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Implementing lean in knowledge work: Implications from a study of the hospital discharge planning process

Christopher M. McDermott[1] · **Ferdinand J. Venditti**[2]

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Abstract With its Lean production system, Toyota championed an innovative way to organize and manage processes to eliminate waste and improve effectiveness. While our understanding of Lean and its successes has grown, it has become increasingly clear that contextual variables impact the effectiveness of its implementation. In particular, there is a need to better understand those principles and practices of Lean that are most relevant for specific processes in knowledge work environments. In this paper, we use action research methods to explore the implementation of Lean techniques in the discharge planning process (DPP) of a large hospital. Our aim is two-fold: first, we conceptually frame and link our observations of Lean implementation in this knowledge worker setting with the overall framework of Lean management to provide researchers with further insight into important contextual elements/variables that need to be considered in this environment. Second, we articulate elements of Lean and its implementation that proved most useful and relevant in this environment. We identify critical elements of Lean that were central in this implementation and also identify key challenges of Lean implementation in this environment and link our findings to existing research on the topic.

Keywords Lean · Hospital · Action research · Empirical

✉ Christopher M. McDermott
mcderc@rpi.edu

[1] Lally School of Management, Rensselaer Polytechnic Institute, Troy, NY 12180, USA

[2] Albany Medical College, Albany, NY 12208, USA

1 Introduction

Lean production has its foundation in the Toyota Production System and is widely recognized by both academics and practitioners for its ability to improve organizational performance in manufacturing environments through the elimination of waste in operating systems. Narasimhan et al. (2006) describe its central focus as "the efficient use of resources and the minimization of waste." In this context, waste is defined (Ohno 1988) as including defective products, inventory, unnecessary motion, transportation, overprocessing, waiting, and overproduction. Womack and Jones (1996) articulate five key principles of Lean, the fundamental target of which is the elimination of waste in processes and the creation of smooth flows: specify value, identify the value stream, make the stream flow, create pull, and pursue perfection. The philosophies and principles behind Lean are supported by a large array of tools and techniques (e.g. Kaizen blitz, spaghetti diagrams, process mapping, value stream mapping, 5-S, Ohno circles) that help to systematically target waste through a better understanding of the actual transformation processes associated with creating value that are implemented in the organization.

Over the last several years, non-manufacturing organizations have begun to recognize the value and applicability of Lean methods for their operations, and hospitals are no exceptions (Kim et al. 2006; Manos et al. 2006). Clearly, a need exists: US hospitals are significantly more expensive than their peers (Johnson 2010). While not all their issues are due to inefficient processes, there is certainly plenty of room for improvement. According to anecdotal examples, small changes brought about through Lean have been shown to create significant improvements in how hospitals are run. Virginia Mason Medical Center in Seattle is perhaps the best-known case, successfully implementing Lean broadly across the

organization (Weber 2006). There are increasing numbers of publications that consider Lean in healthcare (e.g. Dickson et al. 2009; Lodge and Bamford 2008) and the discussion is moving from papers that simply describe successful cases, to studies where results are linked to extant academic research on Lean's successes and failures (e.g. LaGanga 2011; Stuenkel and Faulkner 2009). Such analysis is increasingly important, given that previous literature identified greater understanding of the role of context as key to the further development of Lean concepts and their successful implementation (Gitlow and Gitlow 2013; Browning and Heath 2009).

Unlike the application of Lean in manufacturing environments, there is significantly more we can learn regarding what Lean elements are appropriate or useful in a setting with a significant knowledge work component (Staats et al. 2011). Such knowledge work environments include hospitals (Waters and Beruvides 2012) and are defined by process ambiguity (Staats et al. 2011) and their reliance on the use of information, as opposed to physical manipulation, in creating value (Drucker 1999).

One critical area in the overall flow of patients in the hospital is the discharge planning process (DPP). This DPP includes those activities that take place when the in-patient has been deemed medically ready to go home, but has not yet physically left the building. It involves "activities that facilitate a patient's movement from one health care setting to another, or to his or her home. It is a multidisciplinary process involving physicians, nurses, social workers, and possibly other health professionals; its goal is to enhance continuity of care." (Mosby 2008).

While the discharge planning process has been examined in relation to such areas as teamwork effectiveness (Pethybridge 2004), coordination (Watts et al. 2006) and nursing (Watts and Gardner 2005), it is important to remember that this process is also linked to the movement of patients downstream from other areas of the hospital, such as the emergency department. This is a process that is critical to overall flow, yet it is unclear how Lean can be effectively applied in this environment. As such, this paper uses action research to examine the adoption of Lean in the knowledge worker environment of the DPP from both the theoretical and practitioner perspectives.

2 Literature

2.1 Lean

Lean production is widely recognized by both academics and practitioners for its ability to improve organizations' performance in manufacturing environments through the elimination of waste in their operating systems. Yet there is little consensus regarding how Lean should be defined or what it includes. Shah et al. (2008) posit that Lean is best viewed as occurring at three levels of abstraction: Philosophy, principles/goals, and tools/practices. *Philosophically*, Lean is described as a process aimed at eliminating waste in processes and creating smooth flows. The goal of Lean production is to eliminate waste (e.g. Hopp and Spearman 2004; Narasimhan et al. 2006) through a focus on value-added processes. In this context, waste is defined as consisting of defects, inventory, unnecessary motion, transportation, overprocessing, waiting, and overproduction (Ohno 1988). In terms of *principles* or *goals*, Womack and Jones (1996) articulate five key concepts of Lean: specify value, identify the value stream, make the stream flow, create pull, and pursue perfection. As we will discuss below, the fourth concept, create pull, is theoretically and practically central to our current focus here on the discharge planning process (DPP). Regardless of the lens through which it is viewed, Lean's benefits to manufacturing are well documented and its use has become widespread. When successfully applied, Lean practices have delivered significant benefits, the most common among these being improved productivity and quality, along with reductions in lead times, cycle time, and reduced manufacturing costs.

