Operations Management in Healthcare – principles for creating swift even patient flow and increased accessibility

Torbjörn Jacobsson (torjac@chalmers.se)

Department of Technology Management and Economics

Chalmers University of Technology

SE-412 96 Göteborg, Sweden

Abstract

This paper investigates the operations management principles that potentially could be transferred to healthcare in order to improve care production processes, i.e. ensuring a swift even flow of patients through the healthcare unit. The discussion and the conclusion from this study are based on qualitative case studies in planned and unplanned healthcare operations, in a large university hospital in Sweden. Given how much we know about the ways in which healthcare could be improved, the efforts devoted trying out different approaches would seem to question why more has not been done to solve the many problems in this sector. Rather than concentrating debate and discussion on the differences with industry, we should concentrate on the similarities with healthcare and draw on the potential for mutual learning between contexts which might facilitate a creative process and identify solutions that would result in swift, even patient flows.

Keywords: Operations Management, Healthcare, Process flow solution, Swift even patient flow, Accessibility

1 Introduction – Operations Management and patients´ accessibility

Most people would agree that access to health care is problematic and there is room for improvement; there are demands from society and taxpayers for change. Many healthcare organizations are faced with increasingly economic constraints, long waiting times and queues of patients. Budget limitations rule out additional resources. However, a first step in the change process must be recognition by the public organization that change is necessary (Radnor et al., 2006). This process has begun in healthcare in Sweden. In Sweden, the need for change was recognized in the mid-1980s, in relation to management, planning and control of health care resources (Trägårdh and Lindberg, 2004).

One way to meet the challenges posed by budget constraints, long waiting times and queues in healthcare is to adopt ideas and implement process flow solutions from the operations management field (Walley, 2003; Vissers and Beech, 2005; Spear, 2005; Porter and Teisberg, 2006; Lindgaard Laursen et al., 2003; Kollberg et al., 2007; Karlsson et al., 1995). The driving force behind the introduction of process flow solutions from operations management to the public sector is increasing efficiency in a context of limited resources (Radnor and Walley, 2008). A trend that could make healthcare more efficient is Lean production (see, e.g. Tolkki and Parvinen, 2005; Radnor and Boaden, 2008; Papadopoulos and Merali, 2008; Fillingham, 2007). Lean Production and the Toyota Production System (TPS) constitute one of the most successful approaches to improving manufacturing processes. The literature frequently equates Lean Production with the TPS. Creating a continuous product flow with less variability, and creating pull-driven production is based on two concepts: JIT (Just-in-time) and Jidoka (Monden, 1983, p. 2). JIT involves producing the necessary units at the right time, i.e. meeting demand instantaneously with the right quality. Jidoka involves automatic error detection, visual control and production that can be stopped by human intervention. TPS requires a flexible labor force that responds to demand and creative continuous improvement work, and incorporates employees' ability to solve problems and suggestions for improvement (ibid., p 2). This is realized in the following ways (Monden, 1983):

- Kanban (ibid., p.14) is the means for achieving JIT
- Adaptation of production to fluctuations in demand by leveling production (ibid., p. 55)
- Reduced setup times (ibid., p. 76)
- Elimination of waste (see e.g. ibid., pp. 55, 69, 119)

- Standardized work routines (ibid., p. 85)
- Factory layout and flexible labor with multiple skills as part of a flexible workforce concept (see e.g. ibid., p. 100)
- Improvement teams with structured ways of working (see e.g. ibid., p. 126)
- Pokayoke systems that facilitate a correct and standardized way to do things (ibid., p. 10)
- Andon, a visual system to indicate failures (ibid., p.148).

TPS was developed in Japan after World War II, at the Toyota Motor Corporation (Shingo, 1981). It was necessary for Toyota to work efficiently due to resource shortages after the war (Schonberger, 1986). TPS and Lean production are closely related. The term "lean production" was coined in the late 1980s by Krafcik (1988), and was referred to in Womack et al. (1990) in their study of the global auto industry. Lean production is described variously in the literature but typically includes five principles (Womack and Jones, 1996):

(1) Defining what is value for the customer

(2) Identifying the value stream for each product and eliminating all waste in the process

(3) Striving for continuous flow

(4) Implementing "pull" (demand-driven production) between steps

(5) Striving for perfection so that the number of steps, amount of information, and throughput are improved continuously in order to create customer value.

Lean can be seen in a broader perspective as encompassing lean development, lean procurement, lean manufacturing, lean distribution and a lean enterprise, i.e. the value chain from product development to distribution (Karlsson, 1992; Åhlström, 1997).

