Integrative practices in hospitals and their impact on patient flow

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Integrative practices in hospitals and their impact on patient flow

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Abstract

Purpose – The aim of this paper is to investigate which integrative planning and control practices are used in hospitals and what their effects are on patient flow.

Design/methodology/approach – The study is based on a three-hospital multi-case study carried out in The Netherlands. The main findings are based on over 40 in-depth interviews and the analysis of detailed patient flow data. The analysis of the flow data is used to explore the effects of integrative practices on lead times and patient flow.

Findings – Based on the various patient groups examined in the different hospitals, four integrative practices stand out: sharing waiting list information, sharing planning information, cross-departmental planning, and combining appointments. In line with earlier studies, the overall level of integration in hospitals was found to be low. However, patient flow performance is significantly better in those hospitals that employ more of the above-mentioned integrative practices.

Research limitations/implications – The study was limited to three major patient groups within the orthopedic supply chain. The deliberate choice for these patients groups was based on the expectations that integration in hospitals is relatively low and that the highest levels of integration would be found in high volume – low variety patient groups. Further research should include patient groups with less favorable characteristics such as lower volumes and/or greater variety.

Practical implications – This study provides clear support for the value of integration initiatives in healthcare operations. The performance of hospitals, in terms of patient flows, benefits from cooperation between the various members of an internal supply chain. Hospital administrators and medical professionals could learn from these results and attempt to abandon their silo mentality and start integrating for and their patients' and their own benefit.

Originality/value – Despite the importance of integration in hospitals, little is known about the integrative practices hospitals actually employ. Most existing studies on patient flows are confined to a single stage in the care process. In this study, the effects of integration in the internal supply chain from the first visit to the end of treatment are examined.

Keywords Integrative practices, Patient flow performance, Case study, Hospitals

Paper type Research paper

Introduction

Torn between reducing costs and improving service levels, healthcare service providers struggle to improve their internal supply chains. Improving patient flow and lead times might well be valued by patients but these improvements can lead to an increase in costs. The various departments involved in the different steps of a care process traditionally focus on their internal processes and costs. In general they are not naturally inclined to coordinate their activities with other departments involved in the same care process. Consequently, it is a challenge for hospital managers to determine which practices will increase patient flow without investing in expanded capacity. Integration has been an effective method in increasing flows in supply chain management. Therefore, the main aim of this study is to examine which integrative

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practices are currently used in hospitals, and to what extent such practices are effective in increasing patient flow.

In a review of hospital-oriented operations management literature, White *et al.* (2011) show that the majority of studies on the planning and control of care processes concentrate on single-stage systems. Rhyne and Jupp (1988) had already recognized that proper planning should tie together key functions within a hospital. Haraden and Resar (2004) show that flow improvements within individual departments often exacerbate problems for other dependent departments. However, most departments in hospitals still operate independently (Lega and DePietro, 2005). Consequently, the different process steps patients undergo are not aligned, and this results in discontinuous patient flow. Improving the flow of patients is seen as crucial for increasing hospital productivity and increasing patient satisfaction (Litvak, 2009; Villa *et al.*, 2009).

It is well known from organizational studies that hospital departments/specialties are highly differentiated (Glouberman and Mintzberg, 2001) and have a high degree of professional autonomy (Smithson and Baker, 2007). Integration is an important theoretical stance with respect to aligning different departments. Integration entails organizational entities within a firm not acting as functional silos, but as a unified whole (Barki and Pinsonneault, 2005). Several authors have found empirical evidence that integration leads to higher performance in a manufacturing context (Narasimhan and Das, 2001; O'Leary-Kelly and Flores, 2002). More specifically, Droge *et al.* (2004) found positive effects of integration on several time-based measures, albeit only in specific parts of a supply chain. Despite the positive effects of integration in manufacturing, it remains unclear if the findings from such integration research can be translated to a healthcare setting (Thrasher *et al.*, 2010). So far, research has paid little attention to what practices might be effective in this specific context, and what the effect of such practices would be on patient flow performance.

The main thrust of this paper is that patient flow performance should be evaluated from the perspective of the entire internal supply chain. On this basis, there are two important gaps in the literature which need to be addressed. First, most studies fail to address entire internal supply chains, while only an integrated approach seems able to address current management problems in healthcare. Second, little is known about how hospitals integrate their internal supply chains and what effects integrative practices have on flow performance.

In this paper we address these two gaps and examine the effects of integration on patient flow performance in three hospitals. Specifically, we investigate within these hospitals the integrative practices with respect to planning and control and we assess the effects of these practices on flow performance. In a multiple case study, we investigate the integrative practices found in the orthopedic supply chain within the three hospitals. Within this orthopedic supply chain, we focus on three patient groups, for which different integrative practices are employed. Our empirical findings provide compelling evidence that although integration is limited, the integrative practices that are implemented enable the hospitals to perform significantly better than hospitals that have not implemented these practices. The results provide health service providers with insights and tools on how to improve organizational performance without compromising patient service performance, and show the importance of overcoming the current silo mentality which still thrives in hospitals.

The paper is structured as follows. First, in the theoretical background section, we present our research model based on the literature reviewed on patient flow, internal supply chains in hospitals, and the concept of integration. This is followed by an explanation of the case study methods. In the results section, we discuss how the integration mechanisms we found affect patient flow performance. Following the subsequent discussion section where we interpret the results, we present our conclusions and the theoretical and managerial implications of this research.

Theoretical background

Patient flow and internal supply chains

Improving patient flow is seen as of great importance in boosting hospital performance (Litvak, 2009; Villa *et al.*, 2009), since flow performance is an important aspect of organizational performance (Schmenner and Swink, 1998; Schmenner, 2001). In line with the definition of flow by Hopp and Spearman (2001), patient flow performance is defined as the speed at which patients are transferred from one step in the care process to the next. According to Schmenner and Swink (1998), improving flow performance can be achieved by overcoming three barriers: bottlenecks, non-value-added activities (e.g. unnecessary waiting or unnecessary process steps), and variability associated with the flow.

Removing one or more of these barriers in order to improve patient flow performance requires including all the relevant departments in a single investigation, rather than examining the contribution of each department individually. Haraden and Resar (2004) even suggest that an individual department that improves flow in its area alone could harm performance in other dependent departments. Nevertheless, most contributions on patient flow continue to focus on single stages of internal supply chains (Haraden and Resar, 2004). For instance, O'Keefe (1985), Swisher *et al.* (2001), Akcali *et al.* (2006) and Chand *et al.* (2009) focus on outpatients; Edward *et al.* (2008) on the pre-assessment stage; Vissers (1998) on inpatients; and Santibáñez *et al.* (2009) on ambulatory services. We could only find two contributions that have focused on several consecutive steps in the care process (Fredendall *et al.*, 2009; White *et al.*, 2011). However, even these contributions do not consider the patient's journey through the entire internal supply chain, and provide little insight into how to improve patient flow throughout a care process.

