Developing lean and agile health care supply chains

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Abstract

Purpose – The objective of this exploratory paper is to find out what is important to consider when developing a supply chain in health care, what is required in order to establish a supply chain orientation and how lean and agile can be used as process strategies in order to improve supply chain performance.

Design/methodology/approach – In order to build an empirical framework for using both lean and agile strategies in health care supply chain management illustrative examples are provided from a Swedish health care setting describing the patient flow and planning processes.

Findings – Supply chain management has potential to work well as a philosophy for patient flow in the health care sector. However, it should not only be about the use of the concept of lean in health care, as in fact is the case in practice today. It is rather about organizing for quick response and flexibility in a hybrid strategy through combining lean and agile process strategies. This can only be done if a systems approach is applied together with a strategic orientation, where cooperative efforts by the supply chain members should synchronize and converge operational as well as strategic capabilities into a unified whole.

Practical implications – The analysis in the paper underlines the importance of focusing on both agility and leanness combined. Hospitals or health care systems that introduce such an approach, as opposed to only relying on lean strategies, could gain both competitive advantages and improved performance.

Originality/value – In health care, even more so than in the manufacturing industry, containment of costs without sacrificing quality is important. This paper applies SCM techniques, tools and concepts that have not been used previously for patient flow in a health care setting, combining lean and agile in one and the same analysis.

Keywords Supply chain management, Health care, Lean production, Agile production, Health services sector

Paper type Research paper

1. Introduction

During the last 20 years, an era of expanding public health challenges and decreasing resources (Ix, 2009), the health care industry and the field of supply chain management (SCM) have both experienced significant changes (Ford and Scanlong, 2006). Health care systems, on a global scale, have due to decreasing resources and increasing demand been forced to find new approaches and concepts in order to improve quality but at the same time lower costs and increase value. Supply chain management has been applied and adopted by numerous other industries during the same time. There is well-documented evidence that supply chain management practices result in competitive advantage and cost reduction, however, the healthcare industry has been extremely slow to embrace these practices (McKone-Sweet *et al.*, 2005). The application of SCM to patient flow in health care is more complex than in other industries causing SCM practices to not be adopted. McKone-Sweet *et al.* (2005) also reveal that there are numerous other barriers that inhibit the adoption of SCM practices including a lack of executive support and limited education in SCM. This lack of adoption is surprising considering 30-40 percent of hospital expenses are invested in logistics related activities. In addition to this statistic close to half of the costs related to supply chain processes could be eliminated by using supply chain best practices (Poulin, 2003).

Although there are some exemplary initiatives in health care a lack of academic research in the field of health care SCM still exists (Shah *et al.*, 2008). This is a gap that this paper attempts to fill by introducing and applying well known concepts that formerly have not been combined in a study in the health care setting, namely the concepts of lean and agile. Although lean has been applied successfully in the private sector, especially in manufacturing, the approach is less frequently applied in the public sector. Limited research has evaluated whether the lean approach transfers successfully and what impact the approach has on for example productivity, costs and quality of service (Radnor *et al.*, 2006). Agility again has not been extensively discussed in health care literature although the combination of the two concepts has formed a discourse in literature on industrial supply chain settings. The objective of this exploratory paper is to find out what is important to consider when developing a supply chain in health care, what is required in order to establish a supply chain orientation (SCO) (Mentzer *et al.*, 2001) in a health care setting and how lean and agile can be used as process strategies in order to improve supply chain

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performance. Our approach in doing this is to treat lean and agile as process strategies and not as company wide concepts as they often are described in literature.

The paper starts with an overview of the development of SCM in industry and its use in health care. This is conducted in order to set the stage for analyzing how the concepts of lean and agile have been used both in industry as well as in health care. Illustrative examples are provided from a Swedish health care setting describing the patient flow and planning processes. The paper concludes with an analysis of SCM in the health care sector and a discussion on how lean and agile process strategies can be used to design supply chains in health care.

