
Lean management in hospitals: Evidence from Denmark

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Abstract: *This single-case study explores whether Lean management can improve efficiency in patient treatment at hospitals. Using a case study methodology, we investigate the implementation of Lean at Odense University Hospital (Denmark) and rely on both qualitative and quantitative data for our analysis.*

We find that efficiency in patient treatment increased, for example through reduction in waiting times, higher process cycle efficiency when patients were treated at the hospital, and shorter walking distances for staff. This was achieved through the use of various Lean tools, such as Kaizen tablets, elimination of non-value adding activities, and Gemba mapping. Success factors in the implementation of Lean were financial pressure from the government under increasing expectations from patients, openness of the hospital's top management toward practices from the private sector, thorough employee involvement, provision of the necessary funding for the change toward Lean, and a better definition of what the business model of our case organization is.

This study illustrates a successful implementation of Lean in a public hospital. Thereby, it contributes that practices from the private sector can be successfully transferred if they are adapted to the quite different business models of organizations in the public sector.

Keywords: *Business model; lean management; new public management; lean implementation; public sector organizations; Kaizen.*

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Introduction

Healthcare organizations are constantly battling conflicting priorities. On the one hand, they focus on high quality patient care, preventing infections, maintaining hospital security, and ensuring patient safety. On the other hand, they need to use their resources economically (Pedersen & Huniche, 2011b). Two of the most important issues that healthcare organizations around the world face today are financial challenges (hospital productivity) and patient satisfaction. The solutions to these two challenges seem to be mutually exclusive (Berger et al., 1991; Graban, 2011; Källemark et al., 2004; Meliones, 2000; Womack & Jones, 2010): Hospitals face severe financial challenges since the healthcare costs are rising with aging populations (AHIP, 2014). This development pressures healthcare organizations to achieve the same level of quality of care, but with fewer resources (Meliones, 2000). The second main challenge for hospitals is patient satisfaction, which is commonly measured by reduced lengths of stays and prevention of readmission (Naidu, 2009).

One way to handle these two conflicting priorities is the management philosophy of *Lean*. Lean helps increase value for patients by reducing wasteful activities through process optimization. Eventually, streamlined and simple processes will lead to less mistakes and higher quality, a better use of resources, and hence improved financial performance (Pedersen & Huniche, 2011a; Womack & Jones, 2010). Taking a customer perspective, Lean determines the value of any given process by distinguishing *value-adding* activities from *non-value-adding* activities, i.e., *waste* (Baines et al., 2006; De Souza, 2009). Lean became popular among car manufacturing organizations in the 1980s and popularized by the book “*The machine that Changed the World*” (Hines et al., 2004; Holweg, 2007; Kollberg et al., 2006; Womack et al., 1999). Since then, Lean has spread across industries, such as services, healthcare, and the public sector in general (Abdi et al., 2006; Atkinson, 2004; De Souza, 2009; Piercy & Rich, 2009; Swank, 2003). Studies like the one from Kollberg et al. (2006) have reported very favorable results from the introduction of Lean in healthcare.

However, several authors have documented barriers to the successful implementation of Lean (e.g., Cusumano, 1994; Hazlett & Hill, 2000; Silvester et al., 2004; Womack et al., 1999). Barriers include lack of customer focus, too many processes, and setting too many targets. It appears that Lean is most successful if not only top management, but all employees are invested in the implementation process (Hogg, 1993; Sohal, 1996; Sohal & Egglestone, 1994). Furthermore, Radnor and Walley (2008) highlight that public sector organizations must not blindly copy approaches from the private sector but adjust the Lean philosophy to specific organizational goals. This paper aims to understand how Lean can contribute in healthcare. Therefore, we pose the research question “*How can Lean improve efficiency in patient treatment?*”