Lean production has been used by industry for several decades. Although the Lean concept is ascribed to industrial contexts, it can be applied to other activities with fairly stable demand, relatively high-volumes, limited numbers of product variants and sequential processing of goods and services (see e.g. Anupindi et al., 2006). Already in the 1980s Schonberger (1986) was stressing the importance of striving for simplicity in processes to enhance improvement. High quality products and processes, with low variability are a prerequisite for efficient production and high productivity (see e.g. Monden, 1983; Krafcik, 1988). However there are contemporary concepts related to Lean and TPS. The Toyota Motor Corporation can be seen as a good representative of the quality movement, e.g. Total Quality Management (TQM). For a deeper discussion of TQM and similar concepts, see, e.g. Alänge (1994), and for a

discussion of quality movement developments in Sweden from an organizational innovation perspective, see e.g. Lundgren (2003).

In healthcare, the terms "Lean" or "Lean Healthcare" are used in the literature as umbrella terms for process flow solutions that improve processes and create more efficient patient flows, see e.g. Radnor, et al. (2006) and Brandao de Souza (2009). In the public sector, there are several tools and techniques associated with Lean, and concepts such as Kaizen Blitz (or Rapid Improvement Events - RIE), value stream mapping (VSM) and Six Sigma (Radnor and Boaden, 2008). The degree of process innovation in healthcare organizations is low. In the 20th century the industrial sector pioneered the development of process innovations and the creation of efficient production organizations. The medical profession and current healthcare organizations generally think it inappropriate to apply management knowledge from industry because of the differences in activities, and especially because healthcare deals with people not goods (see e.g. Papadopoulos, 2008).

One of the key differences between Lean production and traditional resource efficient companies is that Lean focuses on flow efficiency, i.e. reduced throughput times and swift even (patient) flows, rather than high resources utilization (see e.g. Rognes and Åhlström, 2008). Instead of focusing on economies of scale and optimal utilization of resources, Toyota focuses on flow efficiency and producing only to meet demand. It is almost impossible to achieve both high resource utilization and significantly reduced throughput times in healthcare due to natural variability, e.g. in patient inflows to the acute unit. However, there are undesirable variations in care production that could be reduced, such as duplication of work, unnecessary process steps, and capacity planning. In the 1970s, Levitt (1972) argued that organizations in the service sector could achieve significant benefits by applying industry approaches. Lean is one way to achieve these benefits outside of manufacturing (Swank 2003; Åhlström, 2004).

2 Healthcare - a public professional organization with resource focus

Healthcare is a professional organization, which means that the work requires nuanced assessment based on skills and experience (Mintzberg and Glouberman, 2001). The medical profession takes decisions about medical issues based on its knowledge and experience. A profession is characterized by various attributes such as intensive knowledge, authority, codes of ethics and common culture, see e.g. Greenwood (1957). A professional organization is comprised of professional occupations with strong professional identities. Identities are

acquired through education, research and experience. A registered doctor requires an identification issued by an authority, which allows the conduct of certain duties and endows certain rights. For instance, the professional occupation of physician involves adherence to ethical rules and standards, and obligations to colleagues and clients (Norbäck and Targama, 2006).

Glouberman and Mintzberg (2001) suggest that healthcare is difficult to control and change simply because a hospital is not a single organization but rather four organizations or "worlds" with different structures that work independently of each other (p. 57). These four organizations are all necessary for a healthcare system but their perceptions differ about the nature of value adding activities. These organizations are not reconciled or compatible – their structures are incompatible and opinions are different (ibid.). Improvement projects to increase collaboration among them are usually temporary solutions that are not sustainable.

The overall healthcare organization is based on a series of structures which are difficult to transform or break up. Glouberman and Mintzberg (2001) argue that healthcare is one of the most complex systems in contemporary societies and that hospitals are considered especially complex organizations (ibid, p 56). Glouberman and Mintzberg's (2001) four "worlds" that describe the complexity of care are (1) nursing staff, "care", (2) physicians, "cure", (3) managers, "control" and (4) representatives from the community, "community", (see also similar discussion in Östergren and Sahlin Andersson (1998)).

The hospital is organized according to functions, i.e. it is divided into "silos", departments or units that perform particular activities, such as orthopedics or dermatology. Functions involve several care professionals, such as physicians and nurses. Managers and secretaries are considered non-care professionals. Within professions there are specific areas, such as medicine and surgery, which may work in several functions or departments. A department is often a clinic or a smaller unit with a separate administration.

Ways of working in healthcare are usually personalized, and collaboration between process steps is often not efficient in healthcare. Healthcare is characterized by a high level of differentiation and low levels of integration (Mintzberg and Glouberman, 2001, p 70), which lead to communication and coordination problems between functions. Within each department staff carry out their various patient related activities before pushing the patient forward, to the next stage in the care process, involving a wait for the patient each time between steps. Hospitals often have no set up to communicate between process steps, which creates problem

when errors occur or if there is a need for capacity leveling. It is often *only* the patient who sees the whole process (Fillingham 2007, p, 232).

