When patients get stuck: A systematic literature review on throughput barriers in hospital-wide patient processes

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When patients get stuck: A systematic literature review on throughput barriers in hospital-wide patient processes

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Hospital productivity is of great importance to policymakers, and previous research demonstrates that improved hospital productivity can be achieved by directing more focus towards patient throughput at healthcare organizations. There is also a growing body of literature on patient throughput barriers hampering the flow of patients. These projects rarely, however, encompass complete hospitals. Therefore, this paper provides a systematic literature review on hospital-wide patient process throughput barriers by consolidating the substantial body of studies from single settings into a hospital-wide perspective. Our review yielded a total of 2207 articles, of which 92 were finally selected for analysis. The results reveal long lead times, inefficient capacity coordination and inefficient patient process transfer as the main barriers at hospitals. These are caused by inadequate staffing, lack of standards and routines, insufficient operational planning and a lack in IT functions. As such, this review provides new perspectives on whether the root causes of inefficient hospital patient throughput are related to resource insufficiency or inefficient work methods. Finally, this study develops a new hospital-wide framework to be used by policymakers and healthcare managers when deciding what improvement strategies to follow to increase patient throughput at hospitals.

1. Introduction

Demand for health care is rising as a consequence of changing demographics and increasing multi-morbidity [1,2]. Hospitals, meanwhile, are struggling with capacity constraints, insufficient productivity and increasing financial deficits [3–7]. The necessity to improve the health care system is great and further intensified as previously increasing annual rates for healthcare budgets are starting to stagnate or even decrease [8,9]. Consequently, policymakers are searching for options for how to improve the situation, leading them to policies of both cost containment and production improvement [6,10,11]. Cost-containment strategies such as austerity measures may, however, result in short-term cost-savings but are likely to lead to significant costs for society in the long run [9]. The imperative for production improvement projects as a means of lifting the results of the healthcare sector is, therefore, growing [8,12,13].

Accounting for the productivity of hospitals when assessing the performance of a healthcare system has been emphasized by the World Health Organization (WHO) [14], the Organization of Economic Cooperation and Development (OECD) [15,16] and the Institute of Medicine (IOM) [17]. Through their health-system performance assessments, high productivity in terms of optimal use of resources and high availability of treatment are important for offering the right care at the right time for the population served by a healthcare system [17,18]. Improving these system-level productivity performance measurements, however, requires a more local focus on the continuous development of healthcare operations and on the reduction in errors, waste and variation to existing processes. These efforts have been addressed through quality-improvement methodologies such as Six Sigma and Total Quality Management (TQM) [19–23]. Evidently, improvement initiatives have been successful to some extent, but at the same time, the problems of increasing costs [4] and stagnant productivity development [3,8] call for alternative solutions for improving the throughput of patients at hospitals [13,19,23–26].

Previous research has demonstrated that improved hospital productivity can be achieved by directing a greater focus towards the flow of patients through healthcare organizations [8,11,24,26–35]. Improved hospital-patient flow do also have a positive impact on medical quality and the work environment [24,30,36,37], and has become a more outspoken policy priority [34]. Radnor

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et al. [24] and D'Andreamatteo et al. [26] highlighted that the last two decades have seen a plethora of healthcare improvement projects, specifically so-called lean implementations focusing on how to break process barriers and improve the flow of patients. Multiple promising solutions have come from these projects, yet these projects rarely encompass entire hospitals to cover the complete patient process from admission through discharge [26,29,34]. Another promising area for patient flow improvements are projects on clinical patient pathways that seek to, from the bottom up, define and improve the patient flow across the healthcare system for certain well-defined groups of patients [38,39]. Projects on patient pathways do however not take a holistic grip on hospital-wide patient flows as they are restricted to a small number of well-defined patient groups, and consequently, there is a great risk of suboptimization.

A hospital-wide and comprehensive perspective of the myriads of emergent and planned patient flows across a hospital organization is, thereby, seldom addressed, resulting in suboptimizations and process deficiencies along patients' hospital journeys [13,28,31,34,40]. Recognizing a system approach to studying the interaction among system parts across the hospital patient process can offer new possibilities for improving both the hospital-wide patient flow and the health of the population through better healthcare access [29,31].

According to Devaraj et al. [32], research on process improvements at hospitals points to the need to understand the constraints to a process as a means of improving it. This offers possibilities to identify and describe bottlenecks in the system before breaking them [41,42]. This is further articulated by the law of bottlenecks stating that the overall efficiency of a process can only be improved by addressing its major bottlenecks or constraints [31,42,43]. Therefore, research on how to improve hospital productivity by streamlining the hospital-wide patient flow must start by exploring and understanding barriers and associated root causes of hospital-wide patient processes [29,31,37,44].

The flourishing interest in how to improve hospital patient flows has inspired publications of several literature reviews putting empirical findings into system-wide perspectives. D'Andreamatteo et al. [26] explored patient flows from a lean perspective; Vos et al. [44] described organization-wide process-oriented hospitals; and Gualandi et al. [34] identified actions, actors, and enablers for improving the hospital patient flow. All of these researchers touched upon barriers that prevent swift and even hospital-wide patient flows, but none gives a systematic and complete picture of the existing research. Moreover, Villa et al. [29] developed a framework to analyze hospital-wide patient throughput performance, starting with the exploration of patient flow barriers and resulting in six different main causes of patient flow problems. Even so, the review on throughput barriers is rather minimal and does not give a comprehensive overview of the literature.

Hence, to the best of our knowledge, no comprehensive or systematic literature review of studies analyzing hospital-wide patient process throughput barriers has, thus far, been undertaken. To address this knowledge gap, we conducted a systematic literature review by consolidating the substantial body of studies from single hospital settings, synthesizing their results, and finally aggregating them into a hospital-wide perspective. Therefore, the aim of this article is (i) to explore existing research on what factors are preventing swift and even patient throughput at hospitals and (ii) to synthesize those factors into themes, main barriers and underlying root causes.