2.1.1 Lean and context: applicability in knowledge work

While our understanding of the successes of Lean has grown, one of the key areas needing further attention in this area has to do with how contextual variables impact the effectiveness of Lean (Browning and Heath 2009; Shah and Ward 2003; White et al. 1999). Lean is envisioned at a conceptual and theoretical level as focusing on the elimination of waste throughout the value stream. Yet in its implementation, Lean is often associated with its myriad tools and techniques. For the practitioner, it is unclear which tools are relevant for them, and why. Browning and Heath (2009), for example, highlight this shortcoming in their study of the use of Lean in the F-22 program. Because Lean is discussed at multiple levels, and includes such a large number of potential tools, the challenge becomes how to determine which elements are appropriate in a particular setting. Shah and Ward (2003) note that "there is not only a lack of empirical attention given to contextual factors' relationship with Lean practices, but there is also a paucity of theory to guide our expectations about the direction of possible effects." Piercy and Rich (2009) describe the use of Lean techniques in financial services firms, highlighting the benefit of process mapping in this contextual setting.

Knowledge work environments differ from Lean's historical birthplace in the auto manufacturing industry. In addition to the level of training of the workforce, there are other elements that differentiate knowledge workers (Carrillo and Gaimon 2004; Pisano 1994). Staats et al. (2011) studied the software industry, and identify contextual elements that undermine the core tenants of Lean—task uncertainty, process

invisibility, and architectural ambiguity. Taken together, these elements point to an environment where the flow of activities would be less pre-determined and actionable, and therefore waste harder to identify and eliminate. Yet there is clearly waste in these environments. As we discuss below, the present study aims to rigorously examine the efficacy of Lean principles and tools within the specific context of knowledge work, and highlight both knowledge worker and hospital-specific issues/challenges that emerge while implementing Lean in this setting.

2.2 Lean in hospitals

Lean is increasingly being implemented in service contexts because of its appealing focus on smooth flows and waste elimination. In services, waste often comes in the form of long waiting times for the customer, resulting in low satisfaction levels (Maleyeff 2006). There is also a long history of transferring managerial techniques from manufacturing to service environments (Levitt 1972). Lean techniques (Bowen and Youngdahl 1998; Staats et al. 2011) have made this transition as well, although some would like to see the phenomenon more widespread (Gitlow and Gitlow 2013). Maleyeff (2006) argues that Womack and Jones' (1996) five key principles of Lean discussed above do not necessarily map smoothly in service environments because of contextual differences in pull systems in services. Back office service operations often more closely resemble the manufacturing roots of Lean than do front office operations. The participation of the customer in front office operations can eliminate the buffers often used to make manufacturing operations smooth. Moreover, as Staats et al. (2011) point out, knowledge work does not mesh well with many of the core ideas of Lean. Thus, exploring the impact of contextual variables represents a natural progression in building a theory of Lean deployable across multiple contexts.

Over the last several years, innovative hospitals have begun to recognize the value and applicability of Lean methods to their operations (Bhat et al. 2014; Timmons et al. 2014; Kim et al. 2006; Manos et al. 2006). Indeed, the seven types of waste in Lean can be mapped into a hospital setting (Manos et al. 2006). Changes brought about through implementation of the Lean have been shown to create big improvements in how hospitals are run. Virginia Mason Medical Center in Seattle is perhaps the best-known case (Weber 2006). In addition, Martin et al. (2009) have documented the success of its application across multiple areas within the University of Pittsburgh Medical Center. Increasingly, recommendations have called for the more consistent inclusion of Lean in healthcare management (Riley et al. 2010). However, a closer look reveals that the vast majority of published works addressing Lean in the hospital environment focus on its application to *back-office* operations or processes, or to processes that are scripted or routinized (Persoon et al. 2006; Raab et al. 2006a, b; Bhat et al. 2014). A closer look at many of the published, practitioner-oriented works reveals that Lean implementation occurred in a situation that surrounds a specified test or procedure. In such contexts, the activities being addressed by Lean have little task uncertainty, process invisibility, and architectural ambiguity—all central elements of knowledge work (Staats et al. 2011).

Lean's deployment in hospital front-office operations, where the customer is present and the tasks are not nearly as straightforward, are far less common. Exceptions do exist (Shah et al. 2008), however; Lodge and Bamford (2008) describe the implementation of customer–driven Lean thinking in radiology services, achieving a reduction in lead times of nearly 30 %. Additionally, Stuenkel and Faulkner (2009) describe their success in implementing Lean principles throughout the 304-bed Floyd Medical Center community hospital, detailing their results and providing suggestions relating to culture and the importance of top management support. Similarly, Dickson et al. (2009) compare the implementation of Lean in the emergency departments of four different hospitals, and observed that leadership support and frontline employee engagement were central to success in this sample. But again, most of the above Lean hospital studies appear in practitioner-oriented journals. Taken together, they are useful insofar as they promote greater awareness of Lean in this environment, and also can act as a mechanism for encouraging other organizations to pursue Lean in a hospital setting. Yet as Hyer et al. (2009) have noted, "scholarly empirical work on Lean thinking in hospitals is quite limited." LaGanga (2011) demonstrated the effectiveness of Lean techniques in improving the effectiveness of appointment scheduling for an outpatient service. Shah et al. (2008) and LaGanga (2011) are noteworthy in that their work begins to move the discussion from simply describing successful cases, to linking them with extant academic research on Lean's successes and failures. As framed above, they build on existing theory to identify elements that associate context with outcome. We will next discuss one area that, while essential to hospital patient-flow management, has hitherto received scant attention with respect to Lean.

2.2.1 Lean in hospital discharge planning

Discharge planning in a hospital is a complex process with many different requirements depending on the medical condition and social circumstance of the individual patient. Prerequisites for the discharge planning process begin when the patient is admitted to the hospital. The process requires that many caregivers participate, with varied degrees of responsibility. Ownership of key parts of the process is typically shared. It does not occur in one place or over a predetermined time frame, unlike a typical medical procedure or routinized

process. The patient is (ideally) assessed by social services early in care to determine if he or she has special needs that must be addressed prior to discharge or post-discharge. Later, nursing, case management and the physicians begin a more detailed plan for the patient's discharge that considers remaining care requirements and outpatient needs anticipated at the date of discharge. Many items needed by an outpatient require several days to arrange, visiting nursing, home oxygen therapy or infusion therapy are such examples. In addition, special nursing needs may be identified that have to be addressed several days in advance of discharge such as increasing ambulation, instruction regarding special medications such as insulin, and dietary advancement. Ideally, the day before discharge, the patient is tentatively identified as ready to leave the following day. This identification should then trigger a final set of steps that prepare the patient to be discharged. This would include final nurse education, arranging transportation to the next place of care, review of final test results, administration of final medications, medication reconciliation, writing and completion of discharge orders, and the completion of necessary paperwork. All the while, communication with family members is crucial to successful discharge planning.