Several resources in the hospital are grouped geographically, in a so-called functional layout, e.g. radiology department, to achieve higher capacity utilization. However, this means that the patient flow has to adapt to the focus chosen and the poor coordination between process stages. The result is longer waiting times between process stages and longer throughput times. The hospital has a good focus on resource efficiency but a lesser one on flow efficiency. Resource efficiency relates to efficient use of resources, e.g. patients wait for the physician rather than physicians waiting for patients; flow efficiency refers to the value-adding activities related to patients' throughput time in the healthcare system (Modig and Åhlström, 2012). The flow perspective focuses on creating a swift, even patient flow which initially might mean economies of scale being sacrificed, but the "profit" lies in reduced throughput times, reduced waiting times for patients, reduction in "misplaced" patients in the system, and greater flexibility to meet patient needs, requirements, desires and expectations.

To bring order to the often complex and sometimes messy functional layout with long throughput times, a so-called cell layout with flow groups might be more efficient (Hyer et al., 2009; Hyer and Wemmerlöv, 1984). Cells include physicians, nursing staff and administrative staff, and dedicated equipment and other resources co-located geographically, i.e. a cell has the resources to meet the patient's needs. The cell layout can be organized in various ways, e.g. partly as a line or as smaller functional layout.

3 Defining process flow solutions in healthcare

The term "process flow solutions" is an umbrella term for all kinds of solutions aimed at a swift even flow before and after the meeting with the physician or nurse (the care provider). The process flow solution is aimed at unwanted variability and at adapting capacity utilization to the context that sometimes is characterized by unpredictable demand coupled with a non-storable product. These process flow solutions originate in a number of different techniques and approaches such as TPS (see e.g. Spear, 2005), TQM (see e.g. Arndt and Biegelow, 1995; Olsson, 2002), Reengineering (see e.g. McNulty and Ferlie, 2002), Process management (see e.g. Hellström et al., 2009), Six Sigma (see e.g. Lifvergren et al., 2008), and Cellular manufacturing (see e.g. Hyer et al., 2009).

The process flow perspective is discussed in Anupindi et al. (2006), where the flow unit (in this case the patient) enters the system and flows through a series of activities including passive waiting, and leaves the system as output. Process flow solutions focus on reducing

throughput times, for instance, from initiation of a referral for primary care until the patient is accepted at a specialist clinic, or from physical entry to departure from a specialist clinic. In this view, the patient is the customer, and the assumption underlying the process flow perspective is that customer satisfaction improves with shorter throughput times, both before and after the meeting with the care provider. (Note that the consultation with the physician is excluded from the process flow definition. It is too complex to apply process flow solutions to services with high levels of patient contact (Åhlström, 2004) and speeding up patient flow by including the meeting with the physician would not necessarily increase the patient's experience of quality (Johnston and Jones, 2004).)

In the process flow view in this paper, it is important to note that the solution is not confined to a particular philosophy, method or technique for improvement, such as lean production, TQM or cellular manufacturing. Rather, it emphasizes adaptability, i.e. the ability to adapt a solution to the local environment, but without major changes to its content. Key to process flow solutions is variability reduction and capacity utilization, both of which drive process performance (see e.g. Anupindi et al., 2006). In healthcare, variability refers to arrival times and processing times. Increased variability always degrades production system performance (see e.g. Hopp and Spearman, 2000).

To achieve swift and even patient flow and reduced throughput times, the process flow solution must respond to one or more of the following criteria:

- Reducing unwanted variations in inter-arrival time and processing times
- Reducing average inventory, i.e. reducing the number of "misplaced" patients within the process boundaries to increase accessibility for patients in need of care
- Increasing capacity utilization whenever possible and finding a balance between capacity utilization and natural variations in the system
- Adapting capacity to demand (increase capacity whenever needed and possible)

These criteria act as theoretical "goals" or embracing principles within the process flow solution definition.

Planned healthcare often includes buffers against variations in demand in the form of a referral queue. Planned care allows higher capacity utilization which has to be more cost efficient than emergency healthcare. Emergency healthcare means that demand cannot be predicted. Emergency medical care generally operates with speed (quick response) and flexibility. Flexibility requires excess capacity if waiting times are to be at acceptable levels. Where variations are inevitable, throughput time can be changed by "building in" excess

capacity. If variability increases for a given capacity utilization, throughput-time will increase. Reducing unwanted variability will reduce throughput-time for the same capacity utilization (for a further discussion, see Hopp and Spearman, 2001, p. 304). To deal with variations in operations, healthcare units can decrease capacity utilization, which is viewed as a "cost". Healthcare does not have appropriate measures for these variations and it is difficult to determine the appropriate or "practical" maximum level of capacity utilization.

However, the effect of a process flow solution can be measured by through-put times. The assumption is that reduced throughput times in health care improve accessibility for patients seeking help. Reduced access means that the patient does not receive the care that he/she needs, in a timely way. Greater accessibility is good for both society and the patient, research shows that better access to healthcare leads to less contact in the future because patients are more confident of receiving health care when it is needed (SoS Hälso- och sjukvårdsrapport 2009, p. 17).