1.1. The theoretical framework

The theory of swift and even flows (TSEF) presented by Schmenner and Swink [42] describes that the roots of productivity innovation lie in improving throughput time and reducing variation. The potential from directing TSEF to health care can be derived from a need to enable an efficient patient throughput along the processes within a healthcare organization [32]. Process theory, developed by Holweg et al. [41], further explains that all operations are composed of processes operating together, and that a set of suboptimal solutions can never produce a global optimum. This perspective is often missing in health care as process improvements are, to a large extent, implemented only on a functional level (i.e. single units or clinics) and not on a systemic level [13,29,31]. Holweg et al. [41] presented a conceptual model providing a framework for analyzing process barriers. The process model, as illustrated in Fig. 1, comprises four categories: **inputs** (*resources*), **outputs** (*products*), **transformation** (*conversion of resources to products*), and **management system** (*management and control of the processes*). Of these four categories, transformation can be further divided into two sub-components: **internal sub-processes** (internal *activities of converting resources to produced goods*) and **transfer** (*movement of goods between internal activities*).

The hospital patient process could be described using these categories, although knowing that the theory has not been developed for a flow of patients or for the healthcare sector potentially reduces its applicability. With that said, using the described categories gives us: patients entering hospitals (*inputs*), and moves (*transfer*) between medical clinics (*internal sub-processes*), along a managed and controlled organization-wide system (*management system*), until discharge from the hospital (*output*). These categories of processes are used to further explore and understand the hospital patient process.

The productivity of a process depends on its throughput rate, defined as the actual rate at which output is made. Throughput rate is determined, according to Little's Law, by the throughput time of a process and the work-in-process, i.e. the amount of units worked on within a process [41,45]. In a hospital setting, work-in-process can be viewed as the number of patients within a hospital at a particular moment, where throughput time is the amount of time it takes for a patient to move from arrival/admission to discharge/departure at that hospital or medical clinic. Little's Law is, therefore, used to explain and categorize variables depending on what impact a variable has on the throughput of a process.

According to Glouberman and Mintzberg [46], healthcare processes at hospitals are complex and comprise multiple, interlocking sub-processes. In order to improve a process, it is crucial to map out and define it, i.e. to make it clear and manageable [47]. Today, however, it is not possible to find a common definition of what the patient process generally looks like at a hospital. Johnson and Capasso [12], Ben-Tovim et al. [48], Busby [49], Kolker [50] and Djanatliev and Meier [51] have all, independently of each other, defined and mapped out hospital patient processes. These maps are descriptive and serve certain purposes well but are incomplete in displaying the full picture of how a patient may move through a hospital organization. Therefore, we propose a new and more inclusive hospital-wide process model, as depicted in Fig. 2. The hospital process model is intended to be valid for medium-to-large-sized hospitals, encompassing both planned and acute processes as well as inpatient and outpatient perspectives. Thus, it depicts eight different settings: the emergency department (ED), the outpatient clinic, the operating room (OR), the intensive care unit (ICU), the pre-operative unit (Pre-OP), the post-aanaesthesianesthesia care unit (PACU), the inpatient wards and the radiology department. The internal patient process, the supporting radiological process and the external processes are also depicted in the model. Other ancillary processes such as lab services, material replenishment, medical delivery, etc. are not included since they involve a patient only indirectly. Finally, the five process categories have

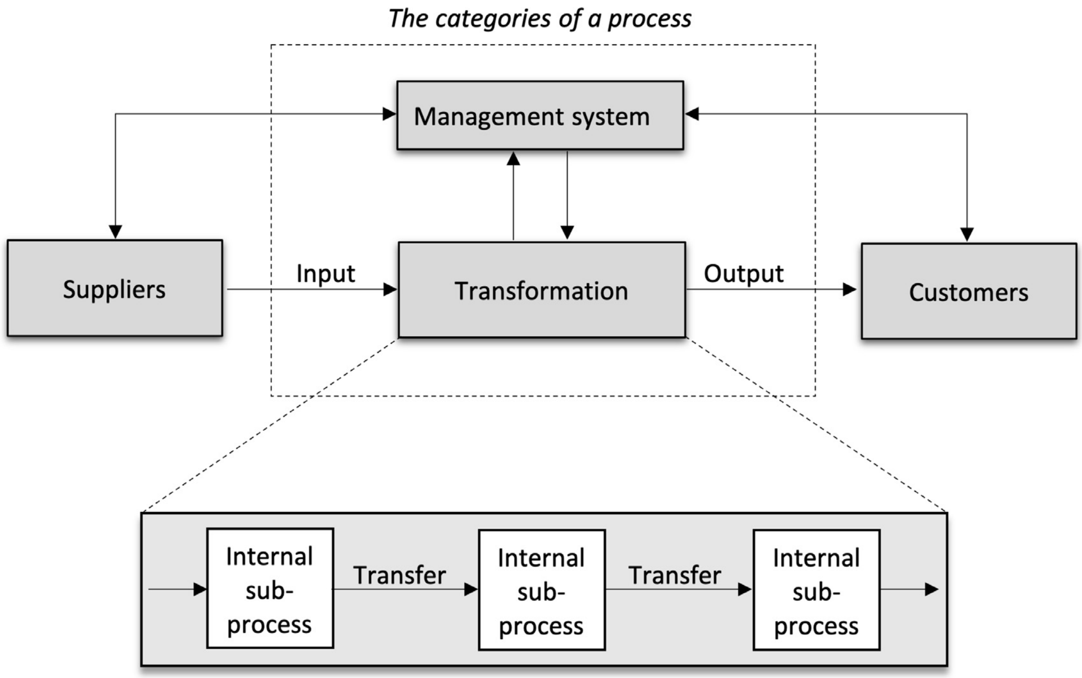

Fig. 1. Categories of processes, inspired by Holweg et al. [41].