The benefits of discharging patients earlier in the day include not only the potential for reducing patient mortality rates (Gilligan and Walters 2008), but also of greatly increasing patient satisfaction (Kravet et al. 2007). Obviously, getting healthy patients out of the system can improve cost performance as well, as hospitals receive standard reimbursements for specific clinical conditions, regardless of whether a healthy patient stays an additional day or not.

The discharge planning process, which encompasses the last stages of the patient's stay in the hospital, has been examined in health care literature concerned with such areas as teamwork effectiveness (Pethybridge 2004), coordination (Watts and Gardner 2005) and nursing (Watts et al. 2006). While ideas presented in such studies point to the importance of the discharge planning process (DPP), and improvements in these areas that involve improving the DPP are clearly worthwhile goals, there exists to date no literature empirically examining this critical step through the lens of Lean. Due to its significant customer contact, the discharge planning process is clearly a front office, knowledge worker process, where there has been limited research to date (Tucker 2007; Shah et al. 2008). Moreover, the discharge planning process is clearly a knowledge worker environment. Staats et al. (2011) articulate three characteristics of knowledge work which are satisfied in this environment. Variation in individual patient needs and requirements at the time of discharge create significant *task uncertainty*. Patients vary in the extent to which they need specific elements of the process (e.g. ride home, physical therapy, counseling…), and the very fact that this is a front-office activity dictates that more uncertainty occurs. The *process is also invisible* in the way that one sees in a manufacturing environment. It is not at all clear to an observer (or participant) what the next stage in the process is. Finally, the discharge planning process involves significant levels of *architectural ambiguity*; in other words, there is significant low level exploration of tasks involved (March 1991). In addition to higher level process design that may occur in the organization, the individual worker often needs to actively problem solve to complete the tasks. The tasks being performed are not repetitive (or exploitive) in nature.

To our knowledge, this is the first research effort targeted at examining the DPP of hospitals from a Lean perspective. Our aim is two-fold: first, we conceptually frame and link our observations of Lean implementation in this knowledge worker setting with the overall framework of Lean management to provide researchers with further insight into important contextual elements/variables that need to be considered in this environment. Second, we articulate the elements of Lean and its implementation that proved most useful and relevant for hospitals pursuing Lean in the discharge planning process. Such research can provide a broader understanding of Lean not only in this context, but in other environments as well. In the next section we describe the method we used, action research, to achieve these goals.

3 Method

3.1 Action research

This research uses the action research methodology to improve our understanding of the implementation of Lean in the hospital discharge planning process. This methodology, while increasingly common in other fields of management (e.g. Luscher and Lewis 2008) is relatively new to the realm of operations management (Coughlan and Coughlan 2002; LaGanga 2011; Nair et al. 2011). It is particularly appropriate in clinical settings, where a problem or issue is experienced/identified and is subsequently addressed by intervention in that setting (Van de Ven 2007). As the name implies, action research entails the *active participation* of the researcher in a purposeful intervention within an existing organization (Whyte 1991; Reason and Bradbury 2008; Van de Ven 2007). The object of action research is to produce *both* (1) scientific knowledge/theory that furthers theoretical understanding of the phenomenon being studied, and (2) practical knowledge that is useful to people in their lives.(Reason and Bradbury 2008), or, the words of Frederiksen and Mathiassen (2008), to "develop practical solutions as well as new knowledge through close integration of theory and practice." (p 605). This theme of parallel goals is a hallmark of the technique; Brookes et al. (2007) state that "action research aims to contribute both to the practical concerns of people in an immediate problematic situation

and to the goals of social science by joint collaboration within a mutually acceptable ethical framework" (p 816).

Beginning with this dual purpose requires that both researchers and participants clearly articulate and agree upon the importance of both these results at the outset (Brookes et al. 2007; Luscher and Lewis 2008). Articulating these dual goals before the project formally commences creates expectations about outcomes and objectives up front that keep the project from degenerating into merely a consulting exercise. Figure 1 articulates the dual goals of this project from researcher and organization (i.e., hospital) perspectives.

Another defining characteristic of action research is the interplay between researchers and the subject organization. Unlike much case-oriented research, the researcher is not simply observing and documenting. Case studies often examine, retrospectively, successful endeavors or businesses. One strength of action research is that it captures the dynamic as it unfolds. In operations management, this is particularly relevant as the field is often focused on processes. The researcher in action research is typically leading some form of intervention in the organization. Implementing a change or improvement in some operational process. This necessitates complex and ongoing interactions between researcher and the subject organization, and benefits from the triangulation of both input and analysis from the researcher and organization participants. It is not the case of the researcher passively observing and documenting. Rather, the researcher is engrossed in the process, often leading the intervention, but at the same time responding to the demands and requirements of the situation as necessary. The achievement of goals (both academic and organizational) comes about through the combined effort and insight of the entire group.

The literature on action research varies in the extent to which the research process is predetermined (Luscher and Lewis 2008). Some studies are constructivist, exploring open ended questions and constructs (Chisholm and Elden 1993), while others follow and study the intervention of an established process or system as it is implemented in what may perhaps be a new or challenging environment. The present research follows this latter form. In our case, once the joint objectives were identified and agreed upon, the researcher led the organization team through the steps of the action research process articulated in Brookes et al. (2007).