The problem is probably not lack of resources and capabilities (Silvester et al., 2004), but of changing ways of working, and of ensuring that the right people are responding correctly and at the right time (Rognes and Åhlström, 2008). "Swift" patient flow does not mean hospital staff running between patients or cutting corners in patient care but involves applying operations management principles.

3.1 Research question

There are several theoretical studies on the benefits of using operations management in healthcare, but their impact has been limited, because of the complexity of healthcare organizations. There are different groups, such as specialist physicians, nursing staff, administration, and managers, who have different interests (Papadopoulos, 2008; Glouberman and Mintzberg, 2001). It is very difficult to manage the organization of healthcare. The context is ambiguous; work is structured around functions and involves unclear work routines (Spear, 2005). There is a need for research into the obstacles to implementing process flow solutions from the operations management field. However, they can be reduced by better knowledge about the principles of implementation of a process flow solution. Implementation is the process and activities involved in realizing or striving to realize a process flow solution at an operational level. This implies some reconciliation between the process flow solution and the healthcare context, i.e. the process flow solution must be adapted to and adopted in the local conditions, without change to its basic principles.

Thus the research question investigated in this paper is which operations management principles are most suited for use in healthcare to improve care production processes, i.e. to create a swift even flow of patients through the healthcare unit.

4 Method

The findings in this paper are mainly based on experience from five research case studies of a dermatology clinic and four emergency departments performed at a large university hospital in Sweden (see Jacobsson and Åhlström, 2011; Jacobsson, 2010; Jacobsson and Åhlström, 2010 a; Jacobsson and Åhlström, 2010b; Jacobsson et al., 2007; Jacobsson and Åhlström, 2007; Jacobsson et al., 2005). In all cases the task was to reduce patient throughput times and study the implementation of the process flow solutions. Moreover, findings are also based on the author's experience of supervising bachelors and masters theses (see Eriksson et al., 2011; Iversen, C. et al., 2012) and masters thesis (Barr and Khajador, 2011; Nilsson and Petersson, 2007; Anger and Sigholm, 2007), which developed various process flow solutions, derived from operations management.

4.1 Dermatology clinic case study

To identify process flow solutions and study the implementation process, a clinical methodology (Åhlström, 1997) was chosen in which the researchers participate in and study organizational change from within the organization. The aim is to contribute to both the advancement of knowledge and the practical concerns of the organization. This methodology provides access to relevant data, important in the dermatology case because of the scarce knowledge about which solutions might fit the context and what factors affect the implementation of process flow solutions. The dermatology clinic consists of ten units related to different groups of dermatology diagnosis. The study was carried out between June 2004 and November 2006 with differing levels of on-site presence. The main methods of data collection were interviews, conversations and participant observation. Between June 2004 and March 2005, 17 planned interviews with doctors, and 14 planned interviews with nurses were conducted. Between March and August 2006, 14 planned interviews were conducted. We also conducted follow up telephone interviews. The length of interviews varied between 20 and 60 minutes. Numerous conversations and unstructured interviews and observations occurred during my time at the clinic, e.g. meetings in corridors, rest rooms and coffee areas, and during lunch and smoking breaks. The information gleaned from these encounters as very

valuable for the study. To improve validation, ongoing discussion about process flow solutions and implementation factors were checked and rechecked with the clinic's management and staff. The clinic was responsible for the implementation of its particular process flow solutions.

4.2 Emergency departments case studies

A qualitative method similar to a clinical methodology was chosen (Åhlström, 1997) as an effective approach to acquiring relevant data. Data collection was guided by a modification of Pettigrew's (1988) framework where change is studied by investigating the interplay between the implementation process, the content of the solution, and the context in which the solution is realized. The study was introduced began at the beginning of 2007 through participation in three works-shops on planning a physical reconstruction of one of the emergency departments.

The main study, which included all four emergency departments, began in May 2007 and finished in September 2008. A few follow-up visits were made between September 2008 and March 2009. The interview questions were unstructured and open in order to include potentially valuable side-tracks. Many unplanned conversations happened on site. A conversation is a relaxed, informal chat, with no predetermined structure, generally lasting less than five minutes. The information gleaned from these conversations, in most cases, was very valuable. These conversations took place in corridors, rest rooms, coffee areas, during lunch breaks and also outside the emergency department area. Additional data were collected via telephone conversations, and email was used for short questions. Important data were gathered also from the many observations that took place whilst on site in unplanned meetings with staff, observation of daily activities, participation in patient examinations, regular walks through the department corridors, sitting in reception, and participation in internal meetings.

The case studies were conducted in two stages: problem-solving phase and implementation phase. The problem-solving phase focused on patient flows within each emergency unit. During this phase, 33 interviews took place and 46 valuable conversations were documented. Most of the interviews were short, about 30 minutes; a few lasted over an hour. The purpose of the implementation phase was to identify and study the factors that influence implementation: 52 interviews and 58 valuable conversations were documented during this phase. Most of these interviews lasted between 20 minutes and an hour; a few lasted longer for more than an hour. The emergency departments are responsible for implementation.