2. SCM in industry and health care

SCM is based on a systems approach (Mentzer *et al.*, 2001) and the essence of SCM is about solving the problems of functional division (silos) that occur within and between organizations and to create seamless processes. This indicates that there is a need for both functional specialization as well as process orientation in organizations. Most studies focus on a smaller part of the supply chain due to practical reasons, however. Supply chain management is in this paper seen as a philosophy, which is ultimately about influencing behavior in particular directions and ways (Storey *et al.* 2006) and it is used to describe an overall flow oriented strategy whereas lean and agile are considered to be process strategies. The supply chains discussed in this paper are the patient's pathway through the health care system from first contact until the last for a specific medical problem, addressing the question of how Supply chain management (SCM) theories, specifically the use of lean and agile process strategies, are applicable in helping to design more efficient patient flow in health care.

The general similarities in terms of needs and flow-complexity compared with industry, indicates that the introduction of supply chain theories could be beneficial to the health care sector. Health care is a service industry, which means that the customer is part of production process. Instead of going to the store to buy a finished product, a patient seeks medical help and is then a part of the whole process until the treatment is finished. Storage cannot be used, therefore the only alternative is a queue of patients waiting for assistance. Håkansson and Persson (2004) identify three trends in industry, one is increased focus on integration to reduce cost, the second is increased specialization, and the third is an increase in the rate of product changes and new introductions. The same development can be seen in the health care sector. Lean as a principle has been introduced to streamline processes and to reduce costs or the ability to treat more patients with the same resources. Specialization is driven by competence needs and medical development. Medical research is advancing at a fast pace, making it necessary for hospitals to continually adapt to new knowledge by introducing new treatments as well as developing already existing treatments.

Kumar *et al.* (2008) present earlier studies carried out in the field of health care SCM, of which many of the studies focused on reengineering. Jarrett (1998) describes the advantage of reengineering in the healthcare supply chain, noting that the healthcare industry has historically viewed itself as being operationally different from other businesses. Numerous investigators have studied the cases of process redesign in healthcare supply chains (Christopher and Marino, 1995; Cynthia and Muller, 1997; Huarng, 1998). Bar coding has also been suggested as the key to controlling health care industry's increasing costs (Rundle, 1997). Analysis of the complete healthcare system indicates that the supply management system is one of the primary areas where cost reductions are a predictable outcome (Butters and Eom, 1992). In accordance with this, Alt (1997) argues that the increase in healthcare cost and inefficiencies are due to inadequate and tedious purchasing procedures and purchasing information systems.

More recently, Chow-Chua and Goh (2000) investigated how quality management principles improved the healthcare sector in Singapore. Quality of care was evaluated in a study that investigated the costs of current hospital practices and their impact on quality of care Poulin (2003). Ford and Scanlong (2006) discuss the utilization and evolution of SCM principles in health care and identify specific elements of the supply chain being targeted through purchaser initiatives. Another recent article explores the barriers to implementation of SCM practices and concludes that one of the barriers to implementation is limited education on supply chain practices (McKone-Sweet *et al.*, 2005). An article by Shah *et al.* (2008), examine work design and process improvement in a health care supply chain. This article also discusses the concept of lean production, and the authors claim that many health care organizations in fact report using lean concepts. In their study they use lean principles in an investigation of front-office customer-processing health care service. Front office processes are argued to be considerably different as customer presence increases process variability, e.g. process time, delivery time etc. The implications of this study suggest that lean principles can be used successfully in health care service processes. An observation from a case study at one of the largest hospitals in Sweden shows that over half of the patients admitted to the hospital arrived through the emergency department, indicating that the supply chain has to be organized for quick response and flexibility, that is, to be agile.