For this, we conduct a case study in one of the three largest Danish hospitals, Odense University Hospital (OUH). The Danish setting is well suited for a case study since the Danish hospitals face the typical challenges of reduced resources and increasing patient expectations (Pedersen & Huniche, 2011b). The Danish population upholds the Scandinavian welfare model and expects the most advanced treatments for everyone (Green-Pedersen, 2002). Hence, Danish patients have very little tolerance for economic arguments when it comes to their medical care. Opposed to this, its aging population has to cope with fewer resources (Springborg & Krogh, 2011). The Danish government understands that these ends can only meet if hospitals are streamlined. OUH has increased its effort within new public management (NPM) during the last 8 years through the use of Lean (Hood & Jackson, 1991). We study how the Lean initiatives conducted at OUH have added value to patient treatments (the *business model* of public healthcare). The main stakeholders of OUH are the regional governments who encouraged the implementation of Lean. Since the initiation of Lean in 2006, the financial performance of OUH has been improving steadily. We will focus on the initiatives that have led to this favorable development, i.e., value-streams, Gemba mapping, and Kaizen tablets. Based on these findings, we suggest five success factors of Lean in OUH: (1) financial pressure from the government under increasing expectations from patients, (2) openness of the hospital's top management toward practices from the private sector, (3) thorough employee involvement, (4) provision of the necessary funding for the change toward Lean, and (5) a clearer definition of what the business model of OUH is.

Section 2 provides conceptual backgrounds on Lean. Section 3 explains the methodology of our study. We present our findings on Lean in OUH in the section 4. Section 5 discusses implications for hospitals, our study's limitations, and future research opportunities.

1. Conceptual background

1.1 The history of Lean Management

By writing the book "*The Machine that Changed the World*" in 1990, Womack, Jones and Roos (1999) wanted to wake up mass production, from what they called, a slumber. Their aim was to present a better way of organizing and managing customer relations, supply chains, R&D, production and operations. The main point was to "*do more with less*". Eventually these concepts would evolve and later be labeled as Lean production. With 400.000 copies sold, the response to "*The Machine That Changed the World*" was overwhelming, and the ideas of Lean production quickly started to spread (Womack & Jones, 2003).

Womack et al.'s book was the beginning of modern Lean thinking in production. Many of the Lean principles have its origin from the Toyota Production System (TPS) which goes back to 1959, where the first high-volume car plant was opened. Toyota had beforehand sent delegations to American and German manufactures to achieve knowledge about mass production. After

analyzing the western approach to mass production, Toyota found that this approach had two logical flaws. First, they found that mass production led to high inventories, which had a negative effect on the cost of capital and production defects. Secondly, the western approach to mass production did not include the ability to meet different customer preferences (Holweg, 2007). Toyota was of the opinion that the root of this problem was that Western manufacturers—especially General Motors—relied heavily on the use of standard components, which reduced changeover costs, and enabled economies of scale advantages.

The initial focus of TPS was waste reduction. But gradually, the system evolved, which led to inclusion of parts of the system used by General Motors; most importantly combining the advantages of economies of scale production with small lot production. The system used by Toyota has been defined in various ways. Holweg (2007) describes TPS as “*dynamic learning capability*”, because it combines practices from several production approaches.

The TPS was documented for the first time in 1965, when Toyota diffused it successfully implemented Kanban system to its suppliers. Yet, the system was not given much attention before the first oil crisis changed the focus on manufacturing (Holweg, 2007). Toyota continued to improve their production system, and the system evolved through “*dynamic learning capability*” which led to its concepts being collected and used by Womack et al. in the writing of the previously mentioned book “*The Machine that Changed the World*” in 1990.

1.2 New Public Management: Lean in the public sector

Radnor & Walley (2008) argue that Lean is a method of making public institutions more customer focused through the efficient use of resources. Applying Lean in the public sector is part of New Public Management (NPM) that makes the public sector more market oriented. A 2008 poll showed that approximately 50 percent of state organizations in Denmark were working with Lean. In contrast, the corresponding amount for 2006 was only 15 percent (DIOS, 2008). For instance, the Danish Ministry of Finance suggests that the public sector should focus on transparency of results, as well as best practices, and management tools from private organizations (Finansministeriet, 2005).

