress. As a result, comparing the living-donor kidney recipients group with heart and liver transplants (both cadaveric organs) may not have been appropriate. Thus, we repeated our main analyses examining only cadaveric kidney transplants as the treatment group and comparing it with the heart and liver patient control group. Our results from these analyses remained consistent with those reported in Table 4. Interestingly, a follow-up analysis comparing the two transplant types suggested the post-intervention likelihood of readmission is 0.58 times lower for living-donor recipients compared to the rest of group. Standard work implemented therefore appeared to positively impact living-donor recipients more than cadaveric organ recipients. We leave it to future research to examine the implications of this result. Nevertheless, we hope that the supplementary analyses we conducted increase confidence in the robustness of our results.

Finally, our interactions with the hospital caregivers during the post-implementation phase also allowed us to learn more about some of the reasons for patient readmissions. The prevalent system for recording readmissions calls for caregivers to classify the reasons based on ICD codes (International Classification of Diseases and Related Health Problems). This system may not identify whether a readmission occurred due to some non-adherence by the patient that can be related to the discharge instructions. However, our conversations with the coordinators who admit the readmission patients indicated that the top five reasons for possibly avoidable readmissions were patients: (1) missing two consecutive labs; (2) developing infections; (3) not taking the immunosuppressant medications on time; (4) not communicating their pain issues in a timely manner to the post-discharge coordinators; and (5) not drinking enough water. This list of reasons remained the same during the course of the study during which time readmissions decreased. The coordinators admitting the patients suggested that the readmissions that occurred during the post-implementation phase had fewer number of patients having the avoidable readmission causes. This suggests that the reduction in the number of readmissions after our intervention is more likely due to increase in patient adherence to their discharge instructions. Furthermore, the outpatient coordinators noted a drop in the number of phone calls about clarification of discharge instructions received from the patients, which further supports the efficacy of our intervention.

7.0. Discussion and Conclusion

Our data analysis and participation with the caregivers in the standard work implementation unearthed several theoretical and managerial insights that we detail below.

7.1. Theoretical Implications

First, results from the analyses showed a significant reduction in treatment group readmissions after the implementation of the new standard work when compared to the control group. Additionally, the overall HCAHPS scores for the treatment group increased post-implementation while those of the control group declined. Thus, we find support for both our hypotheses relating the implementation of the new standard work to readmissions and patient experience outcomes. Implementing new processes in the context of healthcare delivery involves designing work standards that considers the variations introduced by patients. The implementation process involves multiple professionals at different hierarchical levels in the delivery process. Unfortunately, there is lack of knowledge on how to bring about process change in such settings and about the relationship of specific changes with their intended outcomes. Our research therefore offers, to the best of our knowledge, the first empirical evidence for Lewin's (1947) theory of organizational change applied to high contact service settings and the inherent conditions of customer-related variations and heterogeneous groups of employees executing the processes. We show that a systemic approach to triggering change would result in minimal tradeoffs among process outcomes even in the initial stages after implementation and would sustain compliance over time while seeking opportunities for further changes.

Second, our action-based research design offers new insights on the process of initiating and successfully implementing process changes in high contact service settings. Through our use of rich qualitative data and on-the-ground observations, we show how to initiate healthcare process improvements using employee and patient input; we offer testable propositions based on these actions. We included patient input in the design of the new standard work. It is important to note that patients' role in our process improvement was confined only to input on the standards developed by the caregiving team. We intentionally did not include patients in the caregiver workshops to maintain anonymity, and to ensure that both patients and caregivers would share their perspectives without fear of negative consequences. Patients may not have provided frank and critical feedback in the presence of caregivers, some of whom may be involved in providing continuing care for chronic conditions. In addition, caregivers may have feared discussing specific variations in care delivery that individual patients necessitate. Thus, we gathered patient input separately but in tandem with caregiver workshops, and iterated through exchanges and input syntheses from both sets of participants. This approach proved particularly useful in making changes to delivery of education and training for patients. Although previous studies on process changes have advocated for customizing service process delivery (e.g., Boone et al. 2008), they shed little light on how to incorporate customer input during design and development. Studies

suggest surveying customers to gauge their perceptions of the process and use them for the design (Bendapudi and Leone 2003). Others recommend using service provider–customer focus groups to simultaneously consider their viewpoints (Gittell 2003). Neither, however, may work well in healthcare because of reasons described earlier. Although patient input can be useful to understand modes of discharge instruction delivery, it sheds little insight on how to design an intervention to achieve this goal. Our research, by contrast, delineates a new strategy for incorporating patient feedback in improving healthcare delivery. Hospitals find themselves continually redesigning service delivery in response to reimbursement changes (e.g., VBP requirements) or new care delivery models (e.g., Accountable Care Organizations – Shortell et al. 2014; Population Health Models – Moffat-Bruce et al. 2014). Findings from our research suggest that using the caregiving team’s evidence-based standards for process changes and, in parallel, incorporating customer-centric features based on their feedback can be an effective approach for care delivery process redesign. The initially sequential then separate but simultaneous collection of caregiver and patient viewpoints can be useful in synthesizing information and counterbalancing process features. Ultimately, this can help achieve better patient health outcomes and higher customer satisfaction.

Third, we increased caregiver acceptance by conducting a process study prior to considering process change. Though we had senior management support at the outset, the nurses and surgeons at Apollo were uncommitted to the process change initiatives. Initial interviews with nurses suggested some surgeons were dissuading them from participating altogether. For example, a nurse commented, prior to the intervention, that it was “just another organizational reaction to the changing regulations.” The results of our pre-intervention study, however, sparked a stark contrast in nurses and surgeons’ attitude toward the need for change, leading to enthusiastic workshop participation and continuing involvement from all caregivers. This evolution, from skepticism to enthusiasm, is reported in the operations management and organizational routines literatures (Staats et al. 2016, Nembhard and Tucker 2011, Adler et al. 1999, Sterman et al, 1997). Previous research studies however, do not describe how change was initiated, a gap that is perhaps responsible for the failure to reap benefits from improvement efforts in all sectors, including manufacturing (Kelley 2011, Pay 2008). By demonstrating the effectiveness of pre-intervention studies and analyses, we add specificity that can help organizations better initiate process changes.