Health care is organized in functional silos just as industry, and has a need of well functioning processes to meet patient demands on availability of services and short lead-times as well as on efficiency and quality of care. Many times the patient process involves a large number of functions in need of coordination both in space and time. This has consequences for the design of the supply chain that will be elaborated further in the end of the paper. The rest of the paper focuses on how industrial knowledge can support the design of health care supply chains using a combination of lean and agile process strategies.

3. Lean and agile as process strategies in industry

The lessons learned from Toyotas lean production principles have had a profound impact on manufacturing companies in a wide range of industries. Lean has brought with it an emphasis on creating good supplier partnerships, reducing the number of suppliers, transferring responsibilities to the supplier of just-in-time deliveries and quality.

Changing conditions of competition and increasing levels of economic and environmental turbulence in concert with the requirements for organizations to become more responsive to the needs of customers, has raised interest in the concept of

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"supply chain agility". A common thread of the literature defining agility has been the focus on being able to compete within a state of dynamic and continuous change (Sarkis, 2001). The concept of agility, according to Naylor *et al.* (1999) received attention later than the concept of lean thinking. In their paper they introduce leagility as a concept. The choice between agility and leanness can purposefully be related to the industrial organization school of thought in that agility may be a source of differentiation whereas leanness is a source of low costs. Agility is therefore not to be confused with leanness. Lean focuses on doing more with less, to be efficient, while being "agile" includes that the organization is able to respond rapidly to changes in demand (Christopher, 2000).

Christopher (2000) introduces that one single supply chain can consist of agile as well as lean parts, terming this a hybrid strategy. Christopher (2000) also makes a division into different parts of the organization's supply chain, and argues that a lean process strategy is appropriate upstream where the supply chain activities performed are planned based on forecasts. An agile strategy again is suitable downstream the supply chain, where demand is known and visible. The shift from lean to agile is done at what Christopher defines as the decoupling point. Kihlén (2007) takes this argumentation one step further when discussing logistics based business models, arguing that hybrid strategies display an ability to handle varying flows of goods in terms of volume and assortment while pursuing lean processes. An enabler behind this hybrid strategy, combining a lean process with an agile assortment, was identified in the standardized processes, which allow for high assortment variability.

A prerequisite for combining lean processes and agility in supply chains is the understanding of how activities and departments in hierarchic organizations can be integrated. Abrahamsson *et al.* (1998) point to separation as a means of integration in distribution channel reengineering, arguing separation to be "the key to the restructuring process and facilitates the other important aspect of channel re-engineering - the integration of activities" (Abrahamsson *et al.*, 1998, p. 244). In their argumentation, organizational separation and integration of functions improves the efficiency of the distribution process in three ways:

1 Economies of scale are exploited as a result of physical activities to be separated from administrative activities such as planning, allowing the physical activities to be consolidated. Cost advantages are then gained by increasing volumes, while reducing fixed costs.
2 A positive effect from this separation is greater specialization and increased expertise, from focusing on the core competencies, e.g. physical distribution in an industrial setting or, e.g. surgery or X-ray in the healthcare setting.
3 A prerequisite of this separation is modern IT/IS allowing increased coordination and control of information, both within functions and between functions in the supply chain.

Supply chain integration involves defining a clear division of roles between organizational units to increase specialization and to avoid double work and then defining internal processes, in order to build up a supply chain orientation in the organization (Mentzer *et al.*, 2001). This division of roles along the supply chain is meant to redesign a traditional functional set-up to a more process oriented one.

With this demand on processes, the flow of goods (or patients) is expected to be performed in a standardized way with high efficiency from a lean set-up. It is also flexible from high agility in some of the processes, to support different requirements and changing conditions. These processes are then used as pieces in a puzzle that can be solved in different ways, depending on how many of processes that are to be combined and how. This requires lean and agile process strategies to be combined in different ways in order to design the required output from the supply chain in focus, to, e.g. different customer segments.

The industrial experience points to the need for functional specialization as a means to achieve economies of scale, as well as the positive effects of mixing lean and agile process strategies in the same supply chain. The need of coordination between functions is also pointed out as a key issue.