The lack of an internal supply chain perspective in hospitals can be explained by the fact that hospitals are traditionally considered to be a collection of individual resources or service centers (Roth and Van Dierdonck, 1995). Most general hospitals have adopted a functional organizational structure, built around discipline-based specializations (Lega and DePietro, 2005). These specializations are mostly based on anatomical divisions or medical technologies, and to a lesser extent based on segments of the population (e.g. age groups) or urgency (Montgomery, 1990). Given this strict functional division and the autonomy of departments, the planning and control of each department's resources is carried out locally and decoupled from other departments.

Over the past three decades, several approaches have been proposed that adopt a process view on the delivery of care, rather than the classical functional perspective. These ideas include service lines (MacStravic, 1986; Berenson *et al.*, 2006), focused factories or specialty hospitals (Herzlinger, 1997; Cram and Rosenthal, 2007), and clinical pathways (Pearson *et al.*, 1995; De Bleser *et al.*, 2006). Such approaches reflect that considering hospitals as a set of internal processes, rather than as a set of departments, is gaining momentum in both academia and hospital management circles. In reviewing the healthcare operations literature we find an important paradox. On the one hand, the contributions that adopt a process or internal supply chain view do not focus on planning and control aspects whereas, on the other hand, if planning and control are considered then it is not usually from an internal supply chain perspective. For instance, in appointment scheduling, the dominant focus is on a single-server situation (Bailey, 1952; Cayirli and Veral, 2003; Green *et al.*, 2006; Cardoen *et al.*, 2010). Again in studies on the scheduling of ancillary services such as laboratory services (Abdul Hamid *et al.*, 2010) or diagnostics services (Green *et al.*, 2006), the linkages with the other parts of the internal supply chain are not considered. Beyond the scheduling literature, we were able to find a few contributions that consider two-stage systems. Longo and Masella (2002), Beliën and Demeulemeester (2007) and McGowan *et al.* (2007), for example, link operating theatre capacity to ward capacity. Although these examples provide some insight into multi-stage systems, most contributions on capacity management or the management of patient flow do not go beyond two consecutive steps in a care process (White *et al.*, 2011), let alone discuss how to create a more integrated internal supply chain in hospitals.

Integration

As little research has been conducted on integration within a healthcare context, we have to draw on other fields of research. The concept of integration is thoroughly ingrained in both organization theory (Lawrence and Lorsch, 1969) and operations management (Hayes and Wheelwright, 1984), and is also considered as an important concept in supply chain management (Flynn *et al.*, 2010). However, there is no generally accepted definition (Mendes Primo, 2010). Typically, integration is defined according to several multilevel constructs such as interaction, collaboration, and cooperation (Frohlich and Westbrook, 2001; Pagell, 2004; Braunscheidel *et al.*, 2010; Flynn *et al.*, 2010). We position our research around the central idea of integration: breaking down the functional barriers which appear both within and between firms (Zhao *et al.*, 2011).

Pagell (2004) supposes that integrative efforts move along a set course, from no integration to full integration, in discrete steps. These steps can be classified along several scales. When looking at the various classifications in the literature we can distinguish between the scope of integration, the span of integration, and the intensity of integration. The scope of integration addresses which aspects of the organization are integrated. Jaspers and van den Ende (2006) distinguish integration in the areas of coordination, tasks, ownership, and knowledge. Van Donk and Van der Vaart (2004) define five dimensions of supply chain integration: organization, physical flow, information flow, product development, and planning and control. Since our research is limited to planning and control, we do not need to elaborate on the various scopes of integration. The span of integration addresses which, and how many, organizational entities (e.g. departments, business units, organizations) are integrated. Stevens (1989), divides the span of integration into four incremental categories: no integration (baseline), functional integration, internal integration, and external integration. Frohlich and Westbrook (2001) have a similarly increasing scale of integration: inward facing, periphery facing, and outward facing. Compared to the span of integration, the intensity of integration focuses more on the nature of the integration. In defining the intensity of integration, Van der Vaart and Van Donk (2004) identify three stages: the transparency stage, in which supply chain members share relevant information on issue like inventories, demand, and promotions; the commitment and coordination stage, where supply chain members not only share relevant information but are also bound by quantity commitment clauses or similar; and finally the integrative planning stage, where the planning and control of at least part of a supply chain is effectively centralized. Integrative planning and control practices can therefore differ in terms of the span and the intensity of integration, and thus vary in the way they influence patient flow performance.

Research model

In this study, we aim to contribute to the understanding of how the integration of planning and control affects patient flow performance. A positive effect of integration on patient flow performance is suggested by Fredendall *et al.* (2009) although they found little empirical evidence to link the two concepts. We argue that if the integration of planning and control contributes to patient flow performance it will do so by overcoming one or more of the barriers to flow proposed by Schmenner and Swink (1998). That is, integrating planning and control either reduces the variability associated with patient flow or helps in removing bottlenecks or non-value-added activities in a care process (Figure 1).

Considering the three barriers to flow, it seems logical that integrating planning and control should reduce non-value-added activities by reducing the number of queues in a process by linking the capacities of the process steps and reducing the period between times of scheduling (i.e. a patient does not have to wait for a process step to be completed before being scheduled for the subsequent process step). A reduction in variability can be achieved through information sharing (Chen *et al.*, 2000; Chen and Lee, 2009) and capacity coordination (Frohlich and Westbrook, 2001). Whether integration can remove bottlenecks is less certain. We argue that temporary bottlenecks (such as those caused by peaks in demand) can be eliminated through a reduction in variability. However, a structural bottleneck can only be eliminated by increasing capacity or reducing the demand for the existing capacity. One way in which the integration of planning and control could contribute to a reduced demand for capacity is by establishing a patient acceptance policy (such as a pull system which uses information from all the steps in the care process to determine the workload in the system. Entry to the system would be refused when the workload is too high for any one of the steps). This, however, could result in the undesirable scenario of refusing patients access to a care process.