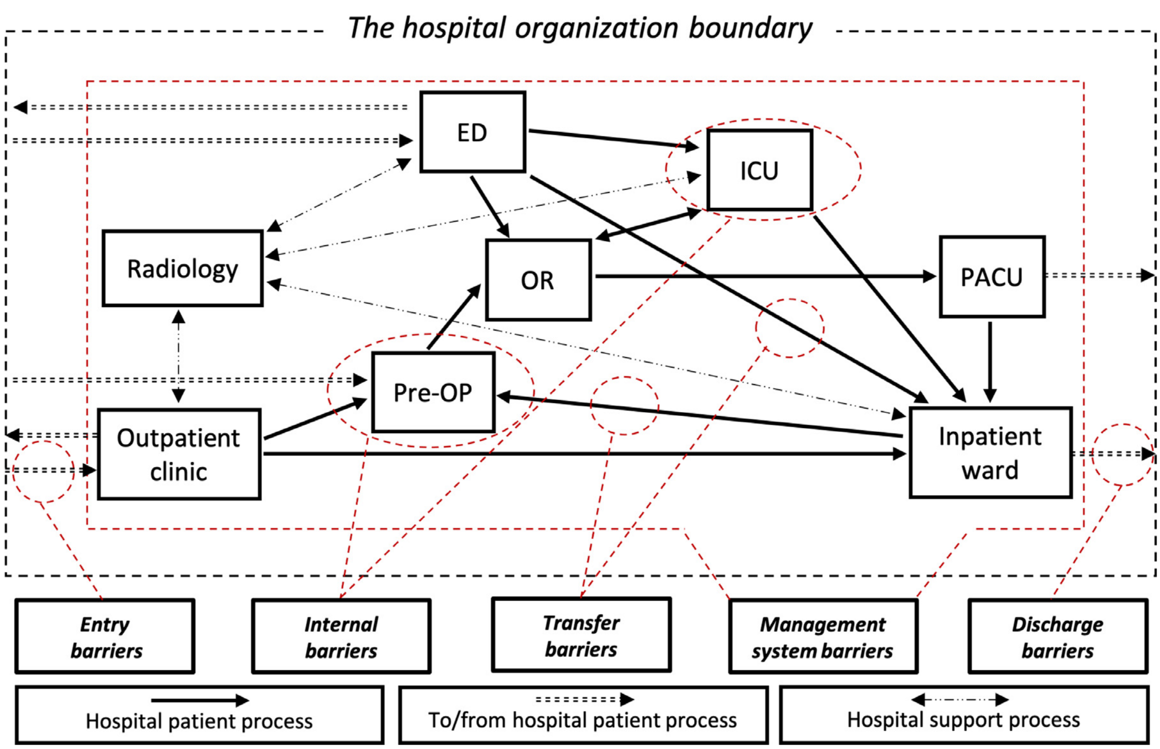

Fig. 2. The hospital-wide process model.

been partially renamed as inflow (*inputs*), outflow (*outputs*), internal (*internal sub-processes*), transfer and management system to recognize that it is a patient and not any object that moves through the process. The categories have then all been depicted in the model, oriented according to where their associated process barriers appear. This theoretically deduced process model serves as an analytical framework for analyzing and categorizing hospital-wide patient process barriers and their associated root causes.

2. Materials and methods

2.1. Search strategy

We conducted a systematic literature review following a procedure based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement by Moher et al. [52]. A database search was conducted in PubMed, Scopus and Web of Science screening for relevant English-language articles published

Table 1
Keyword search strategy & inclusion and exclusion criteria.

Database	Keyword Search
PubMed	("Hospitals"[Mesh] OR "Hospital"[tiab] OR "Hospitals"[*tiab*] AND (("Efficiency, Organizational"[Mesh] OR "Efficiency"[tiab] OR "Productivity"[*tiab*] AND (("Process Assessment, Health Care"[Mesh] OR "Organizational Innovation"[Mesh] OR "Product Line Management"[Mesh] OR "Hospital Restructuring"[M*esh*] OR ((Process[tiab] OR Processes[*tiab*] AND (flow[tiab] OR throughput[*tiab*])))
Scopus	(TITLE-ABS-KEY (improv*) OR TITLE-ABS-KEY (develop*)) AND (TITLE-ABS-KEY(hospitals) OR TITLE-ABS-KEY (hospital)) AND (TITLE-ABS-KEY (organization * W/2 efficiency) OR TITLE-ABS-KEY (efficiency) OR TITLE-ABS-KEY (productivity)) AND (TITLE-ABS-KEY (process W/2 assessment) OR TITLE-ABS-KEY (organization* W/2 innovation) OR TITLE-ABS-KEY ("Product Line" W/2 management) OR TITLE-ABS-KEY (hospital W/2 restructuring) OR ((TITLE-ABS-KEY (process) OR TITLE-ABS-KEY (processes)) AND (TITLE-ABS-KEY (flow) OR TITLE-ABS-KEY (throughput))))
Web Of Science	(TS=Improve* OR TS=Develop*) AND (TS=hospitals OR TS=hospital) AND ((TS= (organization* NEAR/2 efficiency) OR TS=efficiency OR TS=productivity) AND ((TS= (process NEAR/2 assessment) OR TS= (organization * NEAR/2 innovation) OR TS= (Product Line" NEAR/2 management) OR TS=(hospital NEAR/2 restructuring))) OR (TS= (process) OR TS=(processes)) AND (TS=(flow) OR TS=(throughput)))

Category	**Inclusion and Exclusion Criteria**
Inclusion Criteria	**The article must:** Contain an abstract; Be written in English; Be a qualitative or quantitative empirical primary study on patients receiving hospital care; Contain at least one description of a patient process related barrier; Have been published between 1st January 2010 and 1st November 2020
Exclusion Criteria	**The article has a focus on:** Primary care or care within a rehabilitation setting; Healthcare processes not relating to the hospital patient process; Description of theories, methods or models without empirical data; Editorials or policy statements without immediate empirical support; Literature reviews

between 1 January 2010 and 1 November 2020. This time span was selected to capture the most recent research from the last decade on patient process barriers at hospitals. Consequently, we began by identifying useful Medical Subject Headings (MeSH) and related free-text keywords for an initial search in PubMed. We finally settled on a combined keyword selection including various inflections of the words ‘hospital’, ‘productivity’, ‘efficiency’, ‘process’, and ‘throughput’. This search string was then translated to Scopus and Web of Science, with the only exception being complementing the string with ‘improv*’ and ‘develop*’ to narrow down the assessment. See Table 1 for full keyword search.

2.2. Study selection and data extraction

After initial article assessments, we removed all duplicate articles, whereupon two rounds of screening were conducted. During this screening process, two of the authors, (PÅ) & (PA), read the assessed articles independently to eliminate subjective bias and errors. The authors have previous experience working with patient flows at hospitals (PÅ) and conducting research on healthcare productivity (PA), thus further reducing the risk of errors in the selection process. In the first round of screening, titles, keywords, and abstracts were read to make an initial selection. Generous early inclusion criteria were used, including every peer-reviewed article that related somewhat to the research aims. Thereafter, we excluded gray literature, proceedings, reports, and books. The remaining articles were then scrutinized in detail according to predefined inclusion and exclusion criteria (see Table 1), resulting in a highly relevant set of studies to be included in the review synthesis. Following this, we used a predefined extraction checklist to capture the most important characteristics of the assessed articles. These included the title, author(s), year of publication, country of study, hospital setting and study design. Finally, we extracted the number of beds at each hospital from their official websites, given that the name of the hospital had been outlined in the study, thus enabling a comparison of size and volume. For a full overview of extracted data, see Appendix A.