5 Operations management principles in healthcare

There seems to be potential for operations management principles to be transferred to healthcare in order to improve care production processes, i.e. to ensure swift even flow of patients through the healthcare unit:

Elimination of everything that does not add value

Eliminate unnecessary steps in the process

Standardization of work routines

Focused factory in healthcare - separation of patient flows

Synchronization of patient flows

Multi-disciplinary teamwork with physicians and nurses

Capacity planning - matching resources to demand

Visualization of the patient flow

Focus on the patient process

5.1 Elimination of everything that does not add value

To eliminate waste, or muda, is the distinctive principle of Lean Production (Åhlström, 2004). Anything that does not add value to the product from a customer perspective is a waste (Monden, 1983). Overproduction and inventories are considered the most important forms of waste to reduce, see e.g. Liker (2004), Åhlström (2004). In principle, everything that the customer is not willing to pay for is waste. Lowering the level of the company's inventory, primarily work in progress, reveals operational problems, and a large inventory conceals problems in the organization (Hayes, 1981; Åhlström, 2004). Identifying customer value and adapting layout to process makes it easier for the organization to see problems and take action (Womack and Jones, 1996). An effective way to reduce work in progress is to reduce set up times (Shingo, 1981). Shingo (1981) argues also that it is better to inspect manufacturing processes than to control the final product. Work should concentrate on improving the quality of product parts and processes so that post-control (i.e. controlling the product after it has been produced) is eliminated, i.e. right process creates faultless products. The principle of eliminating everything that does not add value is generally transferable to health care (Karlsson et al., 1995; Fillingham, 2007).

Working towards elimination of waste in healthcare involves efforts to eliminate unwanted variation. This is important for reducing waiting-times without injecting more resources into the production system. One way to do this is to remove different types of waste, see e.g. Monden (1983), Womack and Jones (1996), Fillingham (2007). Waste occurs in:

- Overproduction - producing more than the customer has requested. Excess capacity is waste when it is used to create the surplus. However, surplus capacity in healthcare need not be waste. Excess capacity that exists due to levels of capacity utilization being lower due to variations in inter-arrival times and service times, is not waste in healthcare operations, e.g. emergency healthcare.
- Inventory - waiting rooms where patients gather and wait for their appointments with the physician/nurse. There are exceptions, such as waiting for changes in the patient´s medical condition, i.e. direction of a disease. There are waiting areas on the acute unit that are necessary to facilitate monitoring and care.
- Transportation - unnecessary moves that do not add value to either process or product. The aim should be to reduce the need to move either materials or patients.
- Reducing staff movements - everything needed by the medical staff should be positioned conveniently and close by.
- Ensuring equipment is reliable - the need for more storage space increases if equipment is not reliable.
- Quality problems – quality in all processes and products is a prerequisite for swift even patient flow. Poor quality products and processes waste resources and are bad from the customer's perspective. High quality processes result in high productivity and reduced repeat work.

5.2 Eliminate unnecessary steps in the process

One of the most powerful ways to improve patient throughput-time in contemporary health care is to eliminate unnecessary steps in the process (see e.g. Fillingham, 2007; Bushell and Shelest, 2002), e.g., removing unnecessary handovers of patients and information. This can be achieved through cross-functional working in the triage room. Attention can be paid also to aligning processes (and integrating process steps where possible), e.g. taking specimens in the emergency department in parallel with other examination procedures. In the emergency room, a priority must be obtaining patient information and medical histories in order to make

decisions about what to do. This can be achieved through the application of standardized work routines in triage which will reduce uncertainty in the early processes and ensure that patients are assigned to the most appropriate care production flows. The “right skills” early in the patient’s process are essential. In this context the “right skills" are often an experienced physician/nurse, able to cope with stress, make decisions, and work in a multi-disciplinary team. Changes to the care assignment later in the process should be reduced and unnecessary process steps eliminated.

5.3 Standardization of work routines

A vital ingredient in lean production and the TPS is standardization. As far as possible, all activities in a process should be based on standardized work routines. There are several reasons for this. Firstly, a standardized approach can reduce variation (which is important for reducing waiting through-put times). A standardized approach can reduce variation in how different individuals work, and it provides a basis for continuous improvement. A standard should not be interpreted as a fixed solution; it should be continuously challenged by alternative suggestions for improvements, which, after scientific evaluation (e.g. experiments and pilot testing) may be included in an improved standard.

Activities characteristic of the TPS include pursuit of perfection through change for the better, ‘Kaizen’ (Imai, 1986) and working towards zero defects by applying ‘poka yoke’ (Monden, 1983). Kaizen, which is among the most important basic principles of Lean, is based on a standardized way of working that strives for all processes to be built according to a standardized approach. The overall aim is to reduce variability in production systems. Variations that arise because of different working methods and different group settings can be reduced by standardizing work routines.