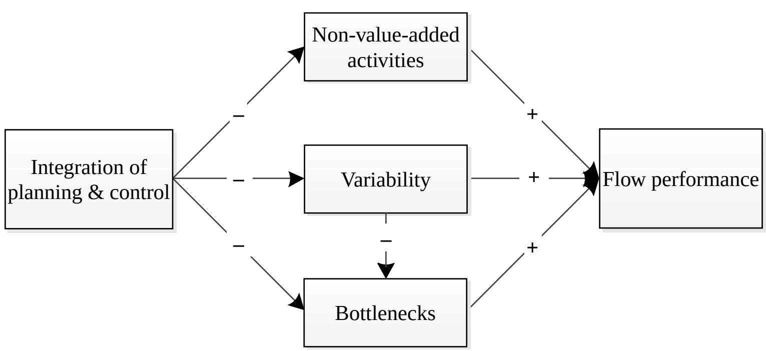

Figure 1.
Research model

Although, a relationship between integration and patient flow performance seems logical, we know very little about which integrative practices are actually employed in hospitals and how they affect the barriers to patient flow performance. Based on the classifications of integration, we believe that hospitals can take various integrative routes to improve their patient flow performance. Given that hospitals generally show a low degree of integration (Bamford and Griffin, 2008), we would expect to find integrative practices with a relatively narrow span and of low intensity. Moreover, we would expect an increased span of integration and an increased intensity of integration to lead to improved patient flow performance.

Methodology

Given that little knowledge exists on how hospitals integrate their departments, and how such integrative practices influence patient flow, we have opted for an exploratory case study as suggested by Eisenhardt (1989) and Yin (2003) for such situations. The case study methodology is considered very useful when the research aims to answer "why" and "how" questions (Yin, 2003). Moreover, this methodology is underused in the field of operations management but is seen as able to contribute to enriching the field (Voss *et al.*, 2002). We chose a multiple case study approach as evidence gathered from such an approach is often more compelling than from a single case (Yin, 2003) Further, the use of multiple cases increases the external validity of the research (Voss *et al.*, 2002).

Following Stuart *et al.* (2002), we selected three hospitals based on their diversity in employing integrative practices and thus their potential to contribute to the research objective. Two of the selected hospitals displayed a relatively high degree of integration, whereas the other hospital showed relatively limited integration. Besides the diversity in integrative practices between the hospitals, we also noted that each hospital employed different integrative practices for specific patient groups, which allows both theoretical and literal replication (Yin, 2003). Given that we did not expect to find high degrees of integration throughout the hospitals, we carefully selected three patient groups that are most appropriate for integration, ones that can be characterized by high volumes, low variety, and low routing variability. Moreover, we decided to choose patient groups that all used the services of the same departments in each hospital and so selected three orthopedic patient groups: Meniscus, Total Hip, and Total Knee. All these patient groups use the services of the orthopedics, radiology, and anesthesiology Departments and of the operating theatre. The patients follow a similar, well-defined, care process in each of the case hospitals. With our unit of analysis being a patient group, we thus investigated a total of nine patient groups.

Capacity utilization is an important variable that affects patient flow performance (Hopp and Spearman, 2001). From a practical perspective, controlling capacity utilization in hospitals proves to be very difficult. Due to the influence of urgency, physician preferences, and patient preferences, it is difficult if not impossible to synchronize at the resource level among different hospitals. Therefore, we chose hospitals with similar high levels of capacity utilization. All three hospitals strive for and achieve high occupancy rates for their key resources (magnetic resonance imaging (MRI) and OR) and we considered them as comparable. However, if a difference in capacity utilization arises, as a possible explanation for better flow performance, we will explicitly address this in our results.

Data were collected in the three hospitals between July 2010 and December 2010. The main data sources consist of quantitative patient flow data covering over 8,500 patients treated during 2009 and 2010 plus 41 in-depth structured interviews. Data triangulation (Eisenhardt, 1989; Stuart *et al.*, 2002; Yin, 2003) was addressed by using multiple respondents, archival data, and observational data. Further, the study's results were presented to all the respondents in each of the hospitals and an earlier draft of this paper was sent to all the respondents for comment. The respondents were invited to react both to the presented results as well as the written draft, and relevant comments and suggestions were incorporated in this revised paper.

The quantitative data used consist of information from each hospital's information system. This system contains the dates of each activity performed by the hospital for each patient and is based on the Dutch diagnosis treatment combination (DBC) system, which is comparable to the more widely known system of diagnosis-related groups (DRGs). However, unlike the DRG system, the DBC system is episode-based and each episode/activity performed within the hospital is registered, from the first outpatient clinic visit through to clinical discharge (Steinbusch *et al.*, 2007). Based on these data, we have reconstructed the complete care process and the time required to complete it for each orthopedic patient. We used qualitative data to determine the span and intensity of integration, and this information was obtained through interviews with hospital managers and department heads, and with physicians, nurses, and planners from each of the four departments involved. In total 41 interviews, with lengths between one hour and two and a half hours, were conducted.

The data analysis consisted of three parts. First, we mapped each of the internal supply chains. In mapping the orthopedics supply chain we took a process point of view, an approach generally not used in supply chain research (Oliva and Watson, 2011). This process view provided a "fine-grained qualitative data analysis" by creating visual maps (Appendix) of the functions and processes (Langley, 1999) and provided a chain of evidence (Miles and Huberman, 1994), which was further supported by the qualitative data obtained from the interviews. Second, the qualitative data from the interviews were coded using existing classification schemes found in the integration literature. For the span of the integration, the definitions of Stevens (1989) were adapted; and for the intensity of integration we followed Van der Vaart and Van Donk (2004). This led to the classification presented in Table I. The third and final step of our analysis consisted of assessing flow performance. We compare the flow times between several steps in the care processes for each unit of analysis. The focus is on those parts of the internal supply chain where we found integrative practices. The flow performance was assessed in two ways. First, we compared and visually displayed the cumulative percentages of the patient population that finished a specific part of the process within a specific lead time. Second, the flow performances at the different hospitals are statistically compared using the Mann-Whitney-U test for each step. This test was selected because the data did not pass the test of normality.

Results

The results section is structured according to the span of integration and distinguishes "no integration", "functional integration", and "internal integration". This structure is based on the notion that organizations, in their integrative efforts, move along a set course in discrete steps from no integration to full integration (Pagell, 2004). Within each

Span	Description
Functional integration	Integrative practices between two members (dyad) of an internal supply chain
Internal integration	Integrative practices between more than two members of an internal supply chain
Intensity	*Description*
Transparency stage	Members of the internal supply chain share information with other members of the supply chain relevant to the planning and control of patients
Commitment stage	Rather than just sharing information, the internal supply chain members enter into commitments regarding capacity allocation, service level agreements, prioritization of patient groups, etc.
Integrative planning stage	The capacity of different departments is linked through combined patient planning, guided by a central objective

Source: Adapted from Stevens (1989) and Van der Vaart and Van Donk (2004)

Table I.
Span and intensity of integration

integration span, we distinguish three levels of intensity. As the "no integration" category has no intensity classifications, we effectively divide the integrative practices we found into six categories (Table II). For each of the integrative practices found, we elaborate on the flow performance effects associated with the part of the process in which the integrative practice occurs. First, in order to understand the empirical setting, we describe the orthopedics internal supply chain as observed in the three hospitals.