From there, the team followed a process-focused path of implementation that one might expect to be associated with Lean activities in more familiar manufacturing-based environments. As is noted below however, there were also instances where flexibility was required to allow for the implementation to work in this environment. Not all activities (e.g. Value Stream Mapping) were performed in the textbook or traditional fashion. Rather, the researcher and participants worked together to follow the spirit of the technique, but changed it as was seen necessary to best insure it could successfully unfold in the organization. As the researchers lead the team through this process, they also document both the practitioner and theoretically focused findings. These elements are documented in notes and meeting minutes (Nair et al. 2011).

3.2 Research questions—action research entry and objectives

As noted above, this research began with the identification of two elements: sets of questions (for the researchers) and organizational goals (for the hospital). From a research perspective, the questions were as follows:

1) What core elements of Lean are applicable and useful in a knowledge worker, hospital environment? What tools and practices are most useful?
2) Given that Lean is very contextual in its implementation, what key challenges emerge when implementing Lean in this knowledge worker setting? How are these addressed?
3) What does the general process of Lean implementation look like in this setting?

The organization's primary goals were to:

1) Gain a better understanding of the discharge process in the hospital.
2) Discharge healthy patients earlier through the reduction of waste in the Discharge Process
3) Improve patient safety and quality of experience
4) Lay foundation for further Lean activities throughout organization

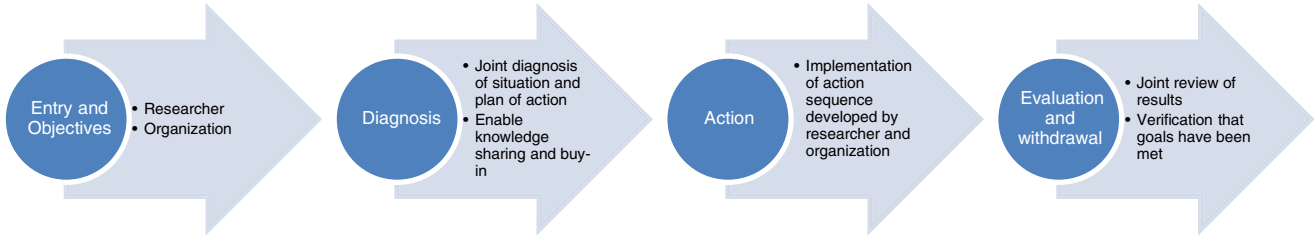

Fig. 1 Modified from Brookes et al. 2007

4 Setting

The Albany Medical Center (AMC) consists of a 651 bed tertiary teaching hospital (Albany Medical Center Hospital) in Albany New York, with a closely aligned medical school (Albany Medical College), and a large physician practice (Albany Med Faculty Physician Group). The hospital is a full service institution with a level I trauma service, surgical transplant services, a level 4 NICU, tertiary level neurosurgery, cardiac surgery, and orthopedic surgery, and the area's only Children's Hospital. The Faculty Practice is a 325-physician group employed by the medical school, which provides the vast majority of inpatient services at the Albany Medical Center Hospital. Most major specialties are represented in the physician group, which staffs all the tertiary level services. In addition, the group provides the teaching faculty for the medical school.

Through its entities described above, Albany Medical Center provides health care services to a large geographic area and population: primary and secondary level services are offered to a population of approximately 1 million people within 30 miles of the facility, while its tertiary services cover over 2.5 million people up to 120 miles from the institution.

Prior to this initiative there have been many attempts to improve the patient discharge process at AMC as a means of improving efficiency and bed availability. The impetus for prior process improvement projects came from either Emergency Department overcrowding, high inpatient census, or both. As volume continued to grow over time, the institution ultimately added capacity, relieving the "pressure" on the discharge process. This pattern was repeated several times as eventually, the congestion problem would reoccur, and focus would return to the discharge process as a means of dealing with the problem.

Previous attempts to improve DPP at AMC typically were unilateral in their approach and did not solicit participation from all stakeholders. In particular, physician participation was hard to achieve. Action items generated by prior efforts typically centered on asking discharging physicians to write the discharge order earlier. This approach typically failed. In 2009, the institution reached its physical capacity. Specifically, there were no more beds that could be opened to accommodate increasing volumes until a new patient care tower was built. The plans called for that tower to open in 2013. As a consequence, patient flow through the hospital, including discharge, became a critical issue.

5 Lean implementation and process

The project to improve the discharge process began with a daylong opening seminar on Lean for the entire team. The members of the team were selected based on their roles in the discharge. The team included RNs, nurse managers, hospitalists/physicians, medical residents, patient services representatives, as well as senior management representatives from quality management, clinical affairs, information services, and materials management. The opening seminar served to educate members of the team about Lean, and included the development of the project's charter. All members of the team were given a short text on Lean and asked to read it prior to the seminar, which was designed to follow the overall structure discussed in the Lean literature review above: philosophy, principles/goals, and tools/practices. While the team was exposed to a breadth of Lean principles and tools, there was deliberately no preconceived notion as to which elements, philosophies or tools would be most appropriate in this setting. To the author's knowledge, nothing to date had been published on the application of Lean in this setting. As such, one of the goals of the research was to determine which elements of Lean would be most useful/appealing in this environment.

Once the seminar was complete, the team discussed what we thought would be the most appropriate next course of action. After significant discussion, it was agreed that the team first needed to understand what the discharge process looked like. As such, the agreed upon next step was for the team to develop a process map of the discharge process, as the participants *believed* it to exist. To do this, the team also needed to create a project charter and to define the parameters of the project. It was agreed that the process to be evaluated would be defined beginning with the identification of the patient ready for discharge and continue through the completion of a room's preparation for the next patient.