2.3. Synthesis strategy

A thematic synthesis methodology was used to achieve a consistent article analysis of the content and to identify central themes. In a thematic synthesis, articles are coded line-by-line as ‘free codes’, whereupon codes are aggregated based on their recurrence into descriptive themes. Finally, descriptive themes are developed as analytical themes to describe the particular phenomenon [53,54]. Accordingly, we coded each article and its content, focusing specifically on the patient process barriers each article had explored and highlighted. As most articles had explored root causes behind their identified patient process barriers, we established a link between them that indicated their interrelated causality. We then examined whether those root causes had been further explored by other articles. If that was the case, we once again established a link indicating the interrelated causality between the two barriers. The process of coding articles continued whereupon an increasing number of barriers and root causes were identified, and connections between barriers and root causes of each article, and between articles were established. As codes and links accumulated, a tree diagram for each setting evolved with multiple branches of barriers and root causes. Each branch was then connected to constructed descriptive categories based on the commonality between different branches in the tree diagrams. When the coding proceeded, multiple categories emerged within each tree diagram, i.e. for each hospital setting. To create a unified categorization across the settings, the previously mentioned categories were finally extracted and consolidated into a smaller number similar across all settings. These were finally renamed as ‘main barriers’.

Next, we used the hospital-wide process model, Fig. 2, to sort the main barriers under the five themes of patient process barriers: ‘entry’, ‘internal’, ‘transfer’, ‘management system’ and ‘discharge’. The number of main barriers connected to the theme ‘*internal*’ became so high and so diverse that we had to consolidate those barriers into a smaller number. We decided to categorize them with inspiration from the three dimensions (through-

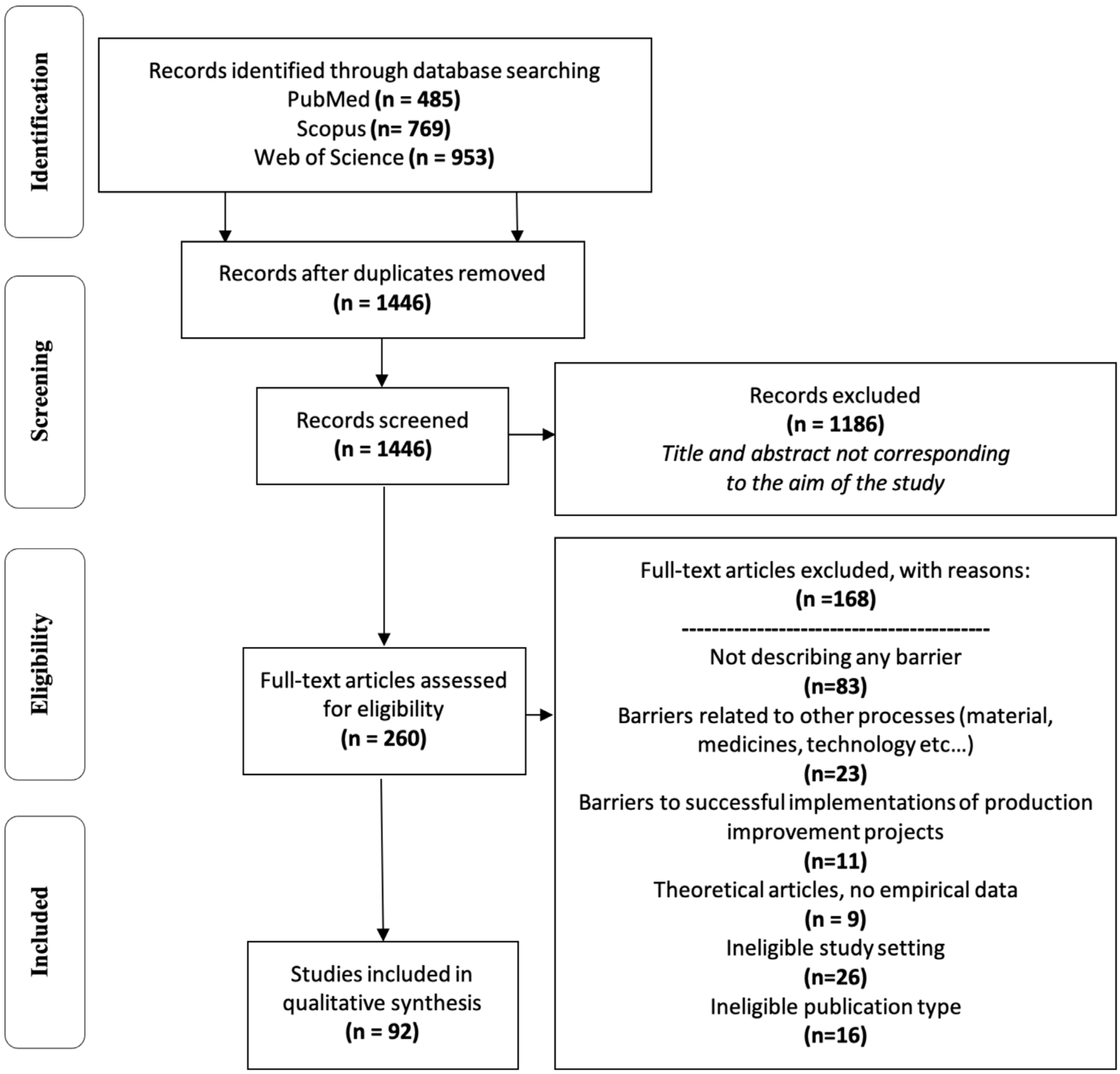

Fig. 3. The literature selection process.

put rate, lead time and work-in-process) of Little's Law. For a full overview of the tree diagrams structured according to the consolidated themes of main barriers, see Appendix B.

Following this, all identified root causes, i.e. the end nodes of all tree diagrams, were extracted. They were then categorized based on their similarity in description into central groups of root causes. As this sorting process continued, a hierarchy evolved based on the number of root causes consolidated under each group. We were finally satisfied with the consolidation process when, following the Pareto Principle [55], more than 80% of the initially identified root causes had been consolidated into a smaller number of unique groups, thereafter named 'main root causes'. To minimize bias throughout the synthesis process, a third author (CW) who had not previously taken part in the study selection process contributed to the thematization of barriers and root causes. For a full overview of the end nodes forming the main root causes, see Appendix C.