The orthopedics supply chain

In general, the care process of an orthopedics patient consists of three stages: diagnosis, pre-assessment, and treatment. Within these stages, several process steps take place and most patients go through the following sequence of process steps (Figure 2). A patient's first orthopedic outpatient clinic consult (OPC1) is preceded by an X-ray performed by radiology. If additional diagnostics are required after the first consult, the patient undergoes MRI, which is followed by a second orthopedic consult (OPC2) to discuss the outcome of the MRI. Where a patient requires surgery, this diagnostic stage is followed by a pre-assessment stage in which the patient has to be evaluated as fit for surgery and is then prepared for the upcoming surgery. This involves attending an orthopedics nurse consult (OC) and an anesthesiology consult (AC). After the patient is declared fit for surgery, the patient will undergo the surgery (OR) attended by the orthopedic surgeon and an anesthetist. In each of the hospitals studied, the internal supply chain for orthopedic patients consisted of four main departments – orthopedics, radiology, anesthesiology, and the operating theatre – all contributing their resources to one or more stages of the care process. Figure 2 also shows the responsibilities of each of the supply chain members, represented by the dotted arrows, in the various stages of the orthopedics care process. The flow of patients is represented by the arrows between the process steps.

The remainder of this section is structured according to the span of integration, i.e. no integration, functional integration, or internal integration, and within each of these classes we discuss the intensity of the integration. In other words, we start by describing the negative effects observed on patient flow performance resulting from a lack of integration. Then we report on manifestations of functional integration and integrative planning, and their effects on patient flow performance.

Table II.
Integrative practices employed in the three case hospitals

Functional integration			Internal integration		
Transparency	Commitment	Integrative planning	Transparency	Commitment	Integrative planning
Hospital 1					
Sharing of planning information (radiology and orthopedics)	Cross-departmental scheduling (orthopedics and anesthesiology)	Combined appointment (OC and AC)	Sharing of planning information (the OR schedule is leading)		
Sharing of waiting list information (anesthesiology and orthopedics in order to schedule the OR)	Cross-departmental scheduling (orthopedics and the OR)	Combined appointment (by means of overcapacity X-ray and OPC1)			
Hospital 2					
	Cross-departmental scheduling (orthopedics and radiology)		Sharing of planning information (orthopedics, radiology, anesthesiology and OR)		Combined appointment (OPC1, OC, AC and OR; for a small patient group)
Hospital 3					
Sharing of waiting list information (radiology and orthopedics)	Cross-departmental scheduling (orthopedics and the OR; faulty scheduling results in capacity loss)	Combined appointment for (OC and AC)			
Sharing of waiting list information (anesthesiology and orthopedics to schedule the OR)					

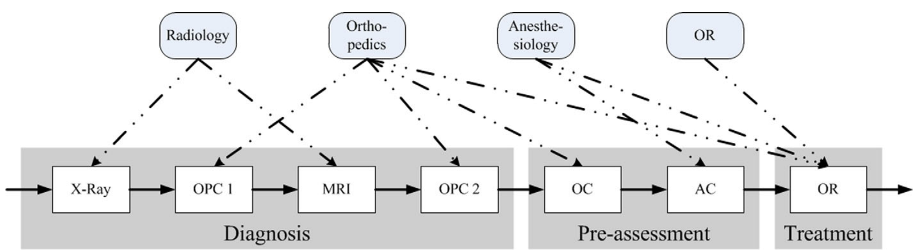

Figure 2.
Process steps for orthopedics patients

The lack of integration and its effects on patient flow

From our interviews, we could conclude that a lack of integration in planning and control has a number of negative effects on patient flow. One of the most striking observations was the autonomy of anesthesiology that we observed in all three hospitals. This autonomous planning hinders the balancing of capacity and the setting of effective priorities, and results in excessive throughput times. An orthopedic surgeon in Hospital 3 noted: "Access time to the OR is only one week, but I have to wait four weeks for anesthesiology to approve the patient for surgery". Not only does this autonomous planning have negative effects on patient throughput time, it also negatively affects resource utilization, as expressed by an orthopedic surgeon from Hospital 1:

> I would really like a small buffer, of five to ten patients, who are already approved for surgery, that I could use to fill acute gaps in our OR schedule. However, I cannot arrange this with Anesthesiology.

We observed several situations in which the lack of an exchange of logistical data negatively affected either the patient or the hospital administrators. An MRI technician at Hospital 1 noted that: "The orthopedic surgeons 'promise' the patient a certain access time to the MRI, which we cannot deliver". Misinforming patients about waiting times creates a discrepancy between a patient's expected waiting time and the actual wait. Cassidy-Smith *et al.* (2007) show that this type of expectancy misinformation negatively affects patient satisfaction. Besides the negative effects on patient satisfaction, the failure to exchange logistical information hinders management in taking effective action. The orthopedic unit manager of Hospital 2 stated: "Real-time control information is completely lacking, sometimes I have to wait for three months before I get insight into the production we have realized".

A positive observation is that the hospitals investigated do seem to be starting to recognize that a care process should not be planned and controlled in a stepwise manner if they want to fulfill the requirements of patients and live up to the standards set by the government. This has resulted in several examples of integration in the internal supply chain.

Functional integration and patient flow

With functional integration we refer to integrative practices linking the planning and control functions of two departments. Table II provides a summary of all the integrative practices we observed within the hospitals. The table shows that, compared to Hospitals 1 and 3, Hospital 2 seems to lag behind in terms of integration. It also shows that functional integration is the dominant form. In this section, we will now discuss each of the functional integrations found in the three hospitals, in terms of the three stages of integration intensity (i.e. the transparency, commitment, and integrative planning stages).