Fourth, we offer insights on how to sustain process change. Our findings and continuing observations after the intervention suggest the caregiving team has been diligently monitoring and improving the standard work even after the initial implementation concluded in May 2015. Inpatient and outpatient nurse teams at Apollo’s transplant unit have practiced regular huddles for nearly two years with sustained enthusiasm. This was not the case at the unit during two previous process transformation attempts. On this matter, past research has shown that fewer than 25% of change management initiatives sustain over time (Towers Watson 2015, Mendelbaum 2006). Evidence on how to sustain new process implementation efforts is lacking even outside of healthcare

(Choo et al. 2007). Success in sustaining the initiative introduced through our intervention can be attributed to the midlevel management’s continuous engagement in ensuring resource availability for huddles. Figure 3 shows the tiered leadership approach that allowed inpatient and outpatient nurse managers to exchange information weekly. This middle-up-down method also helped unit frontline nurses and senior leadership connect in a timely and sustained manner. Nurse managers from the heart and liver transplant control group noted that such coordination of care in their units was, in contrast, mostly ad-hoc and non-routine. Very limited research exists on the role of middle management in sustaining process changes (Tabrizi 2014). In practice, middle managers (e.g., project managers, architectural leads, store and nurse managers, etc.) often are labeled the “muddle in the middle” and considered obstructions for change initiatives (Burgess and Currie 2013). In our study, we found these managers to be critical elements in sustaining changes following process redesign. Expecting senior management (e.g., medical and nursing directors) to exhibit the same level of effort and commitment to daily problem solving was implausible given Apollo’s size. Instead, inpatient and outpatient nursing managers took the lead—not by leading huddles but by ensuring frontline nurses drove bottom-up process changes. They also acted as liaisons between frontline nurses and medical and nursing directors, ensuring necessary resources for improving standard work.

Finally, our research design provides a methodological contribution to the operations management literature for deriving causal inferences. We find that a vast amount of knowledge on process implementation has been derived from case studies (e.g., Eisenhardt et al. 2010, Adler et al. 1999) or pre- and post-implementation data collection (e.g., Choo et al. 2015, Nembhard and Tucker 2011). While case studies derive rich qualitative insights, they do have some limitations for empirical generalization when drawing inferences (Eisenhardt 1989). Similarly, pre- and post-implementation data cannot account for unobservable factors that may affect outcomes. Had we only collected pre- and post-implementation data from the kidney transplant process, we would have incorrectly identified a performance deterioration during implementation. Our quasi-experimental study design, which includes data from a comparable process within the same setting and incorporates rich field observations, overcomes some limitations of previous studies in deriving causal inferences. Though common in healthcare and public policy literature (e.g., Ryan et al. 2015, Dimick and Ryan 2014), this approach is only beginning to receive attention among operations management scholars (Song et al. 2016). Nonetheless, it can be useful in scenarios that do not allow for a randomized control (RCT) approach.⁶ We encourage future studies to adopt such an analytical approach, allowing researchers to account for several organizational confounding elements while deriving inferences.

⁶ An RCT design in our case would require multiple kidney transplant facilities in the same Apollo unit that have different employees, wherein the treatment (standard work) can be randomly assigned.

7.2. Implications for Practice

Our results also offer important managerial insights. During implementation (Phase 2), we observed the treatment group HCAHPS scores decline while the readmission rate remained unchanged. Upon discussing this result with the caregivers, a possible explanation emerged. Phase 2 required caregivers to dedicate time to focus groups, training workshops, and efforts to change discharge information delivery. Moreover, during this phase, patients experienced caregivers following now-standardized protocols more strictly. These two factors likely drove patients to give lower ratings on the HCAHPS surveys. Supporting this possible explanation, multiple patients said during Phase 2 interviews that they received instructions from a veteran nurse who was using the teach-back method with inpatient nurses, which they said degraded their patient experience. One patient even described feeling like a “test subject” at the time. Regardless of patients’ perceptions, their health outcomes, measured using 30-day readmission rates, were not harmed during Phase 2. These results point to two practical insights for implementing process improvement initiatives in high-contact service processes. First, service providers must actively manage customers’ perceptions of process improvement activities when conducted in their presence to mitigate any potential decline in satisfaction. Second, measures of patient satisfaction and patient health outcomes may diverge during care delivery. It is important to note, however, that neither declined post-implementation. By striving for caregiver engagement during process development and including patient input in implementation, we averted the expected initial dip in results following new-process or new-technology adoption (Nembhard and Tucker 2011, Knott and McKelvey 1999).

Perhaps the most valuable practical insight gained from this research addresses critics who dismiss process improvement in healthcare as “medical Taylorism” (Hartzband and Groopman 2016). Medicine is governed by the requirement to follow evidence-based standards, yet their implementation allows the care team much discretion. By seeking to eliminate process variation, the standardized work in this research somewhat limits that discretion but honors it nonetheless by introducing patient-centric elements (e.g., using multiple learning aids, having teach-back conversation, etc.). Applying standard practices in repetitive processes has been shown to improve quality in many industries, yet processes are never “exactly repetitive” in a patient-care setting because of the variation patients introduce. This, therefore, necessitates a standard process design that allows for patient-induced variation. Such design is necessarily iterative and the product of collaborative work by the care team informed by needs the patient articulates. As such, it is not Taylorism. Rather than dictating scientific management, this standardization incorporates the ideas of those who do the work (including physicians and nurses) as well as those affected by it (patients). The design, implementation, and sustaining of standardized, patient-centric processes requires intensive team effort. The evidence provided here suggests it can result in greater patient satisfaction and better medical outcomes.

7.3 Limitations and Future Research

We recognize the following limitations, which may serve as directions for future research. First, all insights from our study are derived from one hospital unit. Although we collected data from multiple sources, validated our findings through post-hoc employee and patient interviews, and ensured the patient mix in our sample compared with national demographics, we must exercise caution when generalizing our findings to other transplant units. Second, we note that our research is limited to the context of kidney transplant discharges, thus caution must be used in extending the benefits of standard work to other types of healthcare delivery. Apollo already has seen evidence of efforts to adopt similar standard work changes in its hip and knee replacement units. We encourage more research from other contexts, which can help strengthen the benefits of patient-centric standard work to healthcare delivery.

7.4. Conclusion

Notwithstanding the above limitations, our study offers important implications for managers and scholars. We provide detailed insights on how to trigger new process change within an organization, especially amid cultural resistance. We demonstrate the key elements of employee engagement and patient input and how these two enable standardization in high contact service settings. Finally, we also shed light on the often-ignored middle manager, essential for sustaining change over an extended period. Our paper also contributes to the operations management literature. By focusing our research design on a fundamental element of process, namely standard work, we empirically demonstrate its benefits. This addresses the questions raised by skeptics about the use of standardization in high-contact service settings.

References

- Abadie, A. (2005). Causal inference. *Encyclopedia of social measurement*, 1, 259-266.
- Abecassis, M., Bartlett, S. T., Collins, A. J., Davis, C. L., Delmonico, F. L., Friedewald, J. J., ... Merion, R. M. (2008). Kidney transplantation as primary therapy for end-stage renal disease: A National Kidney Foundation/Kidney Disease Outcomes Quality Initiative (NKF/KDOQI™) conference. *Clinical Journal of the American Society of Nephrology*, 3(2), 471-480.
- Adler, P. S., Clark, K. B. (1991). Behind the learning curve: A sketch of the learning process. *Management Science*, 37(3), 267-281.
- Adler, P. S., Goldoftas, B., Levine, D. I. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science*, 10(1), 43-68.
- Anand, G., Ward, P. T., Tatikonda, M. V., Schilling, D. A. (2009). Dynamic capabilities through continuous improvement infrastructure. *Journal of Operations Management*, 27(6), 444-461.
- Axelrod, D. A., Schnitzler, M. A., Xiao, H., Naik, A. S., Segev, D. L., Dharnidharka, V. R., ... Lentine, K. L. (2016). The changing financial landscape of renal transplant practice: A national cohort analysis. *American Journal of Transplantation*.
- Bendapudi, N., Leone, R. P. (2003). Psychological implications of customer participation in co-production. *Journal of marketing*, 67(1), 14-28.
- Boone, T., Ganeshan, R., Hicks, R. L. (2008). Learning and knowledge depreciation in professional services. *Management Science*, 54(7), 1231-1236.