Bohmer (2009, p. 16) points to the fact that " ... many of the approaches and tools drawn from industrial settings fail to adequately account for the residual uncertainty in medical care or explicitly address the experimental nature of much care."

During the last decade lean has been broadly introduced in the health care sector world wide, but as a company wide concept. A discussion of lean and agile process strategies is rare in health care literature. Experiences learned from lean and agile process strategies in industry, are that there has to be a well-defined flow of goods or services with a clear division of roles between functions and actors in the supply chain. The purpose with the empirical description in the next section is to describe such a flow (supply chain) in health care, as a basis for a more detailed discussion of the usage of lean and agile process strategies in the health care sector.

4. Swedish health care in a supply chain setting

The case presented is a study conducted in collaboration by Linköping University and Karolinska Institutet in Stockholm. The study is focused on innovation and change of care processes and involves 12 health care organizations ranging in size from large hospitals to single departments. The study is based on a systems approach, describing the supply chain (SC), the functions and the organization according to a framework on supply chain design developed by Aronsson (2000). The definition of a process is in this study borrowed from Aronsson *et al.* (2003) who define a process as: a chain of activities with a clear starting point and a clear end point, consisting of a number of steps, is both planned and repetitive, and has a clear goal and expected results.

A characteristic of a process is that it is spread beyond organizational functions and includes several activities, which are often both operative and administrative in nature. The characteristics of a standardized process are foremost that the process is planned and executed in a standardized manner.

In this case study we will describe patients with hip fractures. This is a fairly large group of patients with a care process involving six departments. There is also a clear need for short lead-times, where the goal is to start surgery within 24 hours. During 2008-2009 a change programme in order to become more flow-oriented and to reduce patient queues was conducted. During this period, semi-structured interviews with personnel from all involved departments were conducted

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every 6 months to describe the changes made and their result. In addition, flow mapping tools were used to describe the patient's pathway through the health care system from first contact till the last for a specific medical problem. In the following sections the supply chain from a patient perspective is described.

From a patient perspective, there is a high degree of variability between different supply chains in health care, from being a short episode in time to lifelong treatment of a chronic disease. The degree of complexity varies as well, from one doctors' appointment, to treatments that involve several care providers as well as social services support. Similarly, treating a patient in a hospital can involve one or several departments. Depending on the diagnosis the time frames (response time) for treatment can vary from minutes to hours to days or even weeks. Since hospitals are functionally organized, each function, e.g. cardiology or orthopedic department is involved in different supply chains, both short and long complex chains as well as in planned or emergency supply chains. This allows for functional specialization but makes it more challenging to design the supply chain in an efficient manner from a systems perspective. A description of one supply chain (hip fractures) is described in the following section, first the whole system is described and then a more detailed description of the subsystems are made to show the complexity of the system.

In Sweden, as in many other countries, the primary care, hospitals, and social services support are different organizations representing different responsibilities within the public sector. A vast amount of the patients are elderly and in need of increased social services, after a stay in the hospital, which causes problems of coordination. The patient process involves both several departments within the same organization as well as inter-organizational transfers. Describing the patients path through the supply chain however, includes five different steps: Social services, Primary care, Hospital, Primary care again and finally Social service again.

Hospitals offer a more or less broad spectrum of treatments, but because of organizational separation and specialization among hospitals, sometimes patients have to be sent from one hospital to another. From a process point of view however, patients always follow three main subprocesses; diagnosis, treatment and convalescence, as indicated in Figure 1.

All steps can be performed by one or several organizations depending on the patient. For example, the first stages of a diagnosis are conducted in primary care and after that the patient is referred to a specialist at the hospital who makes the final diagnosis.