An example of how standardization and quality work have improved healthcare is provided in Spears (2005). Spears’s (2005) article is based on several case studies from hospitals and clinics in Boston, Pittsburgh, Appleton, Wisconsin, Salt Lake City and Seattle. Improvements to working routines related to administration of injections resulted in reduced numbers of infections. The trend in healthcare is towards increased standardization of the work routines of medical staff (Mintzberg and Glouberman, 2001, p. 74).

5.4 Focused factory in healthcare - separation of patient flows

In industry settings, the "focused factory" concept plays an important role in explaining why the productivity of similar industry activities differs (Skinner, 1974; 1985). The focused

factory depends on flows being separated so that each one concentrates on producing a certain set or similar versions of the product, which correspond to a market segment. This can be done by separating operations according to their use of different resources. Flows are kept separate so that they do not disrupt one another. Instead of having several perhaps conflicting objectives and tasks, it is better to concentrate on performing a small number of tasks with similar objectives. This provides many advantages such as the learning effects from repeating activities, more easily standardized processes, reduced number of errors and increased efficiency through reducing variation in the execution of tasks.

Van Dierdonck and Brandt (1988) discuss this concept in relation to services and it can apply also to health care. Of course, it is not feasible to build separate "factories" for each patient flow, but adopting the solution by creating smaller factories within the healthcare unit as practiced by industry, i.e. " plants within a plant ", see Skinner (1974). A related concept is the so-called "flödesgrupper" (flow groups) concept based on group technology (see e.g. Burbidge 1989), which has been common in Swedish industry for decades. It involves the physical separation of a part of production, a product or product family, and its assignment to a group of people responsible for the processes that apply only to that product or product family. The Swedish term “Produktverkstäder “ (product workshops) is also used to describe this approach - usually at higher levels of organizational aggregation.

The idea behind this way of organizing processes is to reduce the complexity of production flow and reduce variation. Production as a whole becomes easier to plan since each cell layout becomes a planning point, e.g. grouping machines together rather than a collection of separate machines. Combining similar activities can increase the focus on them.

Adaptations of these concepts have been applied in health care, with positive results, see e.g. Hyer et al. (2009); Pagell and Melnyk (2004). Another example of a focused operation is the “fast-track” system in emergency departments, which separates patients with simpler conditions into a flow to a primary care unit within the emergency department, see e.g. Combs et al. (2006).

In the emergency department patients needs are responded to at the start of the process, often in triage and then administered to by separation of patient flows, e.g. to surgery, orthopedic, internal medicine. An emergency department in Australia adopted this approach to reduce cycle times and control patient flow better (King et al., 2006). Incoming patients were assigned to different flows in triage. The patients in each flow were directed to different parts of the emergency unit staffed by different teams (ibid.).

5.5 Synchronization of patient flows

The aim of synchronized flows is swift and even patient flow throughout the system. Therefore, it is important to synchronize patient flows between different process steps in which there are dependencies. This can be done by matching the capabilities in all the stages of the flow, and trying to level capacity. Some steps will require more capacity than others. If the system has obvious bottlenecks that cannot be resolved this will affect overall flow. The basic principle of bottleneck theory is that each system has capacity bottleneck which, in the long-run, dictates its output (Goldratt and Cox, 1993). Healthcare units often want to protect their perceived “bottlenecks”, i.e. the physician from lack of work resolved by “storing” patients in waiting rooms or corridors, similar to manufacturing firms handling unreliable processes by having high levels of work-in-progress in their production systems (compare Shingo, 1981). Inventory before and after a bottleneck increases capacity utilization and also results in high levels of tied-up capital and increased throughput times.

Synchronization means that patient flow is synchronized between process steps and healthcare units. The Swedish medical literature refers to “healthcare chains” to achieve higher productivity, increased customer satisfaction, and greater job satisfaction for employees. The purpose of a healthcare chain is to prevent problems when patients are "floating" between different health care units. According to Lindberg and Trägårdh (2000) the benefits are better cooperation among health care players and a more holistic and integrated service. This leads to easier identification of bottlenecks. Lindberg and Trägårdh (2000) argue that the care chain concept is an adaptation of Lean Production in healthcare.

5.6 Multi-disciplinary teamwork with physicians and nurses

Team work in multi-disciplinary groups that include several disciplines with the skills to perform multiple tasks, is a vital part of TPS (see e.g. Monden, 1983). There is decentralized responsibility in team work (Hayes et al., 1988), which allows flexible problem solving among the individual in the group who work closely with production and are very familiar with the process (Wheelwright, 1985). A multidisciplinary team could reduce unwanted variation linked to the personalities and skills of nursing staff and physicians. The team might include a doctor, a nurse, an assistant nurse and a medical (doctor's) secretary. The composition is important to achieve complimentarity. A flexible team will act as a shock-absorber in the event of variation and should result in reduced throughput times for patients. It should allow staff to exceed their regular work routines, e.g. the physician could collect the patient from the waiting room if other team members are busy with a previous patient.