Yet, several authors are concerned about blindly copying the manufacturing-based approach of Lean in the public sector. For instance, the success rates of Lean are still widely debated (Pedersen & Huniche, 2011b) and range from 10% (Bhasin, 2008) to 30% (Bourne et al., 2002). Reasons for these high failure rates are a lack of experience in implementation, low commitment or resistance from employees, insufficient resources (e.g., training of staff), a gap between activities and the overall strategy, unclear customer focus, and too many procedures / targets (Pedersen & Huniche, 2011a; Young & McClean, 2008). In particular, employees in the public sector find that the fundamental Lean concepts *standard time* and *standard work* appear overly related to manufacturing. Also, public sector employees often find it hard to define customer value, which makes it

hard to gauge if the reduction of wasteful activities is effective (Radnor, 2010). In order to deal with these issues, management must demonstrate significant results from Lean and try to motivate staff (Pedersen & Huniche, 2011a; Radnor & Walley, 2008; Womack & Jones, 2010).

1.3 Lean in hospitals

The overall job of hospitals is to create value for its patients by providing healthcare-related services. These services must be conducted in a way that is economically optimal in the long run, but at the same time they must ensure that the patient's expectations are met. Since the financial crisis, Danish hospitals have been under pressure from politicians, employees, and the public to reduce costs while still improving quality. Lean has been seen as a possible solution to these demands (VFL, 2008). According to the Lean Enterprise Institute (2014), Lean is also very relevant in non-manufacturing situations; *“Every core lean principle applies just as strongly, if not more so, beyond the shop floor. In fact, many of the most exciting breakthroughs are taking place in areas such as services, healthcare and government.”*

With the change towards NPM, an ongoing conflict between the traditional way of thinking and the NPM approach is taking place. Moving towards NPM should not only be seen as a new way for hospitals to do their tasks, but also a new way of perceiving their organization (Kollberg et al., 2006). It can be difficult for a public hospital to choose which of the Lean tools to implement. As one of the first steps, it is recommended that value streams are identified, and thereby, the waste that can be eliminated. Waste comprises *“...anything other than the minimum amount of equipment, effort, material, parts, space, and time, which are absolutely essential to add value to the product [or service]”* (Wickramasinghe et al., 2014). Activities that are not valuable for the customer are called non-value activities. An example could be the transport of a patient from one ward to another. Lean would attempt to eliminate all unnecessary transport of patients (Wickramasinghe et al., 2014). Then, appropriate Lean tools can be chosen for implementation (Hines et al., 2004). These include, for example, process mapping, Kaizen tablets, the 5S method, Kanban cards, and value stream mapping. To successfully implement these concepts, all employees need to be trained in Lean, and optimally work in teams (Hogg, 1993; Radnor & Walley, 2008). As a result, the business model of the organization will be clearly linked to the processes at lower levels (Lueg et al., 2014).

For Lean tools to fit the organization, Wickramasinghe et al. (2014) alert that healthcare is very different from the manufacturing industry, where Lean originated. For instance, many errors cannot be corrected in healthcare. Therefore, safety within healthcare is essential and needs to be of high priority. Overall, the authors argue that Lean can be seen as a kit with many optional tools, but first and foremost, it is a philosophy of efficiency and quality.

2. Methodology

We conducted a single organization case study in order to perform an in-depth description of our findings in a real-life context (Yin, 2014). The case study method is the most common method within the academic literature on Lean since it is often illustrative (Radnor & Walley, 2008). Pettigrew (1990) argues that cases should represent extreme polar type situations. We hence chose OUH as a very positive example of a successful Lean implementation. Lean is new to this industry in Denmark, which makes OUH a good setting to illustrate best practices. Also, Scandinavian organizations are generally quite open to grant researchers access for a field study (Dalby et al., 2014; Lueg et al., 2013; Malmlose et al., 2014). OUH is an early adopter of Lean and NPM, which allows us to draw on years of experience in this organization. This gives our case study a longitudinal character.

We gained access to OUH through a personal contact. We used several sources of data to build our conclusions. Primarily, we relied on internal information of department O. These data included, e.g., PowerPoint presentations on the implementation status of lean, written documentation of processes, operative statistics, as well as financial and strategic reports. Second, we considered publicly available reports issued by OUH that related to the implementation of Lean. These sources listed the reasons for Lean adoption, elaborated on key figures in Lean, explained the different implementation stages, documented observations on employees during the implementation process, and assessed the achievement of Lean targets. Third, we used direct observations during our visits at OUH to understand the setting surrounding the implementation. Fourth—and solely for corroborative and illustrative purposes—we conducted four semi-structured interviews with the medical director of the department (each lasted 15 to 40 minutes). Since he was the project lead on the Lean implementation, he could provide us with insightful narratives.

