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A Focus on Throughput: Lean Improvement of Nurse Scheduling in the Operating Theatre

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A Focus on Throughput: Lean Improvement of Nurse Scheduling in the Operating Theatre

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Abstract- The utilization of operating theatres and efficiency of nurse scheduling has an impact on patient outcomes, hospital finances and clinical effectiveness. To date, research has tended to focus on the output rather than on the process of nurse scheduling. We report on use of the Lean mapping tool, Makigami, in operating room (OR) nurse scheduling. This study was conducted at a large surgical department in the Netherlands. A multidisciplinary team of nine health-care professionals used Makigami, including five steps: (1) the current state of OR nurse scheduling, (2) setting the ideal state and the first target condition, (3) performing a fishbone analysis, (4) conducting actions and (5) mapping the revised process of OR nurse scheduling. The current OR nurse scheduling process showed 44 transfers, 42 documents and 64 types of waste, which collectively led to 35 errors in 7 days. The first target condition was to guarantee quality of care: the right employees, at the right time, in the right place without errors. The revised process, as a result of the action plans that emerged through the fishbone analysis, led to an outcome of two errors in 7 days with a reduction in waste of 41%. The use of Makigami led to an optimized OR nurse scheduling process: the right OR nurses, with the right qualifications, were scheduled for the right surgical procedures. A focus on process led to a reduction in transfers and errors, which indicate a higher quality of care.

Keywords: nurse scheduling processes; lean management; makigami; fishbone analysis.

I. Introduction

The operating theatre (OT) of a teaching hospital is a critical and costly resource in the delivery of health care.[1] Usually comprising several operating rooms (ORs), the overall utilization and working efficiency of the OT is an important consideration for health-care managers because these factors have a significant impact on patient outcomes, hospital finances and clinical effectiveness. It is a challenge to balance clinical requirements with the need for process flexibility, standardization and efficiency in busy hospital environments with numerous stakeholders. As a result, clinical governance/quality management systems (activities designed to monitor, review and improve the quality of care) are necessary, and the responsibility for overseeing these usually rests with hospital managers.[2] In the OT, typical examples of quality management activities include using standardized procedures and resource forecasting, such as appropriate allocation of equipment and nursing staff.[3,4]

There are a number of validated quality management systems that lend themselves to health care. One of the most popular systems is Lean; with its origins in Japan, Lean is designed to improve the efficiency of processes by eliminating unnecessary activities in terms of variation (in Japanese: mura), overload (muri) and waste (muda).[5,6,7]

The identification and elimination of waste to optimize process flow can be achieved by a Lean process mapping system known as value stream mapping (VSM), which was originally developed by the automobile manufacturer Toyota. Womack and Jones (2003)[8] define a value stream as "the specific actions required to design, order, and provide a specific product, from concept to launch, order to delivery, and raw materials into the hand of the customer". They describe VSM as "identification of all the specific activities occurring along a value stream for a product or product family".8 VSM can thus be seen as a technique to identify, reduce and eliminate waste and errors that prevent the smooth flow of products and information through a value stream. From a practical perspective VSM involves outlining the key stakeholders, resources, activities and processes on a chart. It provides an understanding of how resources are utilized and highlights any inconsistencies. It is a useful communication tool in visualizing products or services for all staff to review, and value-adding and non-value-adding activities can be readily and systematically identified. Processes can then be revised by omitting non-value-adding elements. A comprehensive type of VSM is Makigami.[9] Makigami (which is Japanese for a roll of paper) is especially designed for mapping processes in complex environments were the product is not directly visible or physical, for example in offices, laboratories or hospitals. This is with the aim of providing a better service or creating a product that

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adds value for the customer or, in the context of health care, the patient.