To exemplify we have chosen to describe patients with hip fractures. It is a fairly large group of patients and the supply chain involves several departments and in addition social services are needed on many occasions. There are also clear demands on maximum lead-time due to medical reasons. The patients often arrive by ambulance to the emergency ward. A diagnosis is made which includes lab-tests and X-rays. The patient is transferred to the orthopedic ward to wait for surgery. After the operation the patient stays for a few days to recuperate. When leaving the hospital there is often a need for social services, which has to be planned and coordinated with the responsible municipality. The supply chain is complex and requires a great deal of coordination. From a production planning perspective the question is then how to organize work in the defined supply chain in an effective and efficient manner to meet the demands of this particular patient group and other groups of patients to be served from the same production resources. The studied hospitals are functionally organized in departments, e.g. emergency department, operating department, radiology department, and orthopedic department, forming the focused system, Figure 2.

Each department is in this functional set-up responsible for a large number of different patient groups representing different parallel patient supply chains. The complexity increases from the fact that each individual department has its own staff but also lends personnel from other departments. An orthopedic physician is employed by the orthopedic department and performs their duties within the department, but they also do work at the emergency department. As a consequence, several departments are sharing the same resources.

Before the patient arrives to the operating room (OR), preparations are made both at the orthopedic ward and at arrival to the OR, e.g. in terms of premedication and administrative controls. Once the patient arrives in the operating room preparations are made before the start of the operation. The work in the operating room is always done sequentially, see Figure 3. There are a number of people involved in the operating room; a registered nurse anesthesiologist, a theater nurse assisting the surgeon, one or two assisting nurses, and a surgeon. In the corridor outside the operating room there is an anesthesiologist supporting several operating rooms when needed. In total, five-to-six people are involved in an operation, each with different competencies and tasks to perform. If one person is delayed in their work it will delay the whole patient-process and if one patient is delayed it often delays the following operations as well. Due to the sharing of staff, delays can easily be spread to other departments and/or supply chains through the sharing of staff.

The operating procedure is often standardized; however the time for performing a task during the operation may vary depending on unforeseen complications. These variations are genuinely unpredictable and must be handled by flexibility. There are also a number of delays caused by personnel unavailability in time, delayed arrival of patients, preparations that have not been done correctly and so forth. These uncertainties are the result of poor discipline and management and can be reduced. Problems with delays are well documented in literature and are in fact a problem worldwide (Saha *et al.*, 2009, for further references).

After the operation there are a number of activities performed on the patient, for example waking the patient, removing covers and moving the patient from the operating-table. The patient is then moved to a recovery area and the operation-room has to be cleaned and prepared for the next operation.

Based on the empirical findings in the study the following characteristics of a health care supply chain have been identified:

Figure 1 The functional steps in a care process

Figure 2 Departments involved in the supply chain

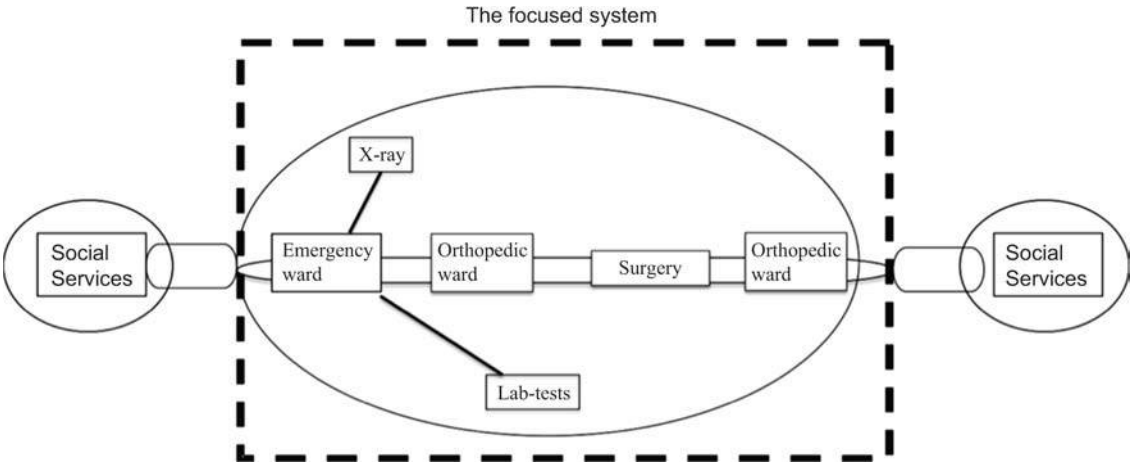
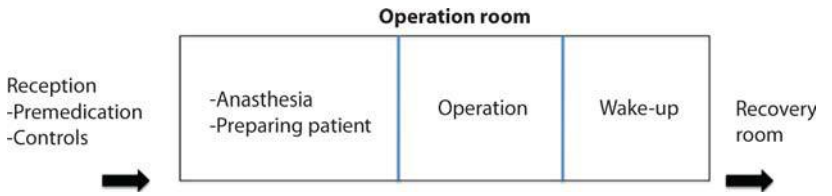