For the data evaluation, we tried to identify causal patterns in the written documentation. We constantly re-evaluated our research protocol while analyzing our data. This means that there was overlap between our data collection and data analysis, which secured constant development of the case. We found that the different data sources led to the same conclusions. Also, we presented a preliminary report to our key informant, who confirmed that we have given a fair representation of the events. As to the structure of our analysis, we have split our longitudinal study into sequences in the findings section. This helped us divide our complex case into sub-themes and periods (Bourgeois III & Eisenhardt, 1988). In our discussion section, we discuss our findings in relation to comparable studies (similar: Larsen et al., 2014; Lueg, Clemmensen, et al., 2013).

3. Findings

3.1. The case organization

BUSINESS MODEL: The department of orthopedic surgery at OUH (department O) is one of the largest departments of its kind in the Nordic countries in terms of outpatient visits and annual admissions. The department is responsible for orthopedic surgery in all of Southern Denmark, as well as the emergency room at OUH. Due to this large responsibility, OUH is expected to be a leader in contemporary medical treatments, and there is little room to reduce the quality of care. Its core competencies lie within the human musculoskeletal system. Main tasks include arm-, leg-, hip-, and back surgery. The department is divided into sections from basic to specialized treatments. The attending physician and the attending nurse are responsible for the overall functionality of the department, and each section has a manager. Department O's performance is measured by different criteria, which include their overall production value, as well as different quality requirements. Examples of these quality requirements include that hip patients have to be attended to within a day, and emergency room patients within 3 hours. The department works with different KPI's, such as patient throughput time, waiting time in the emergency room, occupancy rates, the number of patients seen etc. In the following, we focus on KPIs that measure patient throughput time and waiting time and which can be reduced by using Lean. OUH faced the problem of wanting to offer all-round medical treatments for all citizens. According to Johnson et al. (2008), such an ambition does not lead to viable value proposition. The hospital management realized that they could not overcome the future challenges by working harder or by continuing to utilize the same strategies that had worked before. Hence, the board decided that one department should start a pilot initiative to introduce Lean.

THE LEAN INITIATIVE: The Lean initiative at OUH was launched in the beginning of 2006, when the board announced that OUH would face challenges in the future. The three main challenges included an unfavorable patient/staff ratio, increasing patient expectations concerning the treatment period, and economic pressure from the regional government demanding a productivity increase between 2 and 4% each year. Such an increase could be done by reducing services, cutting costs, or by increasing efficiency through the reduction of waste (Womack & Jones, 2010). OUH intended to go for the last option. The initial idea for the Lean initiative came about when OUH treated a top manager of a large Danish manufacturing organization, which had substantial experience with Lean. During his visit, this manager insistently pointed out processes that he felt could be optimized by using Lean. He later contacted the board of OUH and made a case for Lean. After careful consideration, the board of OUH decided that departments could volunteer for a Lean pilot initiative. The initiative would be centrally funded (e.g., for training or consultants). Department O volunteered since it had already

been fostering a mindset similar to that of Lean for some time. As its medical director stated: “We had been working with different optimization tools for a long time – just without labeling it with a buzzword.”

These were, however, isolated tools and not the ultimate yardstick against which employees measured their efficiency. Also, they were not integrated into a coherent philosophy of healthcare. As an example, our key informant stated that the financial guidelines for hospitals were made by individuals who had studied business and accounting. He had been confronted with the question of whether the process of hip replacements could be streamlined in a way that a surgeon could replace 5 instead of 4 hips a day. While this question would make perfect sense in a manufacturing environment, our informant emphasized that a surgeon is mentally and physically exhausted after 4 hip replacements a day. Hence, a more efficient process would not eventually lead to a higher number of hip replacements. This is an example that the business-educated employees may see an opportunity to enhance efficiency without knowing the physical boundaries of the medical staff. In the following, we will discuss positive and negative implications of how Lean helped OUH to handle these challenges.