The transfer of Lean principles to clinical settings means that health-care managers should be concerned with the input, output and throughput of their processes to steer and realize improvements that increase value for the patient. Several studies have shown that Lean methods can be used to optimize clinical workflow. In 2011 Kuo et al. proposed a new method, the Lean Six Sigma System, to improve workflow in post-operative settings. [10] In a systematic review, DelliFraine et al. (2010) examined the evidence for Lean methods leading to improved clinical outcomes, cost-effectiveness and clinical effectiveness.[11] In the case of caring for patients with hip fractures it has been shown that Lean methods are associated with more efficient patient flow from admission to discharge, with reduced mortality and waste.[12] An example of such a process is patient scheduling, the efficiency of which is of vital importance to the patient and also to the medical team. [13] The use of the Lean method has also been shown to improve OR efficiency in terms of time management.[14]

Most research into the benefits of Lean and other quality improvement systems in the OR have tended to focus on outputs rather than on the Processes of OR planning, patient scheduling or nurse scheduling. In other hospital areas, scheduling of nurses using their experience is known to have an impact on clinical effectiveness.[15,16,17] In the OR, the scheduling of nurses is particularly challenging because of the way in which staffing needs vary with surgical procedures, from day to day and shift to shift, and therefore it is an interesting environment in which to test the utility of Makigami. As far as the authors are aware, no published study has assessed the use of Makigami to improve OR nurse scheduling. In this study we test the application of Makigami to reduce waste and improve clinical effectiveeness during the process of OR nurse scheduling. The rationale behind using Makigami was that in the existing situation patient safety could not be guaranteed and last-minute changes were found to lead to a high workload and increased annoyance among staff. These problems occurred due to daily problems such as shortage of staff on a given day, or abundance of staff on other days, and no guarantee of qualified (trained) staff being present during surgery.

II. Materials and Methods

a) Design

In this study we observed the application of Makigami to nurse scheduling in the OR of a teaching hospital.

b) Study site and participants

This study was conducted at the VU University Medical Center OT, which has 16 ORs and employs 289 OR staff. In 2012 the OT had an annual volume of 13 527 patients and 18 176 surgical procedures, of which 14 762 are elective.

A multidisciplinary team of nine health-care professionals was involved in mapping the current state of the OT using Makigami. The team, accompanied by a Lean methods consultant, consisted of various health-careprofessionals: the head of the OT, an OR nurse, the team lead of surgical assistants, a scheduler, a nurse specialist (orthopaedics), a day coordinator, a workplace trainer and a secretary. The team members were selected based on their involvement in the process of OR nurse scheduling. This approach was chosen because continuous improvement efforts have been shown to be most effective when employees who are directly involved in the work develop solutions to problems that they deal with on a daily basis.[18]

The team had an introductory meeting that explained Lean thinking and were subsequently introduced to the Makigami method that was going to be used to map the process. The Makigami technique was applied at the OT to eliminate non-value-adding waste from the process of OR nurse scheduling. The focus was set on the entire process of scheduling from the annual blueprint to the day of surgery. The establishment of the final schedule depends on various information sources, but the process examined in this study solely shows the process that is arranged by the OT.

c) Makigami 1:mapping the current state

The current-state Makigami was made in three sessions that took8 hours in total, us inga Makigami chart with hand written notes and post-it stickers. The Makigami chart consisted of four elements: 1) activities performed by different professional roles, 2) documents and figures used in the communication process, 3) records of activity duration and 4) identified problems and waste. An activity was classified as waste if it could be categorized according to one of the seven most common contextual wastes proposed by Toyota, namely overproduction, waiting, transportation, over-processing, inventory, motion or defects[19] The Makigami Makigami chart was created by following the steps of the information-route process of OR nurse scheduling. First, the identified steps were organized by professional role. The group then identified the waste per process step and quantified the types of waste before recording the steps of the process that added value.