The most evident manifestation of transparency in functional integration was in the sharing of MRI planning information between orthopedics and radiology. In Hospital 1, radiology provides the planned date of a patient's MRI to orthopedics, which gives orthopedics the opportunity to plan a consult to discuss the MRI outcome shortly after the planned MRI date. orthopedics is then responsible for communicating both dates to the patient. In Hospital 3, orthopedics is kept informed on MRI waiting times. As a result, orthopedics can schedule a consult to discuss the MRI outcome before the actual

MRI is scheduled. In Hospital 2, such information was not exchanged between departments. Figure 3 shows the effects of information sharing between radiology and orthopedics on patient flow. The figure shows the cumulative percentages of the patient population with specific throughput times. The figure shows that, for Hospitals 1 and 3, over 50 percent of all patients completed the OPC1, MRI and OPC2 stages within 27 days, whereas for Hospital 2 the equivalent figure was 36 days. This clearly indicates the positive effects of transparency on patient flow. Other evidence of the transparency stage being reached in functional integration is found between the OPC and OR process steps. In Hospital 2, the scheduling of patients for OR is done by the Admissions Office. In both Hospitals 1 and 3, orthopedics is allowed to itself schedule patients for the OR, using a template provided by the OR. In both these hospitals the respondent responsible for scheduling patients for the OR stated that they did "not wait for Anesthesiology to approve surgery before scheduling the operation"[1]. This was not the case in Hospital 2. Hospitals 1 and 3 were able to schedule patients directly after the OPC (albeit including sufficient waiting time for the pre-assessment), whereas Hospital 2 would wait to schedule until approval had been given by anesthesiology. When looking at the flow performance between the pre-assessment and the OR stages, it is clear that both Hospitals 1 and 3 outperform Hospital 2 (Figure 4).

We found several practices which we judged as having achieved the commitment stage. The first such practice found was in the dyadic relationship between orthopedics and radiology. Hospitals 2 and 3 both use an appointment system to plan patients for an X-ray. However, in Hospital 2, orthopedics can schedule patients themselves, whereas in Hospital 3 patients are scheduled by radiology. The orthopedics secretary from Hospital 3 stated that: "in most cases, but not all, we are able to schedule X-rays just before the OPC visit". Looking at the flow performance of this stage (Figure 5), we see that Hospital 1 can guarantee same day access to the X-ray department for 99 percent of patients, whereas Hospitals 2 and 3 are able to guarantee same day access to the X-ray department for 92 and 81 percent, respectively. This can be explained by the fact that Hospital 1 has a walk-in policy and guarantees a timely access to the X-ray service by means of an overcapacity. This allows orthopedics to combine an X-ray with the orthopedics consult (OPC1).

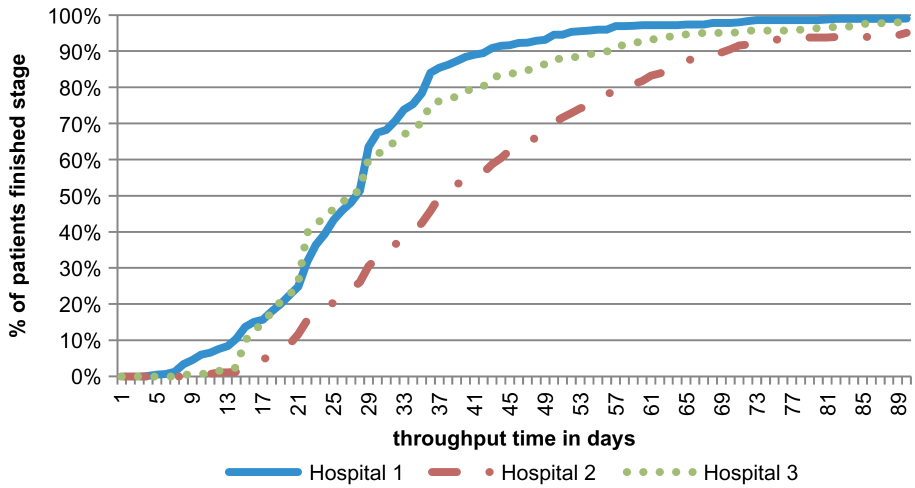

Figure 3.
Flow performance stage OPC1 – MRI – OPC2

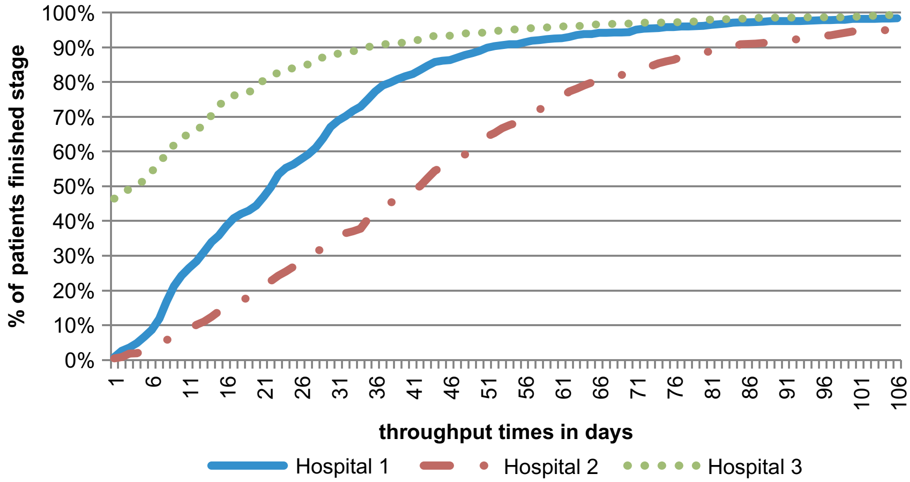

Figure 4.
Flow performance stage pre-assessment – OR

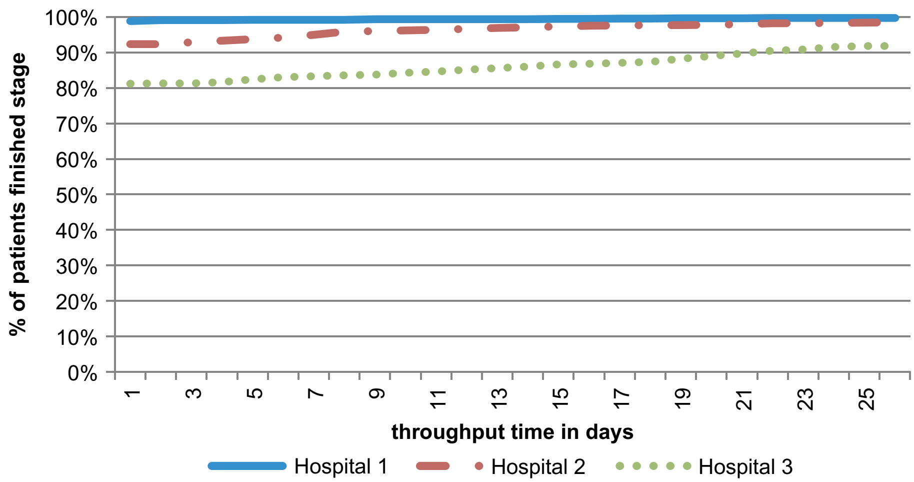

Figure 5.
Flow performance stage X-ray – OPC1

The second such practice found was between the outpatient clinic visit and the pre-assessment (OC and AC). In Hospital 1, orthopedics is allowed to schedule patients using a template provided by anesthesiology. In Hospital 2, a dedicated department – the Admissions Office – schedules all patients for the pre-assessment stage. As such, anesthesiology does not provide orthopedics with the possibility to schedule its own patients for pre-assessment appointments. In terms of the flow performance of this part of the process (Figure 6) we would expect Hospital 1 to outperform Hospital 2 since Hospital 1 has more information with which to prioritize patients. However, Hospital 2 outperforms both Hospitals 1 and 3. The explanation for Hospital 2 outperforming Hospital 3 can be found in a comment by an orthopedic surgeon of Hospital 3: "Anesthesiology has a structural capacity shortage which needs to be resolved". Our interview data did not, however, explain why Hospital 2 outperformed Hospital 1 in this process step.