Brown, J. S., Duguid, P. (1991). Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization science*, 2(1), 40-57.

<https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-instruments/HospitalQualityInits/HospitalHCAHPS.html>

Buckley, B. A., McCarthy, D. M., Forth, V. E., Tanabe, P., Schmidt, M. J., Adams, J. G., Engel, K. G. (2013). Patient input into the development and enhancement of ED discharge instructions: A focus group study. *Journal of Emergency Nursing*, 39(6), 553-561.

Burgess, N., Currie, G. (2013). The knowledge brokering role of the hybrid middle level manager: the case of healthcare. *British Journal of Management*, 24(S1), S132-S142.

Burnes, B. (2004). Kurt Lewin and the planned approach to change: a re-appraisal. *Journal of Management studies*, 41(6), 977-1002.

Chandrasekaran, A., Senot, C., Boyer, K. K. (2012). Process management impact on clinical and experiential quality: Managing tensions between safe and patient-centered healthcare. *Manufacturing and Service Operations Management*, 14(4), 548-566.

Choo, A. S., Linderman, K. W., Schroeder, R. G. (2007). Method and context perspectives on learning and knowledge creation in quality management. *Journal of Operations Management*, 25(4), 918-931.

Choo, A. S., Nag, R., Xia, Y. (2015). The role of executive problem solving in knowledge accumulation and manufacturing improvements. *Journal of Operations Management*, 36, 63-74.

Clancy, C. M. (2009). Reengineering hospital discharge: a protocol to improve patient safety, reduce costs, and boost patient satisfaction. *American Journal of Medical Quality*, 24(4), 344-346.

Cosgrove, T. (2013). *The Cleveland Clinic Way: Lessons in Excellence from One of the World's Leading Health Care Organizations: Lessons in Excellence from One of the World's Leading Health Care Organizations VIDEO ENHANCED EBOOK*. McGraw Hill Professional.

Cukor, D., Cohen, L. M., Cope, E. L., Ghahramani, N., Hedayati, S. S., Hynes, D. M., ... Cohen, S. (2016). Patient and other stakeholder engagement in patient-centered outcomes research institute funded studies of patients with kidney diseases. *Clinical Journal of the American Society of Nephrology*, CJN-09780915.

Damali, U., Miller, J. L., Fredendall, L. D., Moore, D., Dye, C. J. (2016). Co-creating value using customer training and education in a healthcare service design. *Journal of Operations Management*, 47, 80-97.

de Holan, P. M. D., Phillips, N. (2004). Remembrance of things past? The dynamics of organizational forgetting. *Management science*, 50(11), 1603-1613.

Denis, J. L., Langley, A., Cazale, L. (1996). Leadership and strategic change under ambiguity. *Organization Studies*, 17(4), 673-699.

Dew, M. A., DiMartini, A. F., Dabbs, A. D. V., Myaskovsky, L., Steel, J., Unruh, M., ... Greenhouse, J. B. (2007). Rates and risk factors for nonadherence to the medical regimen after adult solid organ transplantation. *Transplantation*, 83(7), 858-873.

Dimick, J. B., Ryan, A. M. (2014). Methods for evaluating changes in health care policy: the difference-in-differences approach. *Jama*, 312(22), 2401-2402.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532-550.

Eisenhardt, K. M., Furr, N. R., Bingham, C. B. (2010). CROSSROADS-Microfoundations of performance: Balancing efficiency and flexibility in dynamic environments. *Organization Science*, 21(6), 1263-1273.

Garnick, D. W., DeLong, E. R., Luft, H. S. (1995). Measuring hospital mortality rates: are 30-day data enough? Ischemic Heart Disease Patient Outcomes Research Team. *Health Services Research*, 29(6), 679.

Gawande, A., Lloyd, J. B. (2010). *The checklist manifesto: How to get things right* (Vol. 200). New York: Metropolitan Books.

- Gino, F., Pisano, G. (2008). Toward a theory of behavioral operations. *Manufacturing and Service Operations Management*, 10(4), 676-691.
- Gittell, J. H. (2002). Coordinating mechanisms in care provider groups: Relational coordination as a mediator and input uncertainty as a moderator of performance effects. *Management Science*, 48(11), 1408-1426.
- Gittell, J. H. (2003). *The Southwest Airlines way: Using the power of relationships to achieve high performance*. New York: McGraw-Hill.
- Gordon, E.J., Prohaska, T., Gallant, M., Siminoff, L., (2009). Self-care strategies and barriers among kidney transplant recipients: a qualitative study. *Chronic Illness*, 5(2) 75-91.
- Hackman, J. R., Wageman, R. (1995). Total quality management: Empirical, conceptual, and practical issues. *Administrative science quarterly*, 309-342.
- Hartzband, P., Groopman, J. (2016). Medical Taylorism. *New England Journal of Medicine*, 374(2), 106-108.
- Health Resources and Services Administration. <https://optn.transplant.hrsa.gov/>. Accessed January 15, 2016.
- Hendricks, K. B., Singhal, V. R. (1997). Does implementing an effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards. *Management science*, 43(9), 1258-1274.
- Huang, K. H., Mas-Tur, A. (2016). Turning Kurt Lewin on his head: Nothing is so theoretical as a good practice. *Journal of Business Research*, 69(11), 4725-4731.
- Imbens, G. W., Wooldridge, J. M. (2009). Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*, 47(1), 5-86.
- Kelley L (2011) Refresh and revitalize. *Quality Progress*. February: 18-23
- King, A. W., Fowler, S. W., Zeithaml, C. P. (2001). Managing organizational competencies for competitive advantage: The middle-management edge. *The Academy of Management Executive*, 15(2), 95-106.
- Knott, A. M. (2001). The dynamic value of hierarchy. *Management Science*, 47(3), 430-448.
- Knott, A. M., McKelvey, B. (1999). Nirvana efficiency: a comparative test of residual claims and routines. *Journal of Economic Behavior and Organization*, 38(4), 365-383.
- Lapr e, M. A., Van Wassenhove, L. N. (2001). Creating and transferring knowledge for productivity improvement in factories. *Management Science*, 47(10), 1311-1325.
- Laureiro-Mart nez, D., Brusoni, S., Canessa, N., Zollo, M. (2015). Understanding the exploration–exploitation dilemma: An fMRI study of attention control and decision-making performance. *Strategic Management Journal*, 36(3), 319-338.
- Lawler, E. E. (1994). Total quality management and employee involvement: Are they compatible? *The Academy of Management Executive*, 8(1), 68-76.
- LeBaron, C., Christianson, M. K., Garrett, L., Ilan, R. (2016). Coordinating flexible performance during everyday work: An ethnomethodological study of handoff routines. *Organization Science*, 27(3), 514-534.
- Lewin, K. (1947). Group decision and social change. *Readings in social psychology*, 3, 197-211.
- Lubetzky, M., Yaffe, H., Chen, C., Ali, H., Kayler, L. K. (2016). Early readmission after kidney transplantation: examination of discharge-level factors. *Transplantation*, 100(5), 1079-1085.
- Mendelbaum, G., 2006. Keep your eye on the ball. APICS Magazine, January 2006
- Naveh, E., Erez, M. (2004). Innovation and attention to detail in the quality improvement paradigm. *Management Science*, 50(11), 1576-1586.
- Nembhard, I. M., Edmondson, A. C. (2006). Making it safe: The effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. *Journal of Organizational Behavior*, 27(7), 941-966.