After the seminar, the remainder of the project was undertaken in weekly meetings. While literature on Lean suggests that an intensive "blitz" might be appropriate, it was determined early on that the constraints of staffing the hospital and caring for patients made that a non-tenable option. These meetings proved to be effective, and frequently included "homework" for various members of the team. The creation of the (conceptual) process map proved to be a significant endeavor. This observation is also consistent with our earlier discussion of process invisibility in knowledge work environments. The process was largely unknown, and many involved didn't even know there was a process associated with the disparate activities. As discussed below, this map became the straw man for our subsequent efforts. Figure 2 shows this map in detail to provide a better understanding of the process and what in entails. It begins with the identification of the patient the day before discharge, and ends with the room cleaned and ready for the next patient. The tasks include many activities and hand-offs involving physicians, nurses, maintenance, and administrative staff, as well as outside groups, such as transportation. Because of the complexity and lack of visibility of the process, it was not surprising that a diverse group

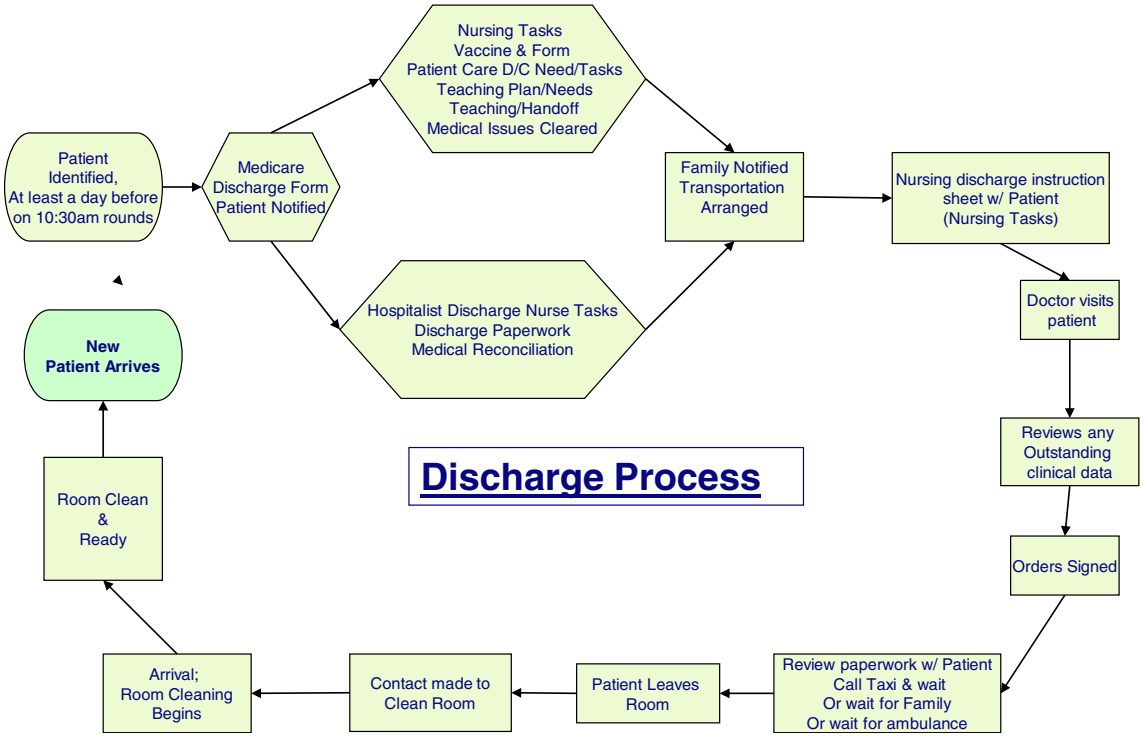

Fig. 2 Process map—hospital discharge planning

was needed to accurately create the map. The patient is present for many but not all of the activities.

Once the conceptual process-mapping task was completed, the team agreed that the next step would be to "walk" through the process (a value stream map of where the work is performed, in Lean terminology). This involved multiple observations of the workflows in the Medical-Surgical (Med-Surg) units over several weeks to examine the accuracy of the steps previously detailed in the team-generated process map, as well as to identify other critical steps that were overlooked or missed when discussed at the conceptual (process map) level, mapping perception to reality. This contrast between "what we think we're doing" and "what we're really doing" was central to the remainder of the project, as many critical observations were made during this step. While this stage of the activity in many ways shadowed the creation of a value stream map (VSM), it was decided that we would follow the spirit of the VSM (i.e., follow the process, study and identify waste), but not use the formal graphs or charts that are typically associated with the activity. As we discuss below, team members in this project were somewhat skeptical/cynical regarding activities they considered full of jargon or gimmicks.

Regardless of the creation of formal VSM maps, the process was directly observed and data were gathered. Once the observation data were shared and discussed, the team met repeatedly and identified numerous opportunities for improvement, discussed in the next section. The team broke into facilitated groups to work out details of improvement plans for each of the identified opportunities. The group used a rank-ordering approach to determine which opportunities offered the highest likelihood of success with the least cost/effort. Some opportunities were implemented as soon as they were identified if they seemed simple and easy.

The team ultimately completed its work creating a list of recommended changes to the discharge process. These findings were presented at multiple venues, including the President's Council of the Medical Center, the institutional leadership group. To conclude the project, the team met as a group to recap all they had accomplished as well as to lay out a plan for potential future Lean efforts across the organization.

6 Outcomes and discussion

The opportunities for improvement involved several different facets of discharge planning. Many issues related to communication and coordination of care. While all caregivers were dedicated to high quality care for their patients, communication between them was often poor. In discussing the results below, we map these topics to the Lean framework of philosophy, principles/goals, and tools/practices where possible.

The recommended changes were grouped into four categories (Table 1): Discharge Process creation, Standard work, Patient care waste, and Patient Services waste. While the table below by no means summarizes all the observations in these four categories, the intent here is to provide some sense of the scope of each one. While some of the recommended changes were implemented before the work of the

Table 1 Recommended changes

Creating the process	Patient care waste	Support services waste	Standard work
Conceptual process flow diagram	Physician interruptions	Coordinated wheelchair transport	8:30 standard MD rounding time
Value Stream map	Patient sitting area	Schedule of ambulance every day	Check-list driven rounds
Observation			
Process documentation	Daily pull of patient from ED	Bed cleaning vs lunch prioritization	Labeled requisition forms for imaging
Process ownership	Communication for return home	Case manager/physician script	Creation of 'best practices' from most effective rounding MD
			11AM nursing/physician rounds

group was completed because they were simple and easy to employ (i.e., standardized 11 AM nursing rounds with the attending physician for 30 min), most required some planning before implementation.