3. Results

Our review yielded a total of 2207 articles, 761 of which were duplicates, thus reaching a final number of 1446 articles. Of these, 260 articles were selected for a detailed review, and finally 92 key articles were included in the thematic synthesis. Fig. 3 depicts the full selection process of articles.

The data extraction shows that included studies have been conducted mostly in the ED, the OR, and the inpatient wards. This review has a broad international coverage, albeit with an overrepresentation in the US and Europe. Finally, hospitals of all sizes are represented, although with a concentration around 200–800 beds; see Appendix A. The barriers identified in the thematic synthesis are categorized with the help of the analytical framework into five themes, 12 main barriers and 15 main root causes; see Table 2. Table 2 also presents the total number of end-node root causes from the tree diagrams, connected to each main barrier, and separately, the total number of end nodes consolidated under each main root cause, depicting their presence and importance according to the included articles.

Of the five general themes, the theme *internal* stands out in terms of the number of main barriers and also in terms of associated end-node root causes; see Table 2. The most common barriers are long lead times, inefficient capacity coordination and inefficient patient process transfer and are linked to almost half of the total number of end-node root causes. Lack of staff, lack of standards and routines, insufficient operational planning and lack of IT functions are the most prevalent root causes of the identified barriers.

Table 2
Themes, main barriers, and main root causes.

Themes	Main barriers	# nodes	Main root causes	# nodes
Internal	Long lead times	42	Lack of staff	32
	Inefficient capacity coordination	40	Lack of standards and routines	20
	Insufficient capacity	28	Insufficient operational planning	19
	Large capacity utilization variation	16	Lack of IT functions	16
	Inefficient capacity utilization	15	Insufficient discharge routine	15
	High work in process	15	Insufficient facilities and layout	15
Transfer	Inefficient patient-transfer process	39	Insufficient communication	13
	Inefficient support-transfer process	15	Insufficient transfer coordination	12
Entry	Unpredictable inflow variation	15	Random internal disturbances	12
	Changing demand	8	Unpredictable patient problems	10
Discharge	Inefficient outflow process	8	Lack of beds	8
Management system	Low interorganizational coordination	7	Medical quality priorities	8
			Lack of ancillary services	8
			Increasing demand	6
			Lack of separate tracks	5
Total amount of root cause nodes		**248**		**199**

The main root causes are often similar among several main barriers. Fig. 4 visualizes connections between themes and barriers as well as interrelated causality between barriers and root causes.

The rest of the results section further presents the 12 main barriers identified in the literature review, following the order of Table 2. This section also highlights connections between barriers and root causes at different hospital settings based on where the specific barriers are most prevalent.

3.1. Long lead times

The time to start or finish a hospital activity (i.e. surgery, examinations, diagnostics, patient transfers, medical dispensation or laboratory services) affects a flow of patients across a hosptial. It will affect the lead time through a medical clinic and, consequently, the total lead time through a whole hospital from admission until discharge. As such, a vast number of studies find long lead times to be a decisive problem [30,56–86]. Long lead times at inpatient wards arise from delays in initiating the discharge process of discharge-ready patients [67,68,87,88]. This delay stems from various sources, such as prioritization of newer and sicker patients [12,87], missing preparatory paperwork for medical rounds [67,69,87], lack of medical and nursing staffing [69], lack of standards to prioritize from [68,73] and late starts of morning shifts [12,73]. Long lead times at wards may also be generated by a prolonged wait for medicines, prescriptions, follow-up meetings and discharge planning for discharge-ready patients [78,87,89–93]. This delay is, in turn, caused by a lack of coordination [91–93], insufficient medical storage layout [89,90] and a lack of physician staffing [73,91]. By contrast, long lead times at outpatient clinics are caused by late appointment start times [79,80,94] that result as a consequence of previous appointments not ending on time [79,80,94,95], delayed or absent patients [33,94,96] or delayed physicians [79,82].

3.2. Insufficient capacity

A lack in capacity cannot always be compensated for by innovative and efficient working methods. The capacity is simply insufficient. A factor hampering the patient flow and, not surprisingly, highlighted by multiple studies, is therefore insufficient capacity [56,65,67,71,74,79,92,97–106]. The patient flow through the ED is constrained by insufficient capacity [56,74,97,98,103,104,107–109] as a consequence of a lack of triage nurses and physicians [56,97,98,108], peak-time staffing resources [56,74,98,108], flow coordinators [104,109], medical scribes as support [74], pharmacists [110] and physician cubicles [56,74,108]. Other articles highlight slow diagnostic testing at the radiology department as a consequence of insufficient capacity [84,102,111,112], in turn a result of lack of digital diagnostic machines [84,102,111] or of staffing resources [102,112].

3.3. Inefficient capacity coordination

How available capacity at hospitals is utilized and how those resources (i.e. staff, beds, equipment, rooms, tools, time) are coordinated is given high importance, and several studies highlight inefficient capacity coordination as a major internal process barrier [30,57,64,69,76,87,92,93,96,97,110,113–128]. At the OR, inefficient capacity coordination is associated with an inefficiently planned operating schedule [121–125,129] as a consequence of a capacity mismatch with the existing demand [61,120], which in turn stems from a lack of capacity coordinators [121,129] and unrealistic resourcing forecasts [120,123,129]. The latter, in turn, are a result of surgery times not being based on characteristics of the individual patient or surgeon [61,123,129], the OR schedule not being designed to take into account the severity of cases [61,120,130] and insufficient capacity statistics when planning the operative schedule [64,123]. Finally, a lack of capacity statistics can be derived from a lack of standards [61,64,120] and high physician variability [61].