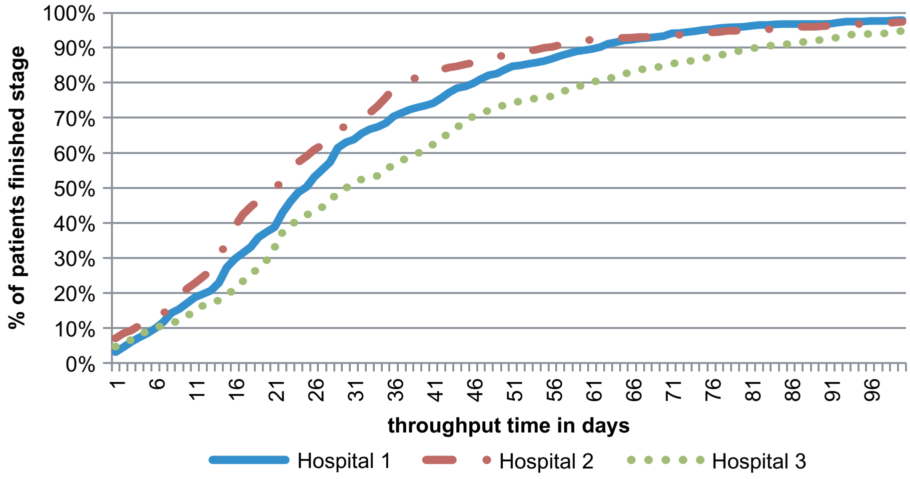

Figure 6.
Flow performance stage OPC – PRE

An interesting observation related to the integrative planning stage in functional integration was made in the pre-assessment stages for both Total Knee and Total Hip patient groups. Hospitals 1 and 3 had both initiated a program in which the capacity of the OC and the anesthesiologist consult (AC) were coupled, with anesthesiology specifically reserving capacity for these orthopedic patients. Hospital 2 has no such program. Figures 7 and 8 show the effects of such integrative planning between orthopedics and anesthesiology on patient flow. Again the figures show the cumulative percentages of the patient population with a specific throughput time. The figures show that over 80 percent of all Total Knee and Total Hip patients completed the pre-assessment stage within one day at Hospitals 1 and 3, whereas only approximately 50 percent of all Total Knee and Total Hip patients did so at Hospital 2.

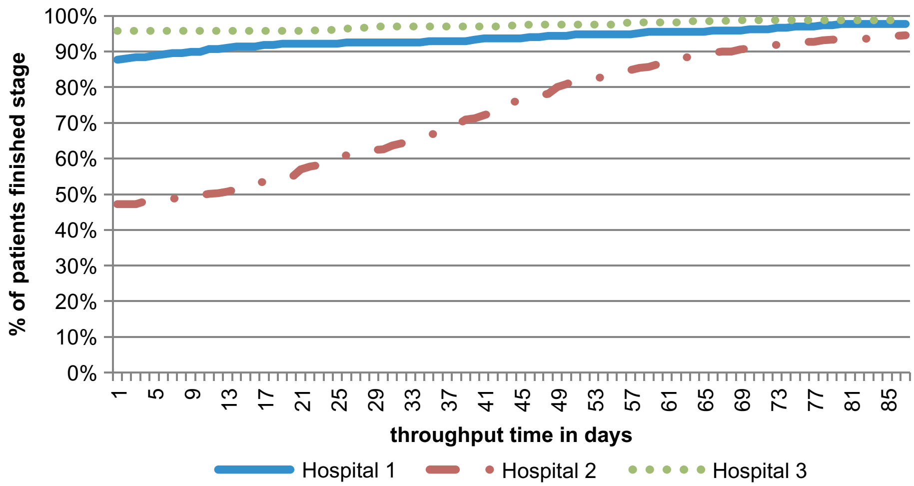

Figure 7.
Flow performance stage OC – AC (total hip)

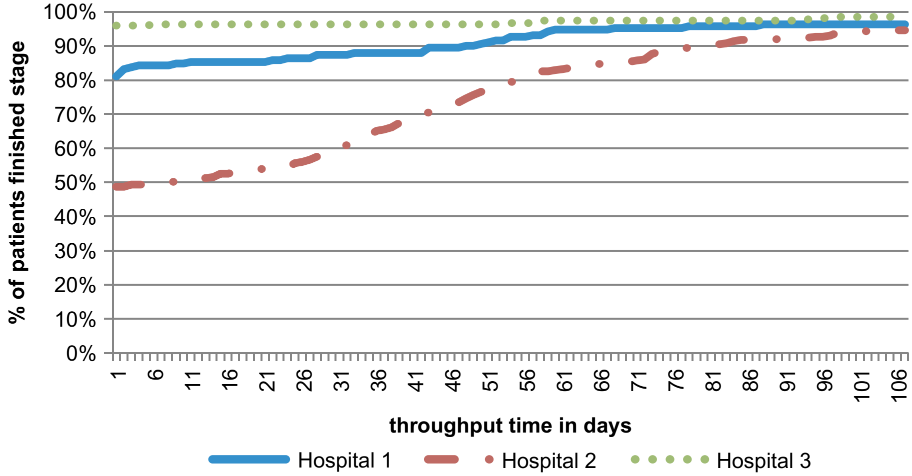

Figure 8.
Flow performance stage OC – AC (total knee)

Internal integration and patient flow

Internal integration occurs when integrative practices are seen between at least three members of the internal supply chain. We observed some, albeit limited, integrative practices that included more than two participating departments, and these are summarized in the right half of Table II. As with functional integration, internal integration can be refined into transparency, commitment, and integrative planning stages.