- Nembhard, I. M., Tucker, A. L. (2011). Deliberate learning to improve performance in dynamic service settings: Evidence from hospital intensive care units. *Organization Science*, 22(4), 907-922.
- Netland, T. H., Ferdows, K. (2016). The S-Curve Effect of Lean Implementation. *Production and Operations Management*.
- Nonaka, I. (1988). Toward middle-up-down management: accelerating information creation. *Sloan management review*, 29(3), 9-18.
- Pay, R. (2008). Everybody's jumping on the lean bandwagon, but many are being taken for a ride. *Industry Week*, 5.
- Powell, T. C. (1995). Total quality management as competitive advantage: a review and empirical study. *Strategic Management Journal*, 16(1), 15-37.
- Provost, S. M., Lanham, H. J., Leykum, L. K., McDaniel Jr, R. R., Pugh, J. (2015). Health care huddles: Managing complexity to achieve high reliability. *Health Care Management Review*, 40(1), 2-12.
- Repenning, N. P., Sterman, J. D. (2001). Nobody ever gets credit for fixing problems that never happened: creating and sustaining process improvement. *California Management Review*, 43(4), 64-88.
- Repenning, N. P., Sterman, J. D. (2002). Capability traps and self-confirming attribution errors in the dynamics of process improvement. *Administrative Science Quarterly*, 47(2), 265-295.
- Rother, M., Shook, J. (2003). *Learning to see: value stream mapping to add value and eliminate muda*. Lean Enterprise Institute.
- Ryan, A. M., Burgess, J. F., Dimick, J. B. (2015). Why We Should Not Be Indifferent to Specification Choices for Difference-in-Differences. *Health Services Research*, 50(4), 1211-1235.
- Schein, E. H. (1996). Kurt Lewin's change theory in the field and in the classroom: Notes toward a model of managed learning. *Systems Practice*, 9(1), 27-47.
- Senot, C., Chandrasekaran, A., Ward, P. T., Tucker, A. L., Moffatt-Bruce, S. (2016). The Impact of Combining Conformance and Experiential Quality on Health Care Clinical and Cost Performance. *Management Science*.
- Shirey, M. R. (2013). Lewin's theory of planned change as a strategic resource. *Journal of Nursing Administration*, 43(2), 69-72.
- Shortell, S. M., Wu, F. M., Lewis, V. A., Colla, C. H., Fisher, E. S. (2014). A taxonomy of accountable care organizations for policy and practice. *Health Services Research*, 49(6), 1883-1899.
- Siemens, E., Balasubramanian, S., Roth, A. V. (2007). Incentives that induce task-related effort, helping, and knowledge sharing in workgroups. *Management Science* 53(10), 1533-1550.
- Song, H., Tucker, A. L., Murrell, K. L., Vinson, D. R. (2016). Closing the Productivity Gap: Improving Worker Productivity through Public Relative Performance Feedback and Validation of Best Practices. (December 12, 2016). Boston University Questrom School of Business Research Paper No. 2884282. Available at SSRN: <https://ssrn.com/abstract=2884282> or <http://dx.doi.org/10.2139/ssrn.2884282>
- Spear, S., Bowen, H. K. (1999). Decoding the DNA of the Toyota production system. *Harvard Business Review*, 77, 96-108.
- Staats, B. R., Dai, H., Hofmann, D., Milkman, K. L. (2016). Motivating process compliance through individual electronic monitoring: An empirical examination of hand hygiene in healthcare. *Management Science*.
- Sterman, J. D., Repenning, N. P., Kofman, F. (1997). Unanticipated side effects of successful quality programs: Exploring a paradox of organizational improvement. *Management Science*, 43(4), 503-521.
- Tabrizi, Benham (2014). The Key to Change Is Middle Management <https://hbr.org/2014/10/the-key-to-change-is-middle-management>
- Tinetti, M. E., Basch, E. (2013). Patients' responsibility to participate in decision making and research. *JAMA*, 309(22), 2331-2332.

Ton, Z., Huckman, R. S. (2008). Managing the impact of employee turnover on performance: The role of process conformance. *Organization Science*, 19(1), 56-68.

<https://www.towerswatson.com/>

Tucker, A. L. (2007). An empirical study of system improvement by frontline employees in hospital units. *Manufacturing and Service Operations Management*, 9(4), 492-505.

Tucker, A. L., Singer, S. J. (2015). The Effectiveness of Management-By-Walking-Around: A Randomized Field Study. *Production and Operations Management*, 24(2), 253-271.

<https://www.unos.org/>

Van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science*, 32(5), 590-607.

Verhaegh, K. J., MacNeil-Vroomen, J. L., Eslami, S., Geerlings, S. E., de Rooij, S. E., Buurman, B. M. (2014). Transitional care interventions prevent hospital readmissions for adults with chronic illnesses. *Health Affairs*, 33(9), 1531-1539.

Zhang, G. P., Xia, Y. (2013). Does quality still pay? A reexamination of the relationship between effective quality management and firm performance. *Production and Operations Management*, 22(1), 120-136.

Zollo, M., Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 13(3), 339-351.