Parallel to mapping the current-state Makigami, the problems that occurred on a daily basis as a result of the OR nurse scheduling process were monitored. The day coordinator assessed the process, focusing on three issues: the right employees, allocated to the right place, at the right time. The assessment was based direct observation sover7 days spread out over 2 months. This direct observation was in line with the Lean methodology “to go and see” (in Japanese:

genchi genbutsu), with the aim of truly understanding what happens on the work floor. The assessment pre-intervention took place in April–May 2012 and assessments were also made following the improvement efforts in May–June 2013.

d) Makigami 1: the ideal state and the first target condition

Next to mapping the current state of the OR nurse scheduling process, the team also mapped the ideal state. The ideal state is intended to provide direction for the process and should contain only value-adding steps in succession: the right things, at the right place, at the right time, in the right quantities, without waste and leading to the outcomes desired by the patient. In order to map the ideal state, value from thepatient's perspective was defined. Next, the ideal state was stated and a first target condition was set, upon which various actions were plotted. Together, the mapping of the current state and the ideal state are referred to as Makigami 1.

e) Makigami 2: actions and renewed process

During the process, the team had a meeting once every 2 months. During each meeting, the gaps between the current situation and the target condition were analyzed and discussed. A fishbone analysis (Ishikawa diagram) assisted in the gap analysis. This fishbone analysis can be applied to any type of problem solving to identify all possible root causes. As a result of each meeting, actions were plotted and discussed at the meeting thereafter. After a period of 17 months a new Makigami, referred as Makigami 2, was constructed with the team to capture the renewed OR nurse scheduling process.

III. Results

a) Makigami 1: the current state

The current-state Makigami (Makigami 1) was created and graphically organized on a Makigami chart. Figure 1 shows a photograph of the Makigami wall chart. The Makigami showed 78 procedural steps in which 44 transfers took place. Table 1 outlines the assessment of the current state, which shows the transfers, the number of figures and documents, and the waste within the process.

The outcome following 7 days of measurement, which had the goal to identify the number of errors and changes made due to the scheduling process, identified 19 defectsin scheduling the right employees, 8 defects concerning the timing of employee scheduling and 8 defects concerning the location of employee scheduling (Table 2).

b) Makigami 1: the ideal state and the target condition

The first step of setting the target condition was to map Patients needs. As research has shown that the difficulty with the Lean technique in healthcare is the specification of end-user, or patient, needs[20] the team mapped the various users of the process. For each of these – the patient, nurse assistant, specialist or day coordinator – the question, "What is the need of the user?" was answered. Next, the team created the ideal state by answering the question, "What does the ideal process look like?" The team developed eventually four main themes: pull planning, no waste, scheduling of student nurses, and process and allocation of functional roles. Within these themes, various ideal sub-states were formulated. In order to reach the ideal state a first target condition was set. The first priority was given guaranteeing quality, which meant the right people, at the right time, in the right place. Moreover, this target condition had the outcome measure of no errors or changes made due to the scheduling process.

c) Makigami 2: actions and renewed process

The Makigami 2process map was created and graphically organized on Makigami paper. Figure 2 shows a photograph of the Makigami 2.

This Makigami showed 72 procedural steps in which 39 transfers took place. Tables 1 and 2 summarize the assessment of the renewed process, showing the transfers, the number of figures and documents, and waste within the process.

The outcome 7 days post-measurement, which aimed to identify the amount of errors and changes made due to the scheduling process, identified two defects in scheduling the right employees, no defects concerning the employees scheduled at the right time and no defects concerning employees scheduled in the right place (Table 2).

IV. Discussion

Nowadays, the majority of hospitals are confronted with increasing demands to reduce costs and yet improve safety, efficiency and quality of care. To guarantee quality and clinical effectiveness in the OT the quality of OR nurses should be ensured. The aim of this study was to analyse the scheduling process for OR nurses in real practice with the use of Makigami Lean mapping tool. The literature on nurse scheduling and its role in clinical effectiveness is quite extensive.[21,22,23,24,25]

The results of our study indicate that Makigami can assist in optimizing OR nurse scheduling in a high-volume hospital setting and help to identify waste and indicate relevant improvements. Application of this method was found to reduce outcome errors by 90% and waste in the process by 41%. Furthermore, the existing processes used to schedule OR nurses had evolved without specific attention to process and design. The Makigami tool assisted our team members in better understanding and identifying who was responsible for doing what work in the scheduling process. This insight enabled the team to review that process and to improve it considerably.