From a theoretical perspective, the existence of these four categories provides key insights into contextual elements surrounding Lean implementation in the DPP. Consequently, we discuss each category from both the theoretical (researcher) and organizational (i.e., hospital) perspective.

6.1 Creating a discharge process

Arguably the biggest issue apparent early on in this endeavor was there existed no clearly defined discharge "process." The task uncertainty and process invisibility (Shah and Ward 2007) of this knowledge worker environment resulted in most of the parties involved to think it was not a process at all. Improving the efficiency of discharging patients starts with having an actual process. The first group of actions was directed at understanding and documenting a process for discharge. The overall structure of the three activities we focused on in this step was half-jokingly referred to as: "what we think we're doing, what we're really doing, and what we want to be doing."

Many in the group had never thought of the DPP in this way and were unaware of the tasks their counterparts performed or their relative order. Several exclaimed, "I never thought this was a process." From an operations management perspective, this seems like an essential task, but most in the organization didn't know such a process existed, much less seen a map of what it was perceived to be. To be clear, this mapping was based on the perceived process, and as such was performed in conference/meeting rooms. Nonetheless, this conceptual process mapping proved to be both a fruitful and time-consuming activity, and when completed it served as an excellent mechanism for members of the team to understand how their tasks fit into the overall scheme of how work was (perceived to be) done.

In terms of Lean literature, this is consistent with Staats et al. (2011) discussion of the challenges of Lean in knowledge work—task uncertainty (i.e., now knowing what was going to happen next—lack of specificity) and process invisibility (i.e., not knowing all the pieces of the process and how they fit together). In turn, this also pointed to the critical importance of process mapping and value stream analysis in this environment. Through process and value stream mapping, individuals gained a better picture of the entire process and their role in it. Only after such realizations could they effectively focus on eliminating wasteful practices. This is also consistent with the findings of Piercy and Rich (2009) in the financial services industry.

Watching the actual process unfold (value stream mapping) using the lens of value versus waste provided the core mechanism for most of the subsequent improvements. Teams went to the job location and passively watched the activities associated with the process, documenting what was actually occurring, and using Lean thinking to re-configure elements of the process to be more efficient. The team also found it essential to have someone not intimately involved in the process be the one performing the value stream analysis. Waste in the process was not always evident to someone who was immersed in it every day. An outsider would ask questions that, while sometimes mundane, often led to deeper insights.

From the hospital's perspective, a number of changes became obvious once the actual discharge process was delineated and understood in this way. However, there were a number of reasons why applying the Lean tools of process mapping and VSM in this environment presented challenges for the organization. The DPP is not a visible process (Staats et al. 2011) and as such it was often difficult for the actors in the process to follow or improve upon it. Similarly, because of the dispersed nature of the activities in the process, it often seemed as if it was not "owned" by anyone. Rather, individuals performed their tasks independently. Assigning communication tasks to the nursing staff and giving them a "script" to work from, having a discharge time for facility discharges, and centralizing the task of arranging transportation for discharges, all created a process where there was none previously. Individual actors in each part of the activity (e.g., rounding physicians, nurses, patient services…) knew how to perform their own tasks but often had little sense of how these fit into the overall scheme of things. It is easiest to coordinate all the

activities associated with patient discharge when everyone who comes in contact with the patient is in agreement on the process to be followed.

6.2 Identifying waste through observation

Once the process itself was identified and described both conceptually through direct observation and measurement of activities, we identified and prioritized the key areas of waste observed. We have divided these into two categories: patient care and support function waste. In the course of prioritizing, we found it necessary to table longer-term projects so the team could focus on those activities that were high impact, low cost, and applicable within a short timeframe. While this was not a weeklong kaizen blitz, the goal was to maintain the spirit of a blitz and keep the objectives and activities to a manageable size. We highlight some of our key findings with respect to these two types of waste separately below.

6.2.1 Patient care

Direct observation of the discharge process revealed an opportunity to improve the efficiency of patient care in many ways. One of the most pointed observations related to the work of the attending physician. Direct observation clearly indicated that there was a need to create a circumstance where physicians' work was better prioritized and interruptions were minimized. Additionally, since frequent interruptions can affect the quality and safety of care provided (Westbrook et al. 2009), minimizing interruptions can have ancillary benefits. Many of the recommended changes created "rules of engagement" between the physicians and the nurses. The predictability created by standard rounding times and other changes that standardized work allowed for minimal interruption without creating gaps in communication among the staff. In part, these efficiency improvements are tied to a standardization of physician availability on the nursing units. But other improvements stem from the observation of physicians' behavior while rounding. Observed differences in the rounding time of attending physicians revealed best practices stemming from strict interruption rules. The team worked with these physicians to document their practices and behaviors, creating work standards that could be shared across the organization to make these practices more uniform.

6.2.2 Support function waste

While much was gained by observing activities performed by those focused on direct patient care, we also identified significant waste in supporting functions. Having a 10 AM discharge time for facility (e.g. nursing home) discharges and arranging for one ambulance to be at the hospital each day at that time was an easy transition in workflow for the hospital staff and added predictability to the discharge. The facilities accepting these patients prefer early transfers so they have more time to get the patient situated in their new environment. The predictability for the ambulance company helped them in planning resource allocation. Further, patients had more notice before their discharge, allowing for better planning by families. Thus, all stakeholders benefited from these changes in work-flow. Finally, there were recommended changes for the Patient Services Associates (PSA) workflow. These staff members are critical in bed turnaround times on each unit. Direct observation of their activities during the course of "walking" the discharge process led to the two recommended changes in their workflow and support structure. On one occasion the observation team watched an empty bed remain dirty for 90 minutes while Patient Services Associates were all occupied serving lunch to patients. Meanwhile, patients in the emergency department waited in hallways for empty beds that were available but needed sheets, etc. to be changed. This resulted in a recommendation that the PSAs restructure their work priorities if too much needs to be done simultaneously. So, if a bed needs to be cleaned during lunch, one of the PSAs will break away from delivering lunch to complete this task.