3.2. Lean initiatives at department O

INCREMENTAL IMPROVEMENT (KAIZEN): Kaizen tablets were one of the Lean tools scrutinized in our analysis. They visualize the work processes and gather ideas for improvement from the employees. Between early 2006 and late 2007, the Lean project team installed 10 whiteboards across the department where employees could give their input. Their suggestions were discussed in weekly meetings. Overall, 1,288 suggestions were made, and 672 were found feasible for implementation. This high acceptance rate indicates that employees and management took the initiative seriously and that it yielded some good results. Through this initiative, the employees felt that their opinion was appreciated.

Yet, there were also obstacles. Some of the employees (primarily physicians) were reluctant to change since they had a problem with the increased transparency of their work. In their opinion, transparency indicated a lack of trust by management toward the medical staff. When a doctor had consulted a patient, he was supposed to write care instructions to the nurses. Yet, many physicians refused to do so and only complied when management placed emphasis on this procedure. As our key informant reported: “Initially, there were problems. But as soon as the process was visualized towards the doctors, they became aware that not writing the instructions was not okay, and then they started doing it.”

This is just one example from OUH where management thought they had implemented a policy by giving orders, but it turned out that the enforcement had to be monitored. According to Charron et al. (2014), organizational change is often more difficult than it first appears. There are three fundamental aspects that can lead to resisting change: fear of the unknown, measurement systems, and contrasting beliefs. In the case of Lean, all three aspects led to resistance to change

at department O. Employees were critical toward the unknown system from the manufacturing industry, and they did not like to be measured. Last, the staff felt that the actions they take every day were correct and disagreements with management took long to be resolved (Charron et al., 2014).

O.U.H. stuck to the implementations they introduced based on the Kaizen tablets but discontinued the process of gathering more input from employees in late 2007. One of the reasons was that a level of efficiency was reached where the cost of collecting more input would have outweighed further improvements. As our key informant stated: “One of the things that we couldn’t maintain were the Kaizen tablets, as the long run benefits got outweighed by the recourses needed to maintain them.”

Also, employees wanted to have the feeling that they mastered this stage and that the management should acknowledge their achievements. But overall, our key informant regards the Lean initiative and the Kaizen tablets as a big success, because many improvements were sustained. He also reported that his colleague from a hospital in Northern Zealand had similar experiences on Lean from his department.

REDUCED PATIENT TRANSFERS: Process improvement is one of the most important features of Lean. Through waste reduction organizations can significantly reduce their costs at steady levels of quality. Even though department O had been working on process improvement, the Lean initiative put it on the top of the agenda. External consultants and staff jointly worked on this task (Lueg, 2009). They used value stream mapping to illustrate process cycle efficiency (PCE), i.e., the relative amount of time a patient was treated while in the hospital. For instance, a study on patients with certain fractures revealed that their total throughput time was 179 min., of which only 43 minutes were used on actual treatment (PCE=24.0%). By evaluating the process stream map, non-value added activities could be eliminated. Most of the waste related to transfers. As the general solution, O.U.H. started sending the physicians to the patients, instead of the other way around. Thereby, treatment time was reduced to 39 minutes, and total throughput time was reduced to 64 minutes (PCE almost tripled to 60.9%). The reduction of the throughput time was not only beneficiary for the patients, but also for department O: more patients could be treated, which generated more revenue for the hospital at a fixed level of resources. Reducing throughput time by implementing Lean tools can be observed in previous studies as well. For example, the Park Nicollet hospital in Minneapolis reduced the waiting times at the urgent care clinic from 122 to 52 minutes through Lean. Also, they have been able to increase the number of CT and MRI scans per day by 2 and 1, respectively, by optimizing their processes (Kim et al., 2006). Furthermore, a case study conducted in four American hospitals by Dickson et al. (2009) reported reduced waiting and throughput times during and after their Lean initiatives.

REDUCED WALKING DISTANCES FOR STAFF: Gemba mapping was another new tool expected to reduce the walking distances of staff in daily operations. Three nurses were provided with GPS devices that tracked their

movement. The tracking system differentiated between the complexity processes. For instance, nurses could indicate if they had to walk somewhere with sterile hands, which naturally suggested that their walks should be short. The results for a single day are visualized in Figure 1.