5.7 Capacity planning - matching resources to demand

Starting from the fundamental relationship between throughput time, variability and capacity utilization, throughput time can be improved by capacity planning and waste elimination. Due to natural variations in demand and unwanted fluctuations in care production, there is a gap in the synchronization between capacity and demand. This results in the health service operating a mix of pull and push systems. From a wider perspective, healthcare can be considered a pull system, in which care cannot be stored and is delivered when the patient requests it. Patients are kept in inventories through referral queues, waiting lists or waiting rooms. Striving towards a pure pull system is desirable, although very difficult to realize (Åhlström, 2004).

In emergency healthcare, variation is caused by random inflows of patients. This variation is especially important since day-to-day demand cannot be predicted in the same was as planned (elective) healthcare. To reduce throughput-time, it is important as far as possible to adapt the workforce (i.e. staffing) to match demand. Capacity planning is about matching resources to demand. In emergency departments, this refers mainly to adjusting capacity required perhaps during a single day, over a week or over a longer period. In general, healthcare has problems related to planning and coordinating resources with associated administrative and information processes. The result is error-ridden processes, duplication of work and delays (Fillingham, 2007). One way to solve this is to work on capacity planning. Radnor et al. (2006) argue that the implementation of Lean is more complex in healthcare than in other public organizations, among other things because of the problems related to matching capacity for medical care with its demand.

5.8 Visualization of the patient flow

Visualization is a central part of the TPS. It can be achieved in different ways in order to visualize process performance and results, e.g. the Andon concept (Monden, 1983). Visualization means striving to make as much as possible visible to workers and managers in the production system. These can be achieved through machines that involved different colored-signal systems indicating whether they are running well, about to fail, or have failed. Visualization is a way of illustrating the system’s production status and provides opportunities for feedback on how the process "feels”. It can involve planning boards that describe, in real time, how all parts of the factory are working, and allow everyone to see the status of the production flow. The principle is to disseminate as much information as possible to those working on production flow. This information primarily concerns the state of processes, but can also involve financial results and strategic information.

However, in healthcare this is more complex because it is difficult to measure and visualize the intangible results of services. Services are activities not goods, and are produced and consumed simultaneously (Grönroos, 1990). However, it is important to measure and to visualize process status when producing services (in this case healthcare) to control and improve the process. In healthcare, it might be a display that shows the number of physicians on duty and/or the number of patients waiting in the waiting room. The principle is to visualize defects in the process immediately and to disseminate this information to those closely involved in the process and to correct errors immediately. When an error occurs with sequential dependencies, the whole production is affected. In this situation, all employees have an interest in solving the problem immediately. The time from a failure occurring to decisions about corrective measures will be reduced significantly if employees with "finger-tip feeling" who are at the core of the operation can put corrective action in place. Seeing the whole picture and allowing staff to see their activities as vital parts in the patient flow, lead to greater understanding. A complete picture of the production system can be achieved by visualization of the "process mapping", see e.g. Condel et al. (2004).

5.9 Focus on the patient process

All healthcare staff would likely agree that the patient should be central, and that a "patient focus" is a fundamental organizational value. However at the operational level, different professions and departments have different perceptions of a patient focus, e.g. who should be seen in the acute unit and who should go to primary care, and how long a waiting time in the emergency department is too long. By starting with the needs of the patient in care production and by focusing on improving these processes from a patient perspective we can identify ways to handle the diverse concepts of customer and value within the organization.

In finding a suitable process flow solution the following parameter play an important role; volume, i.e. number of patients, variety, e.g. number of diagnoses to be considered, variation in demand for healthcare services and degree of patient contact, i.e. performing surgery is different from talking to a psychiatrist (cf. Slack et al., 2004). Combined with this it is important to choose the "right" performance objective, i.e. if we deal with low variability in operations, there will be demand to increase capacity utilization, e.g. when instigating referrals in pre-planned healthcare the performance objective should be cost efficiency. In the case of unplanned healthcare, i.e. emergency, capacity utilization must be lower to cope with the variation in the inter-arrival and service time and the performance objectives must be both

flexibility and speed. It is taken for granted in Swedish healthcare, that in both planned and unplanned healthcare the right treatment is available.

When working with changes to the local layout, e.g. reconstruction of the emergency department, it is important that the layout should adapt to the process and not vice versa. In the case studies there were discussions of a first focus on employees' need, such as lunchrooms, rather than the patients' route throughout the emergency department. There were also discussions among employees about the importance of focusing on employees' work-satisfaction in order to increase service quality for patients. However it is more likely that work satisfaction will increase if the patient process runs smoothly, i.e. if there is swift even patient flow.