In addition to the 90% reduction of errors and 41% reduction of waste, it is likely that the Makigami tool also taught the team members the importance of a multidisciplinary approach. This assumption is supported by previous VSM research in which the importance of cultural change has been reported.[26] It can be difficult for workers, particularly those who have been in positions for a long time, and with deeply engrained work habits, to accept new guidelines for work processes because they believe that they already know how to perform their role correctly. The team members and OR nurses lacked an awareness of the power of Lean VSM techniques. However, workers will follow new guidelines when they understand the rationale behind them.[27]

We found that one of the most significant benefits of using VSM was visualization of waste. The research team also found that reducing transfers (11%) and the number of documents used to schedule OR nurses (14%), better use of existing scheduling software and a decrease in manual scheduling benefitted the OR nurses because it lead to higher-quality schedules while the employee in charge of scheduling reported to enjoy the positive benefits of fewer repeated tasks.

We identified a number of challenges; for example, the demand for information and requirements varied between the OR nurses in charge of nurse scheduling. The monitoring and resolution of this situation was found to be a challenge. We also found that the incentives of various stakeholders were not always aligned, making it a challenge to involve the different stakeholders in the process. We therefore recommend that educational applications should be introduced in parallel to train OT management and employees in charge of scheduling. A further challenge was related to coverageof demand. The OR environment is less standardized than that of an automobile factory, where Lean methodology was conceived. Changing patient mix, evolving needs of the OT and no reliable way to estimate future demands were all factors in this regard.

This case study has a number of limitations. First, its scope was limited to observation of one specific clinical process only; therefore, the findings may not be representative of other clinical processes. However, our study illustrates the potential for further effective application of Lean methods, in particular the Makigami, to the health care environment. Second, the study was performed in a large hospital, a referral centre, in the Netherlands. Therefore the processes studied may not be applicable to smaller units. Finally, the observations are qualitative, without statistical support, and were collected over a short space of time. Further, longer-term, studies looking at different processes are needed. We also suggest that future work could examine other OR personnel as well. The number of attending OR nurses is only one of many components influencing the performance of an OT. To gain a better understanding and to identify areas for improvement it will be necessary to extend this study to anaesthetists and recovery nurses as well. We also suggest developing quality- and patient-oriented scheduling solutions that offer new opportunities for research on systems design for OT scheduling.

In general, this study adds further evidence that Lean techniques such as VSM can improve OR scheduling processes and therefore are useful management systems withwhich to improve the quality of care. Our findings suggest that, as a specific type of VSM, Makigami can help to identify current processes and performance. We found Makigami to be a focused and structured improvement tool that can help visualization of scheduling-process improvements in hospital practice. Previous studies of VSM have also shown its utility when applied to dynamic, high-volume surgical settings to identify waste and promote improvements in existing processes.[28]

V. Conclusion

VSM and Makigami are based on simple and structured problem-solving concepts. These Lean concepts promote continuous improvement, allowing monitoring and measurement of the effectiveness of change. Although our results indicate that the use of the Makigami enhanced the OR nurse scheduling process, challenges still remain. This study, however, achieved its purpose in showing that the Lean method – specifically the application of Makigami – is effective as a means of reducing waste and for standardizing processes in OR nurse scheduling.

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Table 1: Makigami process: number of transfers, documents and figures, and amount of waste

Process	Total number		Improvement
	Makigami 1	Makigami 2	
Transfers	44	39	−5
Documents and figures	42	36	−6
Waste	64	38	−24

Table 2 : The number of errors arising in Makigami 1 and 2

Error (waste)	Makigami 1	Makigami 2
Right employees		
Under qualification	8	0
Over qualification	4	0
No employee scheduled for handwash instruction	3	0
Not enough employees scheduled	2	1
Wrong employee name on schedule	1	0
Officeday for specialized OR nurses not scheduled	1	0
Right time		
Agreements with employees unknown to day coordinator	7	0
Employee rostered while not scheduled	1	0
Right place		
Employee scheduled at wrong place	7	0
Employee not scheduled while rostered	1	1
Total:	35	2

Figure 1 : Photograph of the Makigami 1 process map

Figure 2 : Photograph of the Makigami 2 process map

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