ID	Meters	Marathons per. year	Work days per. year	Waste in hours per. Day
Nurse 1	1218	9	16	01:58 Hr
Nurse 2	990	7	13	02:18 Hr
Nurse 3	809	6	11	00:53 Hr
= Total of 5 hour of non-value adding activities used				

Source: Lean in praksis Dep. O OUH

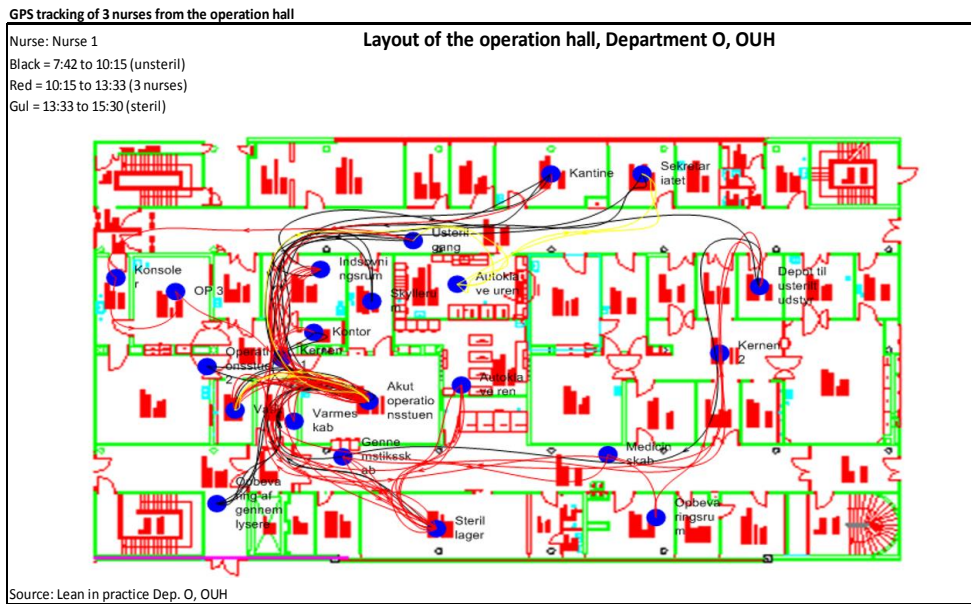


Figure 1. Gemba mapping

The insights from the GPS tracking were then used to identify waste movement, streamline processes, and re-organize the setup of the ward. A lot of time was spent gathering the necessary tools for the operations, which often meant walking a long distance. For a ward with 3 nurses, it amounted to 5 hours of walking per day, which is seen as non-value adding activities. This meant that some nurses spent approximately 16 days a year on unnecessary walks. To minimize the non-value adding process of walking, some depots and storages were moved closer to the ward. A similar technology had been used at the Virginia Mason Medical Center in Seattle, where staff had found ways to shorten the distances they had to walk with 34 miles and the distances supplies had to travel by 70 miles (Weber, 2006).

REDUCED WAITING TIMES: Waiting time in the emergency room can have economic consequences for the hospital as well as medical and physical

implications for the patients and personnel. Two global studies show that 26% of patients are unwilling to recommend their doctors due to long waiting times (PRNewswire, 2011). They also state that patients who are informed about their treatment process are more likely satisfied than patients who are not. Our key informant mentioned that OUH tried different strategies to reduce waiting times, such as remodeling the ward and increasing the number of staff. Yet, these measures were ineffective. He describes it as a paradoxical problem: “[...] it is actually the patients who do not need treatment that are unsatisfied. The patients who wait for 3 hours but are treated are rarely unsatisfied.”

Lean caused several improvements in terms of waiting time, e.g., rules on how long a patient may be kept waiting were introduced. Today, 75% of the patients in the emergency room have to be attended to within an hour. OUH optimized the waiting time by using value stream mapping, where consultants analyzed every part of the process. They found that a lot of the waiting time occurred because every patient had to be treated by a physician, when a nurse might have treated them as well. This led to the implementation of a policy where a physician only attended especially complex cases, while more standard cases were transferred to the nurses. Also, OUH revised the admission process, so patients could be diagnosed faster. The results of this initiative can be seen in Table 1. For instance, the number of patients who had to wait for more than 3 hours in the emergency room fell from 13% in 2009 to 9% in 2010.