Figure 3 The sequences in the operation room



- A patient process, representing a health care supply chain is characterized by a large extension of lead-time uncertainties in individual functions because of the problem to predict the time of for example a surgical procedure.
- The supply chain is organized in functions, with a lack of a systems view or strategy for the supply chain as a whole.
- There is not only a lack of an overall supply chain strategy but also a strategy for the sub processes within each department and how they best contribute to the performance of the whole.
- The volumes are relatively small and the variety high, which indicates that agile strategies are to prefer before lean strategies.
- There is a mix of highly standardized treatments and new experimental treatments, with a high variation in the degree of standardization between different treatments.

5. Analysis – supply chain management in a health care setting

Uncertainties are in lean theories considered to be wastes and should be eliminated. Eliminating internally caused uncertainty is also important when using an agile strategy. For both strategies it is important to reduce uncertainty created by the organizations themselves. The difference lies in how genuine uncertainty is handled. As the example shows there is genuine uncertainty in customer demand as well as in activity lead-time. The sharing of personnel can spread uncertainty between sub-processes and between supply chains making it difficult to foresee the consequences of a delay for the organization as a whole.

Even if lean inspired approaches have been used in several of the hospitals in the study, it has mainly been in order to create a platform from which a more proper production planning can be made. This could be called "lean basics" with the overall purpose of reducing waste and to prepare the organization for a change towards a process orientation according to the SCM-philosophy.

Considering the diversity of demands and needs for the patient processes concerning availability and lead-times and the complexity in production planning due to uncertainty – it can be concluded that different process strategies are needed to fully describe and design a health care supply chain. The traditional lean approach in industry is to protect production from shifts in customer demands by keeping stocks, or in the case of health care, queues. The agile approach is to work with flexible capacity. The difference is illustrated in Figure 4.

Working with fixed (or planned) capacity as in a lean approach, is built on the logic of having high utilization of resources in the processes, e.g. personnel and equipment. Consequently, lead-times will vary over time, depending on volumes to be processed. Large volumes of patient's, above planned capacity, results in longer lead-times and queues, as described on the left hand side of Figure 4. Thus there must be a warehouse or queue buffering one sub-process from the other (which is the case for hip surgery today with long queues and long waiting times for the patients), equal to the principle of "produce to stock". The other alternative, right hand side in Figure 4, is to work with flexible capacity and fixed lead-time, according to the principle "produce to customer order". This step requires high availability of extra personnel or other resources needed to perform the process on-time, independently the actual volume. The advantage with this approach is that the next sub-process receives reliable deliveries in terms of on-time deliveries. This will considerably shorten throughput times in the system as a