Orthopedics in Hospital 2 attempted to achieve the transparency stage by distributing planning information among all the supply chain members. However, the orthopedics planner commented: "I very much doubt if anyone is using this information and I get no information in return". Next, we observed internal integration in Hospital 1 that could also be classified as at the transparency stage. Throughout the departments of Hospital 1, relevant planning information is shared, although this is mainly communicated with the commonly heard phrase "the operating theatre is leading". This results in each department being subject to the schedule of the OR. We were also able to observe integrative planning in Hospital 2, but only for a small part of the Meniscus patient group. Otherwise healthy patients with a specific type of insurance could apply for an integrated path which would ensure that both the diagnostics and the pre-assessment stages would be completed within one week provided an MRI was not required, or two weeks if an MRI was required. In the third week the patient would be treated in the OR. This swift path has been created by reserving capacity for these patients and by coupling the capacities of various departments through central planning.

We did not observe the first two integrative practices (distributing planning information to all departments and having the OR leading) as having any effects on patient flow performance. However, the integrative planning efforts for the Meniscus patients in Hospital 2 did yield positive effects on patient flow performance. Table III shows that Hospital 2 is lagging behind both the other hospitals in terms of throughput for the Total Hip and Total Knee groups, which can be linked to the lack of integration in its processes. However, for the Meniscus group, there is no significant difference between the flow performances of the three hospitals. The increased performance of

Table III.
Median flow time; Mann-Whitney-U test results

Patient group	Process step	Median flow time hospital 1	2	3	Best performing hospital 1 vs 2	1 vs 3	2 vs 3
All patients	OPC1 – MRI – OPC2	27	37	27	1*	1	3*
All patients	X-ray – OPC1	0	0	0	1*	1*	2*
All patients	OPC – pre-assessment	24	21	30	2*	1*	2*
All patients	Pre-assessment – surgery	22	41	3	1*	3*	3*
All patients	Total process	68	77	56	1*	3*	3*
Total knee	Pre-assessment	0	7.5	0	1*	3*	3*
Total hip	Pre-assessment	0	10	0	1*	3*	3*
Total knee	Total process	78	93	65	1*	3*	3*
Total hip	Total process	82	85	51	1	3*	3*
Meniscus	Total process	65.5	58	64	2	1	2

Notes: Significant at: $^{*}p < 0.05$; the Mann-Whitney-U test employed only allows for testing differences between two populations; in order to compare each hospital with the other two, the test had to be performed three times; the results of these tests are presented in the last three columns; for example, 1* in the column 1 vs 2 means that Hospital 1 has a significantly better flow performance than Hospital 2 for that specific group and specific process step

Hospital 2 in this area could be explained by the integrative practices practiced by this group as discussed earlier.

We would summarize our results as follows. First, all the hospitals showed only limited integration, and this resulted in sub-optimal performance. The results did reveal several functional integration practices, such as having insight into other departments' waiting lists, sharing planning data, creating templates for other departments to fill in, and making combined appointments. A second important finding is that, overall, the effects of integrative practices are positive in terms of patient flow performance. The hospitals with the greatest functional integration showed higher patient flows than the hospital with little functional integration. We hardly saw any evidence of full internal integration in our case studies although the one manifestation we did observe yielded a significant positive effect on patient flow performance.

Interpretation of the results

The aim of this research has been to address two important questions related to patient flow performance: determining which specific integrative practices related to planning and control are employed by hospitals and determining the effects of these practices when considering a hospital's entire internal supply chain. The results clearly show that hospitals which employ more integrative practices achieve a better patient flow performance. While this result is in line with our expectations, we did find some unexpected patterns in how specific practices are employed and function in hospitals.

Removing barriers to patient flow: mechanisms for integration

The results show that the three hospitals use a variety of integrative practices that can be summarized as four core mechanisms:

(1) *Sharing of planning information*. Information is shared about when a patient is scheduled for a preceding process step and this information is used by

the planner of the subsequent process step to anticipate when the patient can be scheduled for this step.

(2) *Sharing of waiting list information*. Information is shared about how long it will take to schedule a patient for a preceding process step and this information is used by the planner of the subsequent process step to anticipate when the patient can be scheduled for this step.

(3) *Cross-departmental planning*. A department may schedule patients for a subsequent process step in a different department, allocating capacity of the department that will execute that step.

(4) *Combined appointments*. Multiple steps in the care process are arranged and executed on the same day.

How these mechanisms relate to the barriers to flow as described by Schmenner and Swink (1998), and how this affects our suppositions on the integration of planning and control in hospitals is discussed below.

The sharing of planning information and the sharing of waiting list information both reduce non-value-added activities in the care process. In both cases, the planner does not have to wait for a previous step in the care process to be completed before a patient can be scheduled for the next step. Since the planner of a subsequent step knows in advance when a patient is (or will probably be) scheduled for the preceding step, the planner can schedule the patient's subsequent step shortly after the preceding step. This results in less non-value-adding waiting time for the patient.

Cross-departmental planning has a double effect on flow performance. First, it helps to reduce non-value-adding activities in a similar way as sharing information. Subsequent process steps can be planned closer together as the planner is aware of the planned date of the preceding process step (as this step occurs in the planner's own department). Again the patient has to wait less to be scheduled. More importantly, cross-departmental planning results in a reduction in variability. A planner is able to adapt the case-mix in such a way that different types of patients can be spread throughout the day, week or and/or month. As an example, if orthopedics can schedule patients for pre-assessment then it can spread hip patients (who consume a relatively large amount of OR capacity) evenly across the pre-assessment schedule, resulting in a more even input of hip patients for the OR.

Combined appointments reduce the number of visits a patient needs to make to the hospital. By combining the capacity of several process steps, the number of queues is reduced. A reduction of queues results in less non-value-added activities.