6.3 Creation of standard work

As soon as the discharge process was clearly articulated, the many improvements discussed in the sections above were quickly identified. But to make these changes work in a systematic way required the use of standard work. Improving communication and coordination also centered on standardizing actions and workflows to create predictability in the unit. By way of example, the unpredictable rounding times of the attending physicians resulted in nurses "pouncing on them" when they arrived on the unit. Fearing they would miss the physician, even the most mundane issues were immediately brought to their attention. This constant interruption prevented the physicians from concentrating on their tasks, and in some cases caused the physician to leave the unit to perform charting and other tasks. This avoidance behavior further exacerbated the problem. Predictability, and thus better communication, was introduced into the system by having a standard start time for physician rounds and placing a communication sheet in the front of the chart for non-urgent items. Mechanisms were also created to create a means of quickly (and visually) identifying those patients who were candidates for discharge on a given day. A daily 11 AM set of quick, check-list driven, multi-disciplinary rounds including both nurses and physicians was instituted to allow for the non-urgent communication that was still essential to high quality patient care.

Viewing this observation in light of the literature on Lean, in addition to the use of value stream mapping, above, there was also a need for increased use of standard work and visual controls. But however useful, the creation of work standards

can provoke challenges. Notably, physicians and nurses share a valid concern that standards might somehow supersede their ability to make decisions that are in the best interests of the patient. To avoid this, care was taken to solicit buy-in as these standards were being formulated.

7 Results and conclusion

The lessons learned from this process improvement project were then shared throughout the institution across multiple forums. Obviously, one of the organizational goals of this endeavor was to improve the efficiency of the discharge process, sending healthy patients home earlier in the day. Individual nursing units adopted these best practices to improve patient flow throughout the hospital. To examine effectiveness toward this goal, patient flow data was captured pre- and post-intervention from the hospital registration system. An analysis of these data was then performed.

A total of 9730 admissions to the hospital in two matched time intervals were analyzed. The August 1st through September 30th interval was used in 2009 and 2010 to eliminate any seasonal variation in the data. The project began in November 2009 and the results began to be reported in Mid-March 2010. The time of admission for all medical and surgical admissions during these matched periods were captured and grouped into hour intervals, i.e., admission at 6:30AM would be in the 6-7AM interval. These groups were than compared using a two-tailed t-test for statistical significance.

There were 4772 admissions in this time period in 2009 and 4958 during the same time period in 2010. On average, in 2009 patients were admitted to their nursing units at 2:41 PM. In 2010, the average time was 2:24 PM. This represents a reduction in admission time on average of 17 minutes (Fig. 3), a statistically significant ($p<0.02$) difference. Placed in the context of patient flow, this change means that on average 3 additional admitted patients daily were in their units before 3PM. This is a clinically significant shift in patient flow, given the greater availability of staff and services in the hospital during the day shift. Therefore, over 1000 patients annually were admitted to their units earlier gaining the advantage of a more clinically meaningful first day in the hospital. Earlier diagnostic and therapeutic interventions have the potential to improve quality as well as reduce length of stay.

Moreover, it is important to note that the data include all possible admissions during the study period. This would also include days where the bed was ready but there was no need upstream (i.e., there were no patients waiting in the ED for admission). As such it would tend to mask some benefits—some days the bed was ready but there were no patients waiting.

The line graph shows a three-period, trailing average for admissions, and more clearly illustrates the difference between 2009 and 2010. The leftward shift of admission times in 2010 equals on average admission 20 minutes earlier in the day (Fig. 3).

From an organizational perspective the project was a success. Team members involved in the project presented papers on their successes internally. Many of the lessons learned were transferred throughout the organization, and further efforts to implement Lean in the hospital have been undertaken since (e.g. emergency care).

From a theoretical/research perspective, many insights were gained as well. Mapping the outcomes and activities of this project onto our earlier discussion of Lean literature provided some interesting findings. First, a clear identification with the benefits of process and value stream mapping emerged. As noted, in most instances physicians and nurses did not even view their eclectic set of activities as a process before this endeavor. Consistent with Staats et al. (2011), there

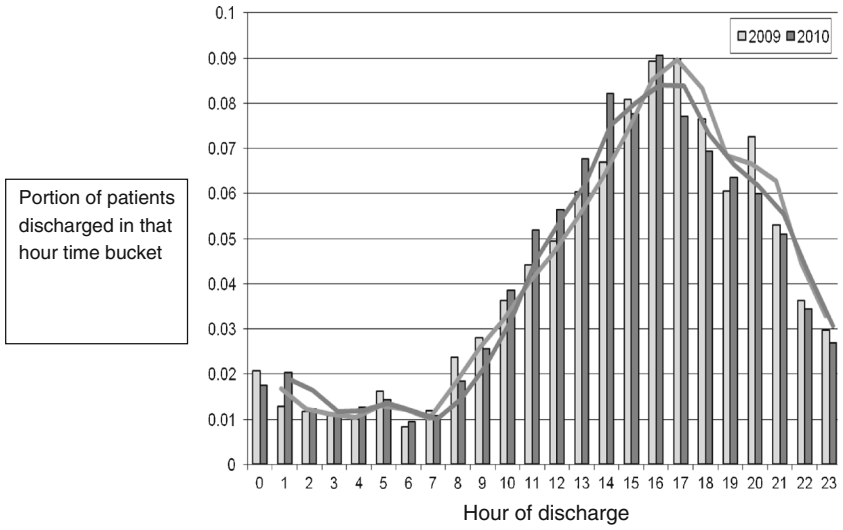

Fig. 3 Hour of discharge: 2009 v 2010

were challenges to implement Lean in this knowledge worker environment relating to task uncertainty and process invisibility. In this front-office discharge planning process in the hospital, mapping the process was central to the effort. Because the process was not visible (as it is in most manufacturing environments) this became a critical first step, and one that allowed the different types of waste in the system to be identified and eliminated. Without this step, prior efforts to improve the DPP at Albany Medical Center were unsuccessful.