Table 1: Patient and Process Characteristics (2013–2016)

	Treatment Group	Control Group	
	Kidney Transplants	Heart Transplants	Liver Transplants
Volume	571	62	103
Age	50.27 years	58.59 years	54.74 years
Length of Stay	7.84 days	24.58 days	16.25 days
30-day Readmissions	36.60%	32.25%	46.6%
30-day Mortality	0.7%	3.25%	1.9%
Gender	40% female	25% female	30% female

Table 2: Variables Used in the Study

Variable name	Mean	Std. dev.	Variable definition
<u>Dependent variables</u>			
<i>Readmit</i>	0.37	0.48	Patient readmitted back within 30-days (1 = yes, 0 = no)
<i>HCAHPS</i>	0.69	0.10	Monthly overall quality ratings for treatment and control groups
<u>Independent variables</u>			
<i>T3</i>	0.30	0.46	Binary variable to capture the post-implementation time period (May 2015 – April 2016, 0 = otherwise)
<i>T2</i>	0.25	0.43	Binary variable to capture the implementation time period (July 2014 – March 2015, 0 = otherwise)
<i>T1</i>	0.16	0.37	Binary variable to capture the pre-implementation time period (Jan 2014 – June 2014, 0 = otherwise)
<u>Patient Controls</u>			
<i>Mortality</i>	0.01	0.10	Binary variable to account for patient death within 30 days after transplant
<i>LOS</i>	8.87	4.82	Length of stay of the patient during hospitalization (in days)
<i>Age</i>	51.5	12.3	Age of the transplant patient
<i>Gender</i>	0.38	0.48	Gender of the Transplant Patient (0 = Male, 1 = Female)
<i>Kidney</i>	0.81	0.39	Binary variable to capture if the patient had a kidney transplant
<i>Heart</i>	0.07	0.25	Binary variable to capture if the patient had a heart transplant
<i>Donor Type</i>	0.37	0.49	Type of transplant donor (1 = Living, 0 = Cadaveric)
<i>White</i>	0.75	0.45	Binary variable capturing patient ethnicity (white); Other is control group
<i>African American</i>	0.20	0.40	Binary variable capturing patient ethnicity (African American); other is control group
<i>Graft Health</i>	0.09	0.28	Condition of the transplanted organ during discharge (1 = Delayed Function, 0 = Healthy)
<i>Pre-existing Cond</i>	0.25	0.75	Patient with pre-existing diabetes condition (1 = Yes, 0 = No)
<i>Year Dummies</i>			Three year dummies to reflect year of transplant (2013, 2014, 2015: 2016 – base group)
<i>Quarter Dummies</i>			Three quarter dummies to reflect the quarter in which transplant is done (Q1, Q2, Q3: Q4 – base quarter)
<i>Month Dummies</i>			Eleven month dummies to reflect the month of transplant for Overall Quality Rating Analysis
<u>Process Controls</u>			
<i>VBP</i>	0.81	0.39	Binary variable to capture the value based purchasing program (1 = after Q3 2013, 0 = otherwise)
<i>EMR</i>	0.56	0.49	Binary variable to capture the EMR implementation across hospital (1 = June – Aug 2014, 0 = otherwise)
<i>Transition</i>	0.18	0.38	Binary variable to capture the transition of outpatient clinic for kidney (1 = June – Aug 2015, 0 = otherwise)
<i>Integration</i>	0.06	0.23	Binary variable to capture outpatient EMR issues for all transplants (1 = August 2015, 0 = otherwise)
<i># of Transplants</i>			Number of transplants performed by the treatment and control group per month

Table 3: DID Results for SDW Implementation Process on Readmission Rates

	Post Implementation		During Implementation		Pre-Implementation	
	Model 1		Model 2		Model 3	
	Coeff	Odds Ratio	Coeff	Odds Ratio	Coeff	Odds Ratio
<i>T1</i>					-0.23(0.67)	0.78
<i>T2</i>			1.12 (0.68)*	3.07		
<i>T3</i>	-0.05 (0.62)	0.95				
<i>Kidney</i>	-0.01 (0.33)	0.99				
<i>T3 x Kidney</i>	-1.15(0.60)**	0.31				
<i>T2 x Kidney</i>			-0.07(0.52)	0.93		
<i>T1 x Kidney</i>						
<u>Patient Controls</u>						
<i>Mortality</i>	0.33(0.28)	0.33	-0.11(0.97)	0.90	-0.59(1.32)	0.55
<i>LOS</i>	0.06(0.02)***	1.05	0.05(0.02)**	1.05	0.06(0.03)**	1.06
<i>Age</i>	0.00(0.00)	1.00	0.06(0.08)	1.00	0.07(0.08)	1.00
<i>Gender</i>	0.42(0.17)***	1.52	0.55(0.20)***	1.74	0.43(0.25)**	1.53
<i>Donor Type</i>	-0.30(0.20)*	0.75	-0.21(0.22)	0.80	-0.13(0.28)	0.87
<i>Heart Transplant</i>	-0.72(0.38)**	0.47	-0.75(0.51)*	0.47	-1.11(0.83)*	0.32
<i>White</i>	-0.21(0.37)	0.80	0.21(0.47)	1.24	1.11(0.83)	3.04
<i>African American</i>	-0.13(0.40)	0.87	0.29(0.50)	1.34	1.03(0.85)	2.82
<i>Graft Health</i>	0.57 (0.30)*	1.76	0.48(0.40)	1.63	0.56(0.47)	1.76
<i>Pre-existing Condition</i>	-0.10(0.11)	0.90	-0.12(0.15)	0.88	0.01(0.15)	1.08
<u>Process Controls</u>						
<i>VBP⁷</i>	1.11 (0.51)**	3.05	0.97 (0.57)**	2.65		
<i>EMR⁸</i>	1.07 (0.47)**	2.93	NA		NA	
<i>Transition</i>	1.15 (0.66)**	3.17	NA		NA	
<i>Integration</i>	-0.71(0.51)		NA		NA	
<i>Year Dummies</i>	Included		Included			
<i>Quarter Dummies</i>	Included		Included		Included	
<i>Psnedo R²</i>	6.0%		5.2%		3.85%	
<i>Wald Chi2</i>	48.51***		29.61**		13.21**	
<i>obs.</i>	702		487		308	

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$, one-tailed tests, standard errors (adjusted for clustering) in parentheses.

⁷ VBP was passed in Oct 2013 - it was excluded in Phase 1 analyses that pre-dated this event

⁸ EMR, Move, and Transitions occurred after Phase 3 and hence were dropped in Phase 2 and Phase 1 analyses

Table 4: DID Results for SDW Implementation Process on HCAHPS Scores

	HCAHPS Overall Quality Scores		
	Post-Implementation Model 4	During Implementation Model 5	Pre- Implementation Model 6
	Coeff	Coeff	Coeff
<i>T1</i>			-0.07 (0.05)*
<i>T2</i>		-0.09 (0.03)**	
<i>T3</i>	-0.06 (0.04)*		
<i>Kidney</i>	-0.02 (0.07)	-0.05(0.07)	-0.13 (0.10)
<i>T3 x Kidney</i>	0.10(0.04)**		
<i>T2 x Kidney</i>		-0.08(0.04)**	
<i>T1 x Kidney</i>			0.03 (0.06)
<u><i>Patient Controls</i></u>			
<i># of Transplants</i>	0.00(0.00)	0.01(0.00)*	0.01(0.00)*
<u><i>Process Controls</i></u>			
<i>VBP</i>	0.02 (0.03)	0.02 (0.03)	0.04 (0.04)
<i>EMR</i>	-0.02 (0.02)	0.08 (0.02)**	0.11 (0.03)**
<i>Transition</i>	-0.08 (0.03)***	NA	NA
<i>Integration</i>	-0.03(0.03)	NA	NA
<i>Year Dummies</i>	Included	Included	Included
<i>Month Dummies</i>	Included	Included	Included
<i>R²</i>	17.18%	15.42%	24.40%
<i>Wald Chi2</i>	67.11**	60.15**	28.67**
<i>obs.</i>	80	54	36