The identification of hospital-specific integration mechanisms and their effects on barriers to flow have led to a revised conceptual model (Figure 9). In this model, two things should be noted: the absence of the term bottlenecks, and the fact that none of the integrative practices except cross-departmental planning contribute to a reduction in variability. Although we continue to believe that bottlenecks are an important barrier to patient flow, we omitted the term from the model because we could not find any theoretical or empirical base to justify a relationship between the integration of planning and control and the removal of bottlenecks. Turning to variability, we had expected to find several examples where information would be shared in order to reduce variability. However, none of the information-sharing practices we found addressed this aspect. It seems that hospitals opt for integrative practices that have

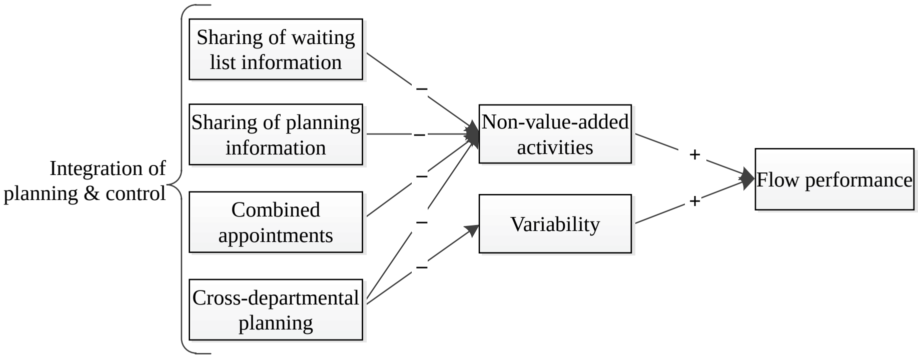

Figure 9.
Revised conceptual model

a direct effect on patient flow performance. The effects of reducing non-value-added activities (e.g. reducing planning activities or removing queues) are rather intuitive and directly visible on the work floor, whereas the effects of reducing variability are far less intuitive. Jack and Powers (2004) showed that, on a strategic level, hospital try to cope with variability through flexibility strategies. Surprisingly, on a more operational level, we could find little empirical evidence of hospitals trying to reduce variability. Consequently, we would argue that achieving a broader insight into reducing variability in hospital operations is a valuable aim for future research.

Conclusions

This paper has explored the integrative planning and control practices that are used in hospitals, and what the effects of these practices are on patient flow performance. Although the overall level of integration in the hospitals studied is limited, patient flow performance is significantly better in those that employ more integrative practices. This study contributes through offering a comprehensive view on the integration of planning and control in hospitals. From an internal supply chain perspective, we show that both dyadic initiatives and, although limited in practice, overall integration along an internal chain increase performance in terms of patient flow.

Four integrative mechanisms were identified: sharing waiting list information, sharing planning information, cross-departmental planning, and creating combined appointments. Each of these mechanisms helps by reducing either non-value-added activities or variability in patient flow. Further, we found that hospitals put little effort into reducing variability in their internal supply chains through information sharing.

This study has important implications for hospital administrators and for medical professionals, especially given that improving patient flow has become an important point on the political agenda. Improving flows benefits both hospitals and patients. A faster flow means that patients spend less time in the care process. As a result, a hospital gets reimbursed quicker by insurance companies (reimbursement takes place only after a patient has finished the care process) and less working capital is tied up in patients waiting for treatment. Since uncertainty concerning care processes is an important factor in patient dissatisfaction (Thompson *et al.*, 1996), more integrated planning which reduces uncertainty about patient scheduling would boost patient satisfaction. We have shown that integration initiatives help to reduce non-value-added activities and variability. However, given the currently high capacity utilization levels, boosting patient flow performance is highly dependent on being able to reduce variability. Therefore, we would stress to hospital administrators that reducing variability though integration is one of the few options open to them in overcoming the challenges presented in the current healthcare environment.

A limitation of this study is that we focus on only one specialism, and that we did not consider the possible side effects of the observed integrative practices on other specialties. Given that orthopedic supply chains share several resources with other specialties, future research should adopt a broader perspective and include supply chains from different specialties that compete for capacity from the same resources. However, we agree with Vissers and Beech (2005) who warn that including too many hospital supply chains in a single study increases the complexity and makes it less likely that important insights will be discerned. Finally, we should note that the complex nature of hospitals and their care processes makes it difficult to control for all the relevant variables that might influence performance. In this study, we tried to minimize this by choosing straightforward care processes characterized by high volumes, low variety, and low routing variability. However, in future research, it would be valuable to assess the value of integration in internal supply chains with other characteristics such as a high routing variability.

This study focused on how performance is affected if integration occurs, and the low degree of integration we found in the hospitals suggests a major theme for further research: how can integration be achieved? Pagell (2004) argues that factors such as culture, structure, communication, physical layout, performance measurement, and cross-functional teams are major contributors to integration within manufacturing firms. The optimum degree of integration is also contingent on many business conditions (Van Donk and Van der Vaart, 2004; Das *et al.*, 2006). Further, as contextual factors significantly influence the use and performance of operations management practices (Sousa and Voss, 2008), a healthcare context might pose different, and currently underexposed, barriers and enablers to integration.

Note

1. Hospitals are obliged to pre-assess all patients before surgery; and this task was not neglected by any of the hospitals.

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Appendix. Visual analysis of the orthopedic supply chains

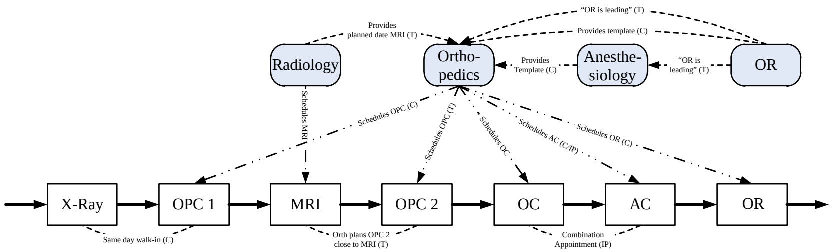

Figure A1.
Hospital 1

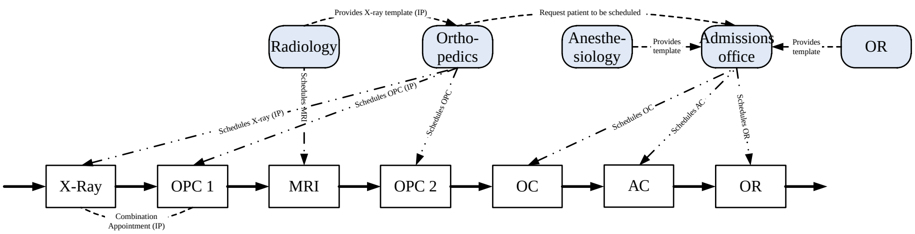

Figure A2.
Hospital 2

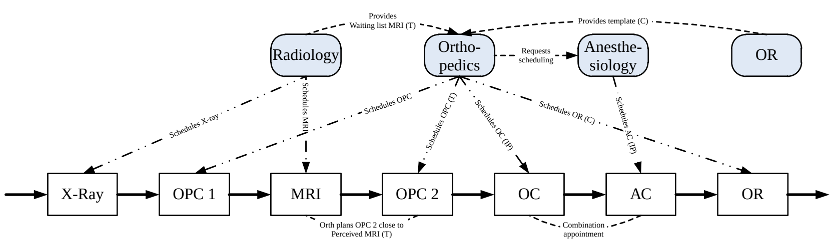

Figure A3.
Hospital 3

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