5.9.1 Creating a sustainable healthcare with a flow efficient perspective

The growing demand for healthcare service in Sweden is a challenge for university hospitals because tax revenues do not allow the delivery of care in traditional ways. To create a sustainable healthcare system requires a rationalization of healthcare. The more that diseases can be treated and the more patients recover, the better it will be for society. Society makes big savings from people who can work and function in society. It is important to cut sickness lead times so people can get back to work. University Hospital spent millions on health care purchased from outside care providers in order to meet demand. Reduced referral queues ensure that care guarantees are met and create opportunities for healthcare to be delivered sooner than the statutory maximum of 90 days. Patients should be able to leave hospital when the medical process allows it and not have to wait for administrative processes. This is good for the individual patient and increases accessibility to healthcare services which provides greater security for society. Implementing the operations management principles discussed in this paper would likely create a more pleasant working environment for staff and reduce waiting times and queues. Standardization of work routines eliminates distractions and leads to lower variability in workloads and thus a less stressful working environment for staff. In turn, this should ensure that conditions exist to focus on the patient's needs. Staff will be more involved in the continuous improvement which should induce a positive impact on work motivation because staff will be better able to influence their work situations and have an impact on their work situations.

The challenges that healthcare providers currently face with an increased need for healthcare and economic constrains, can be met by using operations management principles to provide the foundations for sustainable healthcare.

6 Discussion and Conclusion

This paper investigated the operations management principles that can be applied to healthcare to improve care production processes and create swift even flow of patients through healthcare units. The findings in this paper are based on experience from five research case studies of a dermatology clinic and four emergency departments combined with the author's experience of supervising bachelors and masters theses.

It can be difficult to transfer standardized solutions into professional services such as healthcare. Translating Lean from industry to services generally is complex (Åhlström, 2004) and especially so in the case of healthcare because of how this service is governed and managed. It is a politically-driven professional organization with education, research and care production under one roof and a high degree of variation in demand and diagnosis. The organization has to cope with individual patient needs, requirements, desires and expectations, all of which changed over the care period. What is perceived as waste by the patient may not be considered so by the head of a care unit. Process solutions whose principles originate in industry need to be adapted in order to improve healthcare. For example, Lean Production or TPS has been successful in industry settings with high volumes, low levels of variety (number of product variants), low levels of customer contact and very minor fluctuations in demand (Monden, 1983). Modified Operations Management principles have potential for use in healthcare. However, Spear (2005) for example, shows that a solution that can be applied to one hospital may be inappropriate for another. It can be concluded that process solutions must be tailored to organizations. Fillingham (2007) emphasizes the importance of aligning Lean to the healthcare culture and Young et al. (2004) argue that Lean can be applied to healthcare but there are uncertainties about how the customer is defined. There is a practical and useful literature that describes how Lean can be "translated" to healthcare environment, see e.g. Graban (2009), Lewis (2001) and Zidel (2006) but the implementation of process flow solutions in this sector is complex because of the multiple interests and multiple actors involved (Papadopoulos and Merali, 2008). Moreover, there are few studies and theories on how Lean should be implemented in healthcare, see e.g. Papadopoulos (2008) and Radnor et al. (2006).

Although the healthcare environment is described as unclear and as involving several interest groups (stakeholders), we need more knowledge about why process flow solutions derived from the Operations Management field do not have a greater impact, since the literature

describes some successful cases and there is research evidence of their potential. We know a lot about how processes can be improved in manufacturing. Several of these concepts for process improvements could be applied to services. Although we are fairly clear about how healthcare could be improved, there are few studies that describe how process improvements might be implemented or the factors that influence the process. This paper contributes by increasing awareness of the principles that have potential for healthcare, knowledge which should facilitate implementation. The content of the process flow solution, the implementation procedure and the surrounding management context act in combination and to get real impact these three aspects need to be considered concurrently.

All the operations management principles discussed in this paper assume that it is possible to define “customer value”. Since opinions differ as to who is the customer at the University Hospital this is a barrier to the implementation. The healthcare system includes many stakeholders with different interests (Glouberman and Mintzberg, 2001). To introduce work practices that run counter to traditional views of how operations should be governed can be problematic (Norbäck and Targama, 2009; Papadopoulos, 2008). By identifying need and where it occurs we can define customer value. A focus on patient needs in the production of care, and on improving these processes from a patient perspective, would constitute a good start to how to reduce long waiting times.

Rather than debate and discussion on the differences between industry and healthcare, we should concentrate on the similarities and the potential for mutual learning. In the future, industry may study health care in order to understand how the business of services should be run. Healthcare is the public sector area with the highest number of reported applications of Lean (Radnor and Boaden, 2008). Healthcare is probably at the forefront for application of industrial concepts such as Lean, compared to other public organizations in Sweden. Further research could look at the spread of industry concepts and their implementation in other public services, e.g. the judicial system.

Acknowledgements

This research was carried out within the Sustainable Production Initiative and the Production Area of Advance at Chalmers University of Technology. This support is gratefully acknowledged by the author.

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