3.4. High capacity utilization variation

There seems to be inconsistency in capacity utilization at hospitals. Many articles consider high variation in capacity utilization as having a significant impact on the patient process flow [33,61,64–66,83,94,95,105,111,113,120,122,124,130–134]. At a pre-operative unit, a varying capacity utilization is considered to result from late cancellations of surgeries [61,135], planned patient

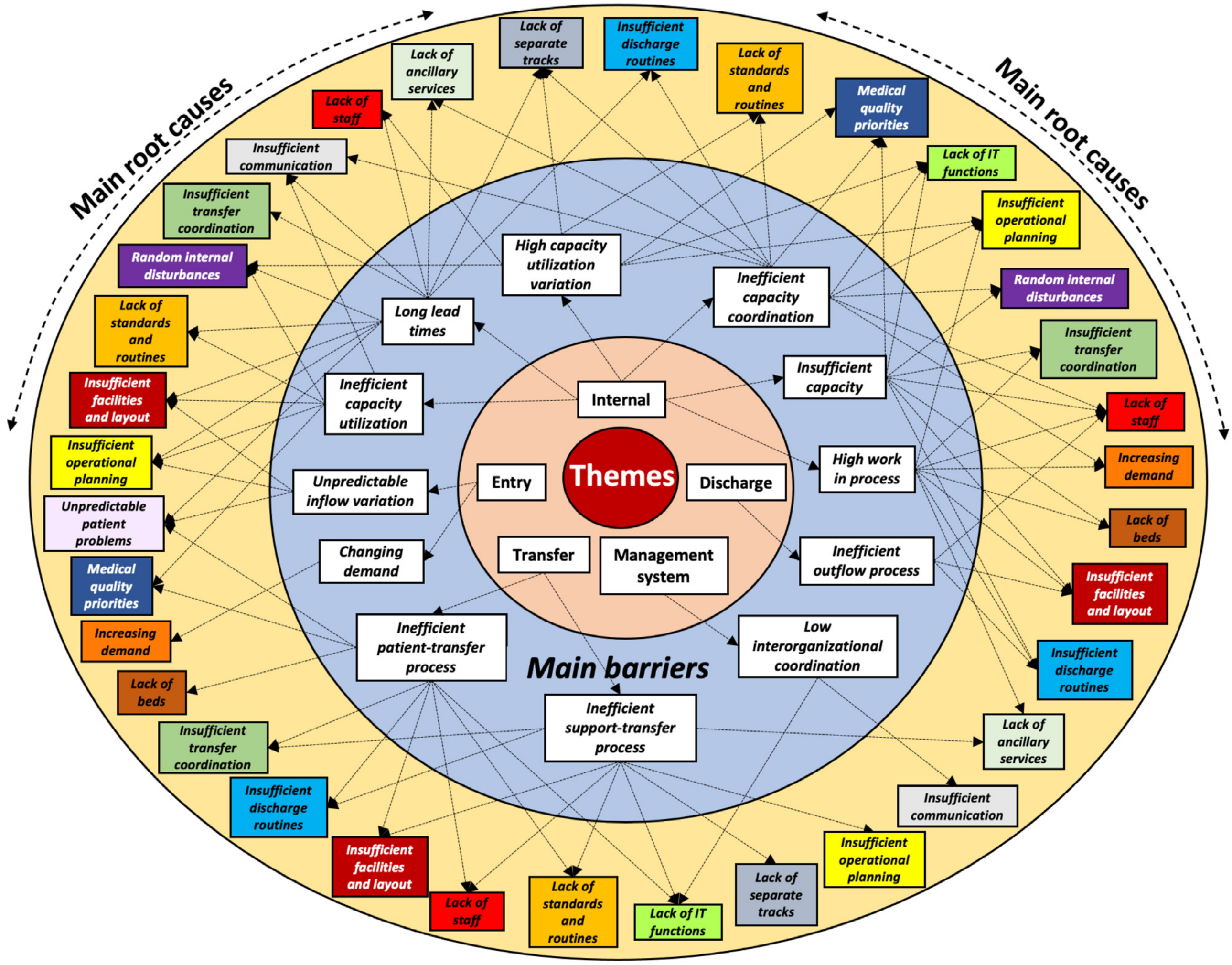

Fig. 4. The interrelated causality of themes, main barriers and main root causes.

flows disturbed by emergent cases [33,126], recurring capacity insufficiencies [33,120,126,134] and varying staffing capacity over the week [134]. This capacity variation is subsequently seen as a consequence of varying available staffing resources [64–66,121,134] and high variability in the patient caseload over the week [33,134], which in turn is a consequence of the pre-operative unit schedule not sufficiently accounting for the characteristics of patients or the required specific OR preparations [33,134].

3.5. Inefficient capacity utilization

Available capacity, whether sufficient or not, can be used more or less efficiently to ensure that an organization meets its objectives. Consequently, inefficient utilization of existing capacity is regarded as an important patient process barrier [57,59,61,62,66,68,81,83,85,89–91,93,96,98,103,104,108,112,114,121,129,130,136]. In the ED, inefficient capacity utilization can be found in the lack of split flows between more and less acute cases [56,103], the lack of using medical scribes to support physicians and nurses [74], in the slow patient-registration process [56], in the bottlenecks a triage waiting-room creates [107] and in the insufficient staffing at peak-time demand [56,74,98,108]. An inability to arrange split flows may then result from a lack of space [97] and the lack of peak-time staffing is connected to a complex and time-consuming triage process [59,97,98,107].

3.6. High work in process

If the number of patients staying or being treated within a hospital at the same time exceeds available capacity, queues and congestion build up and hamper the flow of patients. High work in process is consequently considered a barrier to prompt and timely processes [12,33,56,67,71,77,97,98,100,101,107–109,134,137–139]. At the inpatient ward, a high work in process builds up when too many patients are discharged at the same time [12,71,88], which stems from a lack of continuous patient discharge [12,88], discharge rounds given to all patients at the same time [88] or insufficient discharge preparation [71,74]. At pre-operative units, congestion builds in the morning before the start of the first surgery [33,120,134,135] as a result of multiple patients receiving anesthesia simultaneously [33,134,135], which in turn is related to multiple OR cases starting concurrently instead of having staggered start times [120,134].

3.7. Inefficient patient-transfer process

To transfer patients across a hospital and pass the responsibility for them from one medical clinic to another requires communication and clear routines, which are not always the case [56,58-60,65,66,81,97,104,115–117,120,128,132–134,137,140,141]. At the ICU, an inefficient patient-transfer process arises from patients who no longer require intensive care but are still in the ICU

[60,115], insufficient coordination with the ward [60,100,115,116], ICU staff being unable to reach accepting physicians at the inpatient ward [115,116] and unpredictable ICU discharge procedures [60,115]. That unpredictability is subsequently linked to a lack of routines and checklists [60,100,115] and to physicians making inconsistent judgements (115).