However, whereas Staats et al. (2011) observed teams and their use of a variety of tools in Lean implementation, our analysis points specifically to the power of two specific tools, Process and Value Stream Mapping, in enabling a greater understanding of the process in this knowledge worker environment. Through Process and Value Stream Mapping (VSM) AMC created a commonly understood canvas where the diverse team could improve upon their processes, eliminate waste, and work toward pull systems. Only after these activities were completed, could the group move forward with observations that were key to enabling further change and coordination in patient care and support services. While the process is conceptually straightforward, there was tremendous power in creating a visible, conceptual map and structure whereby the team could then spend time simply watching and documenting the process as it unfolded. While traditional Lean implementation would involve the creation of formal VSM diagrams, it was interesting to note that the team was clear that they wanted to follow the spirit of VSM in this situation, but without creating the complex-looking diagrams. For them, the creation of the process map was considered powerful enough that they felt they could effectively analyze the DPP and identify waste without getting involved with additional jargon and gimmicks that they found distasteful. Thus the spirit of the VSM was executed, but the maps were not formally created. Within the diffuse processes associated with a hospital's front–office environment, the creation of a process map seems to be a critical principle and tool set. Future research might examine this premise in this and similar hospital settings.

Concerning the utility of other specific tools, the discipline to create standard work was also critical for achieving consistency in outcomes across shifts and units. While many tools were discussed, spaghetti diagrams and visual systems were notably valuable. Of all the tools presented in the overview, these seemed to be the most useful to the team as they began their work, and proved essential to achieving the organization's goals.

The use of pull systems is a central element of Lean theory and practice (Womack and Jones 1996). In a hospital context, pull is created when a patient is actively moved on to the next stage in their care path by downstream activities. Ultimately, this patient–centered pull system culminates with the patient leaving the hospital. The work performed by the team in this instance created a process bypassing the "traditional" bed assignment (push) process and instead enabled the direct "pull" of one additional patient a day from the ED when the room was ready. From a theoretical perspective, targeted Lean efforts to create pull (Womack and Jones 1996) can be led by activities surrounding the discharge of patients. As such, the present study's targeted focus on the discharge planning process seems central. The DPP is the last step in the patient's hospital stay, and it would follow that the creation of pull systems in a hospital setting might center on (or begin with) efforts in this area.

7.1 Lean implementation in a knowledge work, hospital context

7.1.1 Non-traditional format

From the perspective of the implementation itself, it is important to also note that this project was successful using a non-traditional format: because of patient/manpower constraints (e.g. physicians and nurses were not able to take a week off from their normal tasks to focus solely on the project), we eschewed the traditional "kaizen blitz" the literature suggests. This is interesting in that it might suggest that additional forms for implementation are currently being overlooked. The flexibility offered by these might be particularly appealing to hospitals and other organizations facing constraints that make the blitz format difficult. Future research might explore this further.

7.1.2 Lean and jargon

The project also encountered challenges, and one of the goals of the research project was to identify and articulate these. The term "Lean" carries baggage, especially in a knowledge worker environment where cost-cutting or efficiency efforts can be viewed as coming at the expense of patient care and/or safety. Getting institutions to buy into the idea that a process such as this could improve effectiveness without negatively affecting care provider autonomy or patient outcomes requires significant effort, yet is essential to success. One way we found of framing this was to state that, skillfully implemented, Lean would allow care providers to spend more of their day focusing on the things of greatest significance for the patient, and less of their time on those that made them pull their hair out in frustration. Also, while Lean can motivate employees (Coughlan and Coughlan 2002), one challenge to waste elimination in a hospital is care providers' concern that any changes not limit their autonomy or ability to deliver effective patient care. Involving care providers in the creation of any solutions seemed to help in this area, as they then owned the solutions. As noted above, there was also some cynicism regarding the perceived jargon and gimmicky nature of some of the Lean activities. Ultimately, the team was able to proceed using the spirit, if not the template, of tools such as VSM, and

this seemed adequate to yield positive results. Again, it is unclear the extent to which this is unique to this organization, hospitals in general, or for all knowledge work environments. This raises interesting questions for future research.

7.1.3 Lean and power distance relationships

The hospital setting offers a challenge to encouraging participation and engagement from all levels of the organizational hierarchy. By design, this project engaged with participants from a broad spectrum of job classifications across the hospital. While this study was successful, and the team seemed to effectively gather input from all levels and job classifications, no such team is completely immune from issues relating to hierarchy. Additional insight can come from drawing upon literature on both power distance and routines. Power distance is the degree to which members of an institution agree that power should be concentrated at higher levels of the organization (Hofstede 1980; Hopp and Spearman 2004). Lower power distances motivate employees at all levels and encourage their participation (Nakata and Sivakumar 1996). Because the DPP is a dispersed and largely invisible process, engagement from all levels is critical to fully understanding and improving the process. Without engagement at all levels, it would be difficult to get an accurate picture of the process much less find areas for improvement. Because of this need for vertical consensus, it might follow that efforts to implement Lean in a hospital can be hindered or enhanced by issues relating to awareness of power distance in the organization. Research on this topic (e.g. Blader and Chen 2011) examines what influences the behavior of participants at different status levels with regard to accepting input from others. Similarly, the creation of routines in organizations is affected by the characteristics of individuals and by organizational context; one can easily see how this might impact Lean implementation in hospitals insofar as creating standard work is concerned. While these topics were not the focus of the present study, our observations pointed to the value of future research exploring these issues' impact on Lean implementation in hospitals.

7.2 Final thoughts

Our understanding of Lean and its successes has grown, and it has become increasingly clear that contextual variables impact the effectiveness of its implementation. Health care is recognized as an area where both waste and costs have risen at an alarming rate. While there are well documented successes of Lean in back-room hospital environments, it is unclear what principles and practices of Lean are most relevant for specific processes in knowledge work service environments that are typical of the more ambiguous and ill-defined front room operations. In this paper, we used action research methods to explore the implementation of Lean techniques in the discharge planning process of a large hospital. Our aim was to conceptually frame and link our observations of Lean implementation in setting with the overall framework of Lean management to provide insight into important contextual elements/variables that need to be considered in this environment, while also providing an example of the applicability of action research to study operations management issues. We also articulated those elements of Lean and its implementation that proved most useful and relevant in this environment. We identify key issues that emerged in the implementation of Lean during our study in hopes that further such discussions and analysis can aid in the success of future implementation in these and similar work settings.

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