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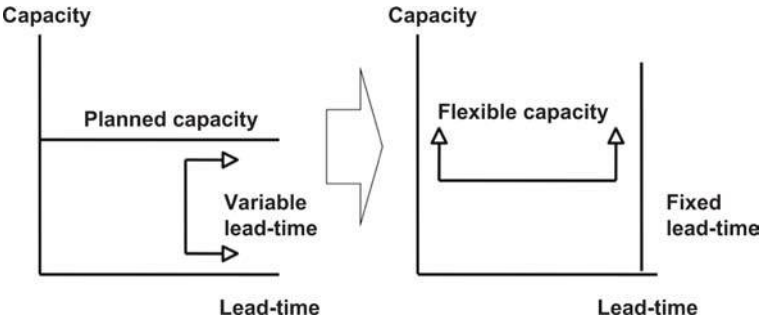
Figure 4 Fixed and flexible, lead-time or capacity



whole (Aronsson, 2000) and in health care it will shorten the queues.

One example of how to handle uncertainties that recently has been introduced in the studied case is the move of preparations from the operating room to another area where patients are prepared by dedicated staff. By doing so it is possible to prepare patients in advance in order to avoid influencing the starting time of the operation if delays occur – equal to a buffer separating an integrated process into two separated sub-processes.

Based our case we have found that the being lean before the decoupling point and being agile after this point is not applicable in a healthcare setting. The reason for this is that the patient (customer) is involved in the whole process. Instead the critical issue seems to be the variety in response-times and lead-times. The variety is high and at the same time there is variability in customer demand, representing the flow of patients. On top of that, as shown in the operation-room example, there are internal variances in time, which further increases the need for flexibility. The first step to manage this is to divide the supply chain process into sub-processes following the department boundaries and thus following the formal organization. As shown in the Operating room example, this approach can be used to further subdivide the process into even smaller parts.

However, that does not mean that all sub-processes need to be agile. From a production planning point of view there are sub-processes that are the same for all patient groups, the variety is thus small and the volume large indicating lean strategies. One example of this is standard blood analysis where the process is exactly the same every time. Thereby, we argue that it is not a question of lean or agile but about combining them in an intelligent way, and using the right process strategy for the right part of the supply chain, according to its specific characteristics. In health care the difference in a lean and an agile process strategy can be summarized as in Figure 5.

From a patient perspective, a supply chain for one patient group passing through different departments can be designed by combining an agile strategy in department 1, followed by a lean strategy in department 2 and so forth. The combination of strategies can differ between different patients groups supply chains, which is often the case in health care were both acute patients as well as scheduled patients are using the same resources.

The theories on hybrid strategies are interesting if the main patient process can be divided into a large number of smaller parts or sub-processes, where each sub-process is standardized. Then, for each of the sub-processes either

Figure 5 Characteristics of lean and agile strategies in a health care setting

	Lean	Agile
Main focus	Inward – reduce waste – cost reduction	Customer – quicker response, greater flexibility, lead-time
Strategy for handling uncertainty	Queues and buffers to protect a sub-process	Sub-processes are not protected
Planning	Fixed capacity	Flexible capacity
Traditionally used when	High volume, predictable demand	Low volume, high variety and/or variability
Industrial examples	Toyota	Dell, Wal-Mart, Inditex

lean or agile could be used as a main strategy, leading to a mix of lean and agile strategies for the process as a whole. This is close to the other form of hybrid strategy, where a mixed portfolio of products and markets result in a mix of lean and hybrid strategies depending on the characteristics in demand for those different products on those different markets (Christopher, 2000).

We suggest that the following issues are important to consider when developing a supply chain in health care – however, not necessarily in the presented order:

- To define the overall system and the supply chain that is to be redesigned.
- To decide on the need for functional specialization. In industry it is often done on grounds of economy of scale. In health care competence as a means to improve quality is an important factor to consider.
- To decide how the supply chain should be divided into sub processes, depending on the services needed from different departments.
- To describe and define the interface between sub processes. Whether or not a lean or an agile strategy should be used for a sub process depends on the interface. If a lean strategy is to be used, the sub process has to be protected from uncertainty by using patient-queue as a buffer, so that the process can be planned and balanced in advance. Sources of genuine uncertainty in the cases are caused by, varying customer demands, varying production lead-times, and uncertainties spread by the sharing of personnel. If an agile strategy is to be used, the interface is

defined in terms of delivery time between processes, which is possible if there is flexibility in resources available.