3.8. Inefficient support-transfer process

At hospitals, there are several supporting processes, i.e. ancillary services, for the main production process. Process barriers associated with a transfer of patients between patient-responsible clinics and ancillary services are highlighted by several studies [74,85,91,97,98,102,107,119,127,137,138,142,143]. Inefficient support-process transfers are found in delayed patient transfers between the ED and radiology department [102,137,138,142,143], long radiology turnover times [84,101,102,111], the lack of dedicated radiology porters [102] and in the difficulty patients have finding the radiology department and the correct treatment room [85,143]. At the inpatient ward, this transfer inefficiency can be found in the long lead times in ancillary services [87,91,102] associated with insufficient ancillary resources [72,102] and the lab or radiology services not prioritizing discharge-ready patients [87]. Inefficient transfers may also result from ordering lab and radiology tests on too short a notice [69,87,88], insufficient discharge routines [87,88] and a lack of resources and time at the ward [89].

3.9. Unpredictable inflow variation

Multiple studies highlight challenges with unpredictable variation caused by patients not complying with booking agreements or arriving with unexpected complications [33,64,66,82,88,96,121,129,132,134,135,144]. This can be related to patients' unknown and unexpected comorbidities when preparing for surgery [132,134] or to patient 'no-shows' for both surgery and outpatient appointments [33,61,66,88,96,121,134,144]; these may result from patients' medical conditions being too severe [129,132], patients' low ability to influence the day of surgery or of an appointment [*129*], health care being taken for granted (96) and physicians not conducting a sufficient pre-operative assessment before surgery [61,88,121,129].

3.10. Changing demand

The ED and outpatient receptions, as hospital gatekeepers, are both directly affected by changes in the demand for health care. The fluctuation in type, number and variety of patients is considered challenging [56,74,95,97,101,105,106,109]. This changing demand is partly associated with a general increase in patients requesting health care [56,95,97,101,106], which is related to an aging population [56,109], an increase in the number of patients with multiple chronic diseases [69,109] and reduced access to primary-care services [56,109]. Another source of changing demand is related to significant fluctuations in incoming medical referrals from primary care [95,105,106], which is caused by seasonal variability in referral volume [95,105] and insufficient dialogues with GPs in primary care [105].

3.11. Inefficient outflow process

Transferring a patient and handing over the responsibility for that patient's care from the hospital to an external provider imposes a significant challenge to healthcare organizations [30,69–73,78,87,88,91,97,139]. At the inpatient ward, an inefficient outflow process is caused by insufficient access to transit or discharge areas [69,88,91], an inability to discharge patients during weekends [30], transfer delays to external providers such as nursing homes [73,76–78,91] and external care providers not being ready for patient transfers [30,87,97]. This lack of readiness is associated with late internal discharge planning [67,73,87], external providers accepting admittance only on weekday mornings [97] and a shortage of care facilities for aging patients [30,97].

3.12. Low interorganizational coordination

Across the hospital organization, interrelated actors need to coordinate with each other to improve the global chain of events. Patient process barriers associated with the management, however, have not been widely explored but are still highlighted by some studies [67,76,86–88,139,143]. At the inpatient ward, low interorganizational coordination can be seen in a slow bed turnover [12,67,76,87], which is associated with a lack of accurate and timely discharge notification [76], insufficient communication with the ED [76,87] and ineffective data management [12,67]. This can also be seen when the inpatient ward cannot prepare for surges in demand for acute care [12,67,88,139], associated with a lack of accessible patient flow status (69, 88, 139) and when the ward cannot track real-time occupancy rates in the ED, ICU or OR [12,88].

4. Discussion

Improving hospital patient flows as a means of improving productivity requires a hospital-wide approach (24, 29, 31, 34). Moreover, improving the overall performance of a process can be achieved only by identifying and solving its main constraints (42, 43). Hence, in the search for a scapegoat to hospital-wide patient throughput problems, our review reveals the complexity behind patient processes at hospitals and that barriers and associated root causes are intertwined and must be addressed as such. In all, 12 main barriers and 15 main root causes have been identified, providing a good point of departure for policymakers and healthcare managers on which bottlenecks to really focus on. The categorization also provides a context to the root causes in terms of connected types of barriers and themes based on type of setting across a hospital-wide patient process. This offers improvement agents further possibilities to identify the most-appropriate improvement strategy according to a specific hospital's policies or objectives. The identified barriers are also confirmed by other hospital-wide studies that highlight *long lead times* [11,12,24,47], *inefficient capacity coordination* [12,46] and *inefficient patient-transfer processes* [26,29,47] as important aspects. Moreover, Villa et al. [29] associates inefficient patient flows to poor allocation of capacity, shortage of capacity, high variability, lack of coordination, presence of bottlenecks along the patient process, and overlaps between elective and emergent cases. Comparing this to our review, this study presents insufficient capacity as one of the identified main barriers, which can result from both insufficient resources (lack of beds and IT functions) and an inefficient use of resources (insufficient discharge routines and transfer coordination). Additionally, inefficient capacity coordination, another identified main barrier, can precisely like insufficient capacity be the result of resource insufficiency (lack of staff and IT functions), or an inefficient use of resources (insufficient standards, routines and communication). This example demonstrates how different throughput barriers can be the consequence of similar root causes as well as how barriers and their associated root causes are intertwined. This review confirms aspects highlighted by previous literature but extends the analysis significantly by ordering barriers in new levels to better explain the complexity behind inefficient hospital patient process throughput.

There is an ongoing discussion on what policymakers should do to improve the financial situation in health care as expenditures keep increasing [3,4]. Another debate revolves around whether policymakers should focus on strategies of cost containment or production improvement [8–10] and whether production improvements can be reached with or without increasing the amount of available resources [11]. This review gives a broad overview of existing literature on patient throughput processes. The identified root causes of the main process barriers consist of several factors where *lack of staff, lack of standards and routines, insufficient operational planning* and *lack of IT functions* are the most prevalent. Together, they indicate that root causes of inefficient hospital patient throughput are both resource-related and work-method-related. The potential of examining work methods to improve patient flow can be compared to *lack of staff* being virtually the only factor that is heard in public debates. This can be seen in debate articles where unions, professional organizations and hospital management, as well as politicians, are arguing for more resources to solve capacity problems [5,145–148]. Even though a lack of resources is a relevant factor, our results indicate that there are several other root causes that are more easily addressed and can lead to capacity improvements without increasing expenditures, a strategy also supported by previous research. Meeting rising healthcare demands with a focus on increasing resources has, in fact, been attempted multiple times over recent decades with consequences of high cost increases and, rarely, equivalent gains in capacity [8,11,29,35,37]. Lastly, recent studies highlight the acute need to use existing resources more wisely as lack of staff is projected to rise significantly in the coming decade [5,146].