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$, one-tailed tests, standard errors (adjusted for clustering) in parentheses

Figure 1: Discharge process for Apollo's kidney transplant patients prior to intervention

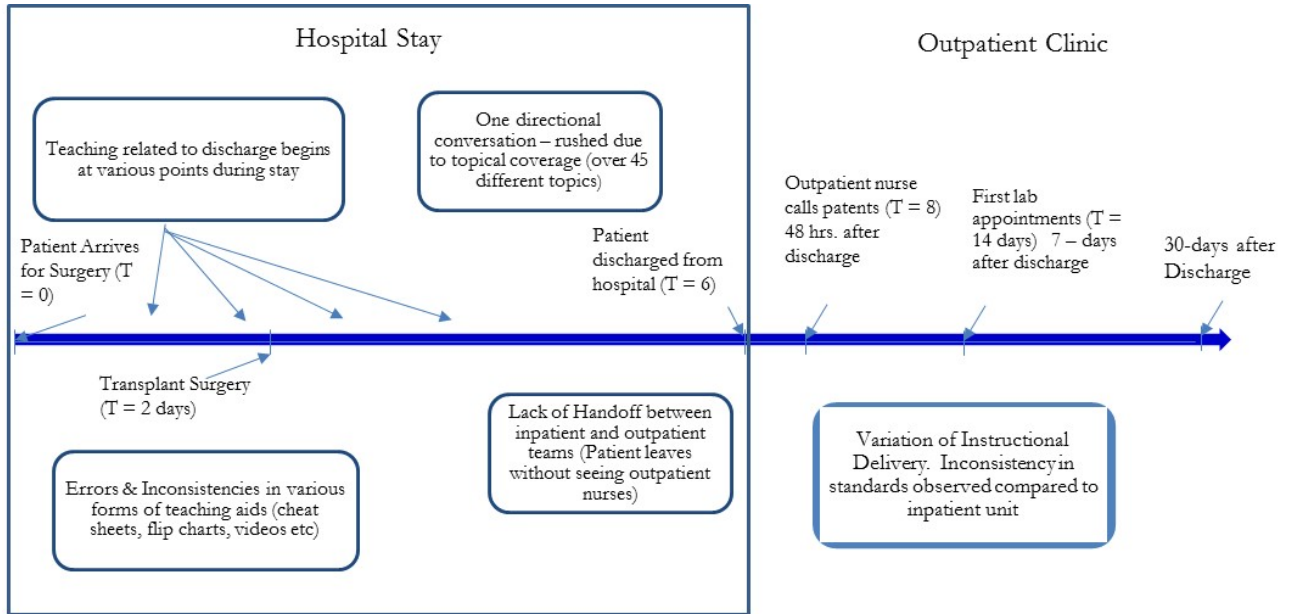


Figure 2: Research design for standardized work implementation.

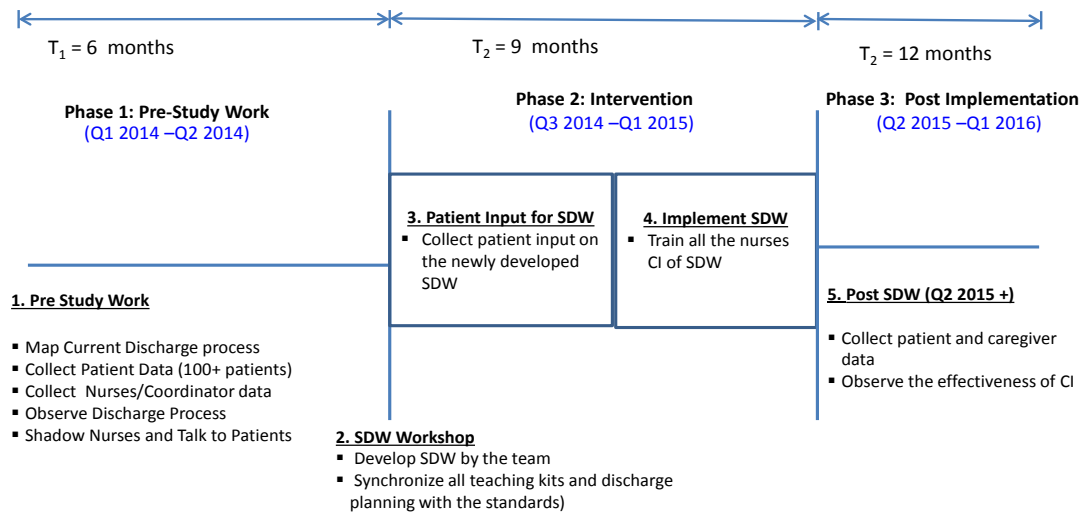


Figure 3: Discharge process for Apollo's kidney transplant patients after the intervention