6. Final discussion

As McKone-Sweet *et al.* (2005) note, there has been limited success in making system-wide SCM improvements in the healthcare industry. However, there is significant evidence that the industry is in need of greater changes. From experience SCM works well as an overall philosophy for a more efficient health care. For the supply chain as a whole the goals for each sub-process must be that it can be relied upon to deliver according to agreement, which is reached, from combining a set of lean and agile sub-processes in a flexible supply chain setting.

A prerequisite for SCM is that a supply chain strategy exists for the system as a whole. If so, the study supports that SCM theories are useful for patient flows in a health care setting. The case exhibits high complexity, and the balancing of the need for functional specialization and efficient and high quality patient processes is an important issue.

Another prerequisite is developing a supply chain orientation (SCO), which requires a shift from functional to process thinking (Mentzer *et al.*, 2001). We regard SCO as a first step (and a prerequisite) towards SCM and that all actors involved in SCM must have a SCO, which is summarized by three main characteristics;

1 The supply chain actors should have a systems approach and regard the supply chain as a whole.
2 A strategic orientation where cooperative efforts by the supply chain members should synchronise and converge operational as well as strategic capabilities into a unified whole.
3 A focus on customer value in order to create customer satisfaction.

The challenge of designing, integrating and implementing cost-effective and at the same time flexible health care systems is to apply an interdisciplinary systems approach, where the production processes and flow of patients are in focus. We believe that a prerequisite is to widen the system borders, allowing the system in focus to include multiple sub-systems which are optimized by their own, in order to achieve a supply chain orientation in the organization (Mentzer *et al.*, 2001). This change will make it possible to consider the system as actor-neutral, which allow us to define and design new interfaces and new sub-systems between existing and new actors. All from the overall demands on the system as a whole, e.g. increased availability of the service and reduction of waiting times for the patients.

Such a systems approach will then increase the possibility of:

- Defining new targets, measures and driving forces for the system and for its sub-systems, from the principle of optimizing the system as a whole.
- Identifying new system roles and actors, e.g. a planning functions supporting and controlling the production specialists and the sub-processes, according to the targets for the system as a whole.
- Defining new and more efficient interfaces and co-planning between the actors, in order to improve the co-ordination of different specialists or treatments, e.g. pre-surgery functions like screen tests that are coordinated with surgery.

Our conclusion is that it is necessary to focus on two types of processes; one is the overall patient process and the other is the production process. Since there are a number of different patient processes in a hospital the key question is how to design an organization that can handle several unique processes in a structured and standardized manner. The lean concept as used at the hospitals today is with the purpose to improve the production planning and reduce waste. But the main problem in today's health care is lack of flexibility. Therefore, it has to be followed by a combination of lean and agile sub-processes, where SCM is the overall philosophy and the glue keeping these processes together.

Based on this discussion we suggest further research on how to implement a systems approach and a supply chain orientation in a health care setting. The following areas have been found relevant for further research and are often mentioned in supply chain literature as important:

- Trust towards partner is perhaps one of the most commonly mentioned prerequisites and cornerstones of the SCM philosophy within organizations and between. How can a supply chain be designed to support trust?
- Strategies for supply chain design, which are shared by all involved parties.
- The role of top management in building supply chains in health care.
- How can information sharing support supply chains.
- Methods for joint planning.

A prerequisite for this is a systems approach that will allow us to understand and deal with the systemic problems and increase the possibility to apply flow-oriented concepts, with lean or agile process strategies into practice in the health care context.

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