Improving hospital performance is not an easy task for policymakers. To address it, a hospital-wide framework has been developed comprising two models. By using the hospital-wide process model (Fig. 2) in combination with the barrier causality model (Fig. 4), it is possible to take different paths based on the unique situation of each hospital. The strength lies in understanding the broader patient process barriers and connections to multiple similar root causes. Using this framework will make it possible to approach an improvement strategy by focusing on a specific setting and, from there, to address associated barriers and root causes. It will also be possible to take the opposite approach by focusing on a specific root cause for addressing multiple barriers. The two models are bi-directional and can, therefore, together serve as a framework for guiding improvement activities, no matter the starting point. Analyzing barriers behind inefficient hospital-wide patient flow can be found in a few previous studies with a focus on performance indicators [29], paradoxes of patient flow [31], applications of lean healthcare production [26] and general improvement strategies [34]. The comprehensive framework evolving from our systematic literature review complements their work by enabling a deeper understanding of hospital-wide patient process barriers in various contexts and from various perspectives.

Hospitals are organizations that consist of multiple interlocking sub-processes and complex change dynamics, with strong professional structures sharing different views on how to improve the healthcare sector [46]. Hospitals struggle from conflicting logics between professional and administrative or political groups where healthcare professionals see the needs of the individual patient while the other groups are advocates for the society or the future patient [149,150]. This complexity adds ethical stress to all those working along the patient flow [151]. Moreover, the behavior of or the influence from patients themselves in the treatment process has a profound impact on throughput. This can be seen in patients' willingness or capacity to comply with the process of care and with the decisions made by healthcare professionals. All these perspectives provide significant challenges to coordinate all the actors across the value chain and, thereby, enable a seamless patient process along the whole trajectory of care [8,27,34]. A system approach might then provide better possibilities for reaching common ground in development projects. Kreindler [31], and D'Andreamatteo [26] also emphasize difficulties in improving the patient flow across hospitals without taking the system-wide approach. They argue that successful local flow improvements in the best case scenario offer local optimization and, in the worst case, risk impairing the patient flow of adjacent clinics or units. An overall organizational strategy to improve hospital patient flows is, therefore, needed.

To support hospitals in designing system-wide improvement strategies, researchers must conduct more studies using a broader lens. Understanding how to improve the hospital-wide patient process is troublesome today as previous research on patient process barriers has focused almost entirely on single medical settings (clinics or units). This literature review demonstrates the strong focus on single settings, seen in the dominance of barriers and root causes associated with the internal theme. These barriers are mostly expressed from the need and objectives of a single setting and not from the need of a hospital or the system. By contrast, studies on process barriers in association with the management system are scarce and indicate that studying patient process throughput from a hospital-wide perspective is rare. This confirms previous research that has pointed to the scarcity of studies taking a hospital-wide perspective on patient process throughput [13,26,31,34]. Consequently, a lack of research on barriers in connection to the management system could mean that we overlook important reasons behind inefficient hospital patient throughput. This expresses a limitation to this study since a review is naturally limited to the included primary studies. To develop this framework further can, therefore, be achieved only by conducting further studies on patient process barriers associated with the management system.

This article contributes to decision-making by healthcare managers and policymakers by providing new insights into hospital-wide patient process barriers, filling a gap previous research has identified. In this study, two models have been built from the use of existing theory on processes, and applied in a novel context, adding to the existing body of knowledge. Using these two models, we have constructed a hospital-wide process framework connecting hospital settings with process categories and connecting those process categories with main barriers and their root causes. It extends the understanding and description of process barriers and their presence and impact on patient throughput at hospitals. The use of this framework also connects to a larger picture of healthcare system performance as it provides insights into how healthcare systems can reach their goals of timeliness, responsiveness and efficiency expressed by the WHO, the OECD and the IOM [15,17,18].

We believe that the greatest managerial contribution will evolve from the use improvement agents, and healthcare managers at hospitals, will have from this framework when designing their improvement strategies. Additionally, there is a decent body of knowledge to be found concerning patient process throughput at hospitals, but this study highlights a need for more hospital-wide research on the whole patient flow from admission through discharge. We also direct a focus to an exploration beyond internal process barriers to learn more about the whole ecosystem of processes at hospitals. Finally, this study has identified numerous main process barriers and their associated root causes related to hospital-wide patient process throughput. Hence, a natural subsequent step is to identify and evaluate sufficient solutions to break down these barriers in order to enable swift and even patient flows at hospitals.

This study comes with some limitations. Even though a rigorous method of systematic reviews has been followed, no quality assessment of included articles was conducted. The reason lies in the purpose of the study to capture all relevant research, enabling a summative approach when identifying the main root causes. Hence, complementing the inclusion and exclusion criteria, the validity of the results has instead been derived from the large quantity of studies included in the review. Another potential limitation is the criterion of including only English-language studies, potentially excluding many important articles. Finally, to understand a whole system by uniting its parts does not guarantee a complete picture. There are, naturally, perspectives lost in this study. Even so, until large hospital-wide primary studies on patient throughput can be conducted, we will have to attempt to understand the whole by summarizing its parts.

5. Conclusions

This article has systematically selected and reviewed 92 papers on hospital patient throughput barriers. From the synthesis, 12 main barriers and 15 associated main root causes have been identified. *Long lead times, inefficient capacity coordination* and *inefficient patient process transfer* are the most prevalent patient process barriers at hospitals. These barriers are subsequently caused mainly by a *inadequate staffing, lack of standards and routines, insufficient operational planning*, and *a lack in IT functions*. This article has demonstrated the need for more hospital-wide primary research to further explore hospital-wide patient process barriers, as previous research generally has taken perspectives of the single medical clinic or unit. Finally, this study has developed a new hospital-wide framework to be used by policymakers, healthcare managers, and improvement agents when deciding upon what improvement strategies to follow in order to increase patient throughput at hospitals.

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Declaration of Competing Interest

The authors declare that they have no competing interests concerning the material discussed in this manuscript. This accounts for interests of either financial nature (such as grants, consultancies, equities, or other employments) or non-financial nature (such as professional, personal relationships or subjective beliefs).

CRediT authorship contribution statement

Philip Åhlin: Conceptualization, Writing – original draft, Methodology, Software, Data curation, Writing – review & editing. **Peter Almström:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Carl Wänström:** Methodology, Writing – review & editing, Data curation.

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Supplementary materials

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