Table 1 Waiting time in the emergency room at OUH

June 2009			
Time	Number	In percent	Accumulated
Under 15 min.	2228	56,40%	56,40%
Under 1 hour	514	13,00%	69,40%
Under 3 hours	698	17,70%	87%
Over 3 hours	512	13,00%	100%
Total	3952	100%	100%
Januar 2010			
Time	Number	In percent	Accumulated
Under 15 min.	2141	58,70%	58,70%
Under 1 hour	541	14,80%	73,50%
Under 3 hours	629	17,20%	90,80%
Over 3 hours	336	9,20%	100,00%
Total	3647	100%	100%
<i>Source: Lean in practice Dep. O OUH</i>			

4. Conclusions

4.1. How can Lean improve efficiency in patient treatment?

This study evaluates how Lean thinking can improve efficiency in patient treatment. We found that many different Lean tools could successfully optimize processes at OUH. These included inclusion of employees as well as eliminating waste through such initiatives as value stream mapping and Kaizen tablets. However, implementing lean also had its challenges. First of all, some of the employees were reluctant to the visualization of their work. Also, a few of the initiatives were time consuming to maintain, and at a certain point they stopped functioning the way they were initially supposed to. We will discuss the implications of the implemented dimensions in the following.

4.2. Implications for hospitals

Our study is a successful example of how Lean can be used in NPM. Thus, it carries several implications for hospitals. First, hospitals can reduce resistance and improve implementation results by employees through integrating them in the implementation process. Dickson et al. (2009) report from a hospital where this was not the case: despite Lean, the emergency room experienced an increase in length of stay and a decrease in patient ranking. Similarly, Waring and Bishop (2010) state that staff question their own legitimacy if Lean is implemented without their input. Without involvement, employees tend to see Lean simply as a cost cutting exercise. Therefore, Lean tools should be explained and visualized to staff members.

Second, the reduction of waiting times for patients has positive side effects on the health of the patients and the hospital staff. While our study does not specifically focus on these issues, Day (2013) reports that distressed patients in the emergency room experience measurable suffering from waiting, mental anguish, and lost productivity in their own work and leisure. Side effects for the hospital staff may include less stress, a more clarified working process, and less pressure from the patients (Healy & Tyrrell, 2011).

Third, hospitals can refine their business model through Lean. Decreasing resources force hospitals to prioritize some treatment over others, which is the practical emergence of the economic vs. best treatment conflict. Lean helps hospitals prioritize in a way that resources are used most efficiently by avoiding waste before cutting into the quality of treatments. Similar to our study, Johnson et al. (2008) claim that the success of an organization crucially depends on its ability to define its business model (i.e., prioritization). Lean can be a strong tool to balance ethics with business.

4.3. Limitations and future research

Our study is subject to several limitations. As to the methodology, we have only used one key informant for the interviews. Using documented evidence on Lean probably reduced the bias this might have led to. Future studies could, however, involve more key informants. Moreover, the literature on Lean has a tendency to report positive examples. Since our work takes place in the light of these existing writings, they may have biased our interpretation.

As to the concepts addressed by this study, Waring and Bishop (2010) question if the distinction of value-adding from non-value activities is as clear in healthcare as it is in manufacturing. Cause and effect are much less clear in life science compared to engineering (Wiener, 2004). In relation to this, Young and McClean (2008) alert that there is still no universally accepted definition for *value* in healthcare, e.g., as opposed to the clear measurably profit maximization goal of most businesses. Waring and Bishop (2010) add that the definition of value strongly depends on the stakeholder involved (patient, taxpayer etc.) and cannot be as easily attributed to a single stakeholder group as in private businesses (e.g., the owners). This debate is a very interesting subject for further research within the field.

Moreover, this study did not consider opportunity costs. So another interesting topic for further research could be to compare Lean with other management tools, such as Total Quality Management (TQM), that share similar features, e.g., waste reduction (Dale & Cooper, 1994). Researchers might find that these tools are relatively more helpful than Lean and should be implemented instead, using an opportunity cost perspective. Additionally, we analyze Lean from the hospital's point of view. Future research could study Lean from the patients' point of view. Finally, our study could be replicated on a larger scale.

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