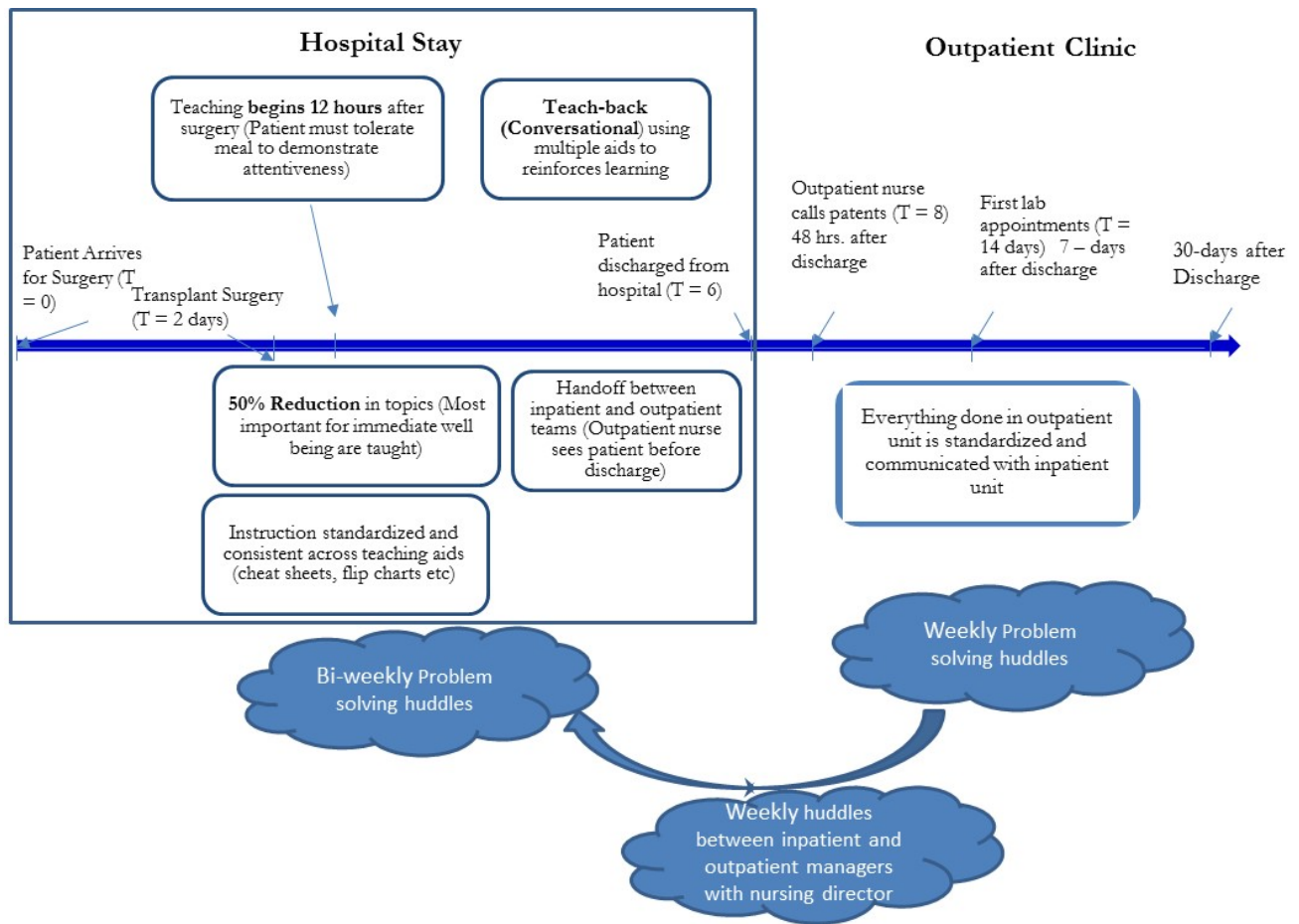


Figure 4: Conditional effects plot of the effect of intervention on occurrence of readmission.

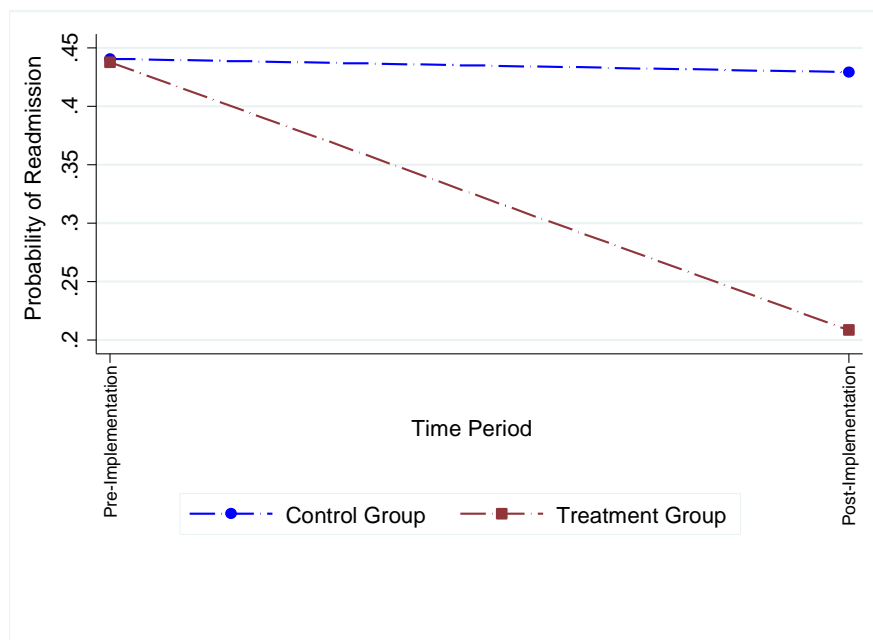


Figure 5: Conditional effects plot of the effect of Intervention on HCAHPS scores.

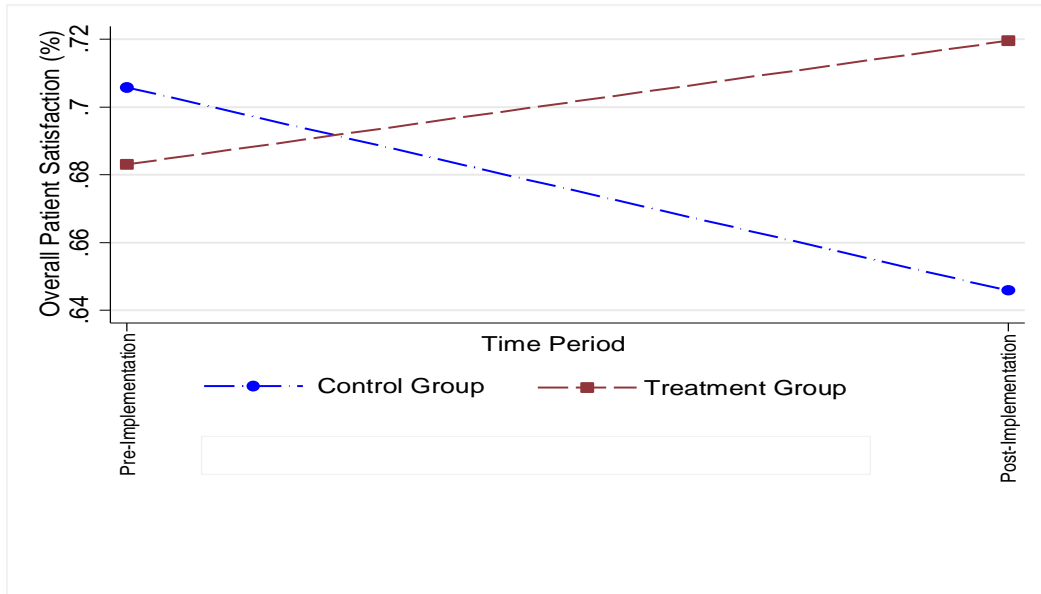
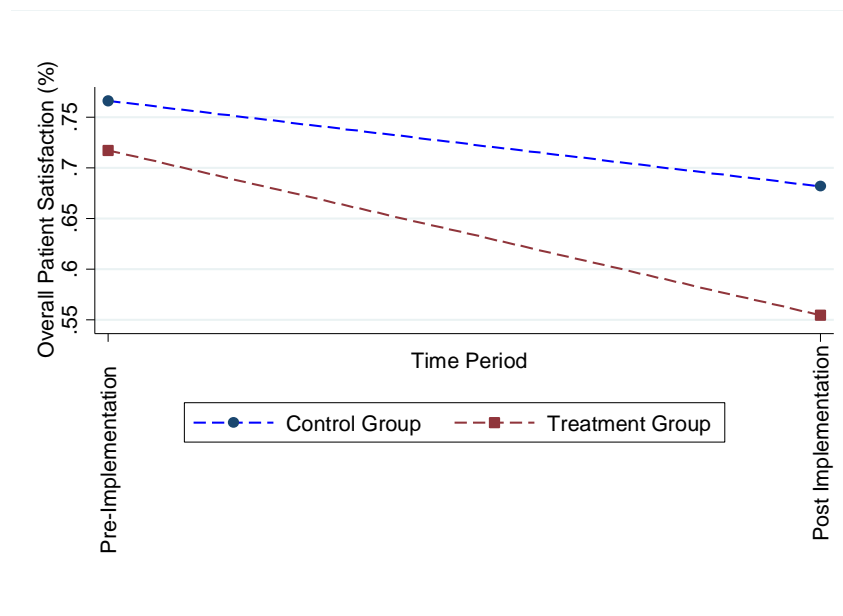


Figure 6: Conditional effects plot of the effect of intervention on HCAHPS scores.



Online Appendix for Design and Implementation of Standard Work on Care Delivery Performance

Appendix A1: Personnel Involved in the Design and Implementation of Standard Work

Overall	6 Caregiver Workshops	Patient Focus Groups
Chief Quality and Patient Safety Officer Medical Transplant Director Chief Surgeon Nursing Transplant Director Inpatient Nursing Manager Outpatient Nursing Manager 15 Inpatient Nurses 9 Outpatient Nurses Social Worker IT Specialists Patient Council Representative Patient Clinical Psychologist 15 Patients Clinical Statistician EMR Representative	15 Inpatient Nurses 9 Outpatient Nurses Social Worker IT Specialists Nursing Transplant Director Inpatient Nursing Manager Outpatient Nursing Manager	15 Patients (in 2 different focused groups) Patient Council Representative

Appendix A2: Type of Data Collected

Phase 1	Phase 2	Phase 3
<ul style="list-style-type: none"> Field observations (recorded interviews with patients) Survey data from 87 transplant patients before standard work Process maps Discharge instruction books and videos Patient quality of care data HCAHPS data Patient clinical data 	<ul style="list-style-type: none"> Workshop data Standard work process steps Caregivers interviews Patient group interviews Patient quality of care data HCAHPS data Patient clinical data Teach-back training minutes 	<ul style="list-style-type: none"> Field observations (recorded interviews with patients) Survey data from 45 transplant patients after standard work Weekly huddle reports Weekly nurse manager meeting reports Patient quality of care data HCAHPS data Patient clinical data

Online Appendix for Design and Implementation of Standard Work on Care Delivery Performance

Appendix A3: Discharge Instructions

Major Topics Pre-Standard Work	Major Topics Post-Standard Work
<ul style="list-style-type: none"> • Infection Prevention* • Symptoms of Rejection* • Labs* • Dental Care • Eye Care • Vaccinations* • Sports and Recreation Activities • Lifestyle changes • Going back to Work* • Treatment of Complications* • When to Call • Medications • Vital Signs* • Gardening • OTC Meds* • Follow-up Appointments* • Fluid Intake* • Activity Progressions* (e.g., Pregnancy, Sexual Activity, Special Activity) • Pet Care • Holiday Schedules for Labs • Wound Care* • Going out to Public Places • Lifting Instructions* • Emergency Contact (e.g., 911, primary care) * • Smoking and Drinking • Use of EMR/Patient Portal 	<p data-bbox="784 321 1317 380"><u>Part-I (During Hospital Stay) by Inpatient Nurses</u></p> <p data-bbox="784 405 1401 499">Starts when the follow: 24 hrs. post-transplant and no later than 32 hours, RASS Score = 0, companion present and patient tolerate first meal</p> <ul style="list-style-type: none"> • Infection Prevention* • Vital Signs and Symptoms* • Labs* • When to Call • Medications • Vital Signs* • Fluid Intake* • Emergency Contact (e.g., 911, primary care)* <p data-bbox="784 873 1373 905"><u>Part-II (After Discharge) by Outpatient Nurses</u></p> <p data-bbox="784 930 1377 1024">Starts within 48 hours after discharge and continues for about 3 months (face-to-face as well as over the phone)</p> <ul style="list-style-type: none"> • Medications • Follow-up Appointments • Activities (e.g. pregnancy, sexual, social, gardening) • Vaccinations • Eye and Dental Care • Lifestyle Change • Treatment of Complications • Post-op care (Wound Care)* • Emergency Contact (e.g., 911, primary care)* • OTC Meds • Going back to work, Public Places • Pet Care • Exercising and Sports Activities*

* Has multiple topics within these major topics (total of 45 different topics)

Example of One Standard Work

Fluid Intake: Pre-Standard Work: Although evidence-based standards suggest at least 2 liters of water every day, there were several variations in the quantity (e.g., 3 liters vs. lot of fluids), fluid type (e.g., coffee vs. water), standard units (ounces vs. liters), and visuals used.

Online Appendix for Design and Implementation of Standard Work on Care Delivery Performance

Fluid Intake: After Standard Work

Content: Established 3 liters as a standard for kidney and pancreas patients. There is a visual aid used – an Apollo jug that can fill 1.5 liters of water. Thus, the instruction is to drink twice this amount daily.

Sequence: Fluid intake is grouped with diet instructions and given as the first set of instructions.

Timing: Instruction starts 24 hours after surgery and no later than 32 hours.

Outcome: Nurse explains the result of noncompliance to the water intake increases creatine levels that can result in increased blood pressure, which can trigger readmission or adverse event.

Appendix A4: Weekly and Bi-Weekly Huddles

The inpatient (twice a week) and outpatient (once a week) huddles had the following formats with some minor variations. The huddles lasted for 10 minutes before the beginning of their shift.

- Who are getting discharged – and their aptitude on discharge instructions
- Staffing levels in the unit for that day
- Hand-off process between inpatient and outpatient unit (has the outpatient coordinator met the patient and discussed Part 2 of the instructional delivery)
- Improvements to teaching process
- Celebrations or other news

Appendix A5: Cost Accounting Analyses for Readmissions

We had access to individual cost data for every readmission that occurred during our study period (2013–2016). To calculate the average cost of readmissions, we divided the annual direct and indirect costs by the total number of readmissions that occurred during the year. Specifically, we used the following direct and indirect cost for each readmitted patients:

Direct Costs

- Room and Board Expenses
- Pharmacy
- Intensive Care and Post ICU
- Blood Storage
- Drugs
- Labs (includes ultrasound, immunology, urology, other therapeutics)
- Renal Dialysis and Hemodialysis
- Emergency Rooms
- Anesthesia
- Miscellaneous (e.g., CT scanner, cardiology, MRI)

Indirect costs

- Salaries and Benefits
- Drugs
- Equipment/Depreciation
- Building
- Purchased Services
- Medical Supplies
- Lab/Transfusion
- Other Supplies and Miscellaneous