Diagnosing Patient Flow Issues in the Emergency Department: An Australasian Hospital Case Study

Abstract

Purpose:

This study investigates how a hospital can increase the flow of patients through its emergency department by using benchmarking and process improvement techniques borrowed from the manufacturing sector.

Design/Methodology/Approach:

An in-depth case study of an Australasian public hospital utilises rigorous, multi-method data collection procedures with systems thinking to benchmark an emergency department (ED) value stream and identify the performance inhibitors.

Findings:

High levels of value stream uncertainty result from inefficient processes and weak controls. Reduced patient flow arises from senior management's commitment to simplistic government targets, clinical staff that lack basic operations management skills, and fragmented information systems. High junior/senior staff ratios aggravate the lack of inter-functional integration and poor use of time and material resources, increasing the risk of a critical patient incident.

Originality:

This study is the first to operationalise the theoretical concept of the seamless healthcare system to acute care as defined by Parnaby and Towill (2008). It is also the first to use the uncertainty circle model in an Australasian public healthcare setting to objectively benchmark an emergency department's value stream maturity.

Research Limitations/implications:

This research is limited to a single case; hence, further research should assess value stream maturity and associated performance enablers and inhibitors in other emergency departments experiencing patient flow delays.

Practical implications:

This study illustrates how hospital managers can use systems thinking and a context-free performance benchmarking measure to identify needed interventions and transferable best practices for achieving seamless patient flow.

Keywords: Audit, Benchmarking, process improvement, Systems thinking, Patient flow, Emergency Services

Introduction

The strategic imperatives of public healthcare systems call for responsive, dependable, and effective care (Bhakoo *et al.*, 2012) despite extreme budgeting pressures (Chen *et al.*, 2013) and the risk of medical mishaps (McFadden *et al.*, 2006). At the same time, such systems are notoriously complex due to their duration, criticality, and emotional intensity for patients and care providers (Berry *et al*., 2022), and they experience challenging operational problems that can be difficult to address (Jessup *et al.*, 2010; Lee *et al.*, 2011).

Hospital emergency departments (EDs) provide an essential gateway to hospital admission and a see-and-treat model for minor injuries involving diagnostic services. However, congestion, overcrowding and high volumes of patient admissions place intense pressure on the ED (Di Somma *et al.*, 2015; Jai *et al.*, 2022), causing long wait times due to a lack of available beds (Willoughby, Chan and Strenger, 2010). Ill-conceived hospital layouts create further problems (Sabir and Mustafa, 2023) that impact patient flow efficiency (Willoughby, Chan and Strenger, 2010; Al Owad *et al.*, 2022), resulting in poor patient satisfaction and mistreatment of patients (Di Somma *et al.*, 2015). Prompt treatment in the emergency department (ED) is essential for clinical outcomes and the patient experience, making patient wait time a popular governmental yardstick for judging overall performance but one prone to political manipulation (e.g., DeFlitch et al., 2015). For example, the UK government's 'four-hour standard' set in 2004, that 98% of all patients would spend no longer than 4 hours in an emergency department, was lowered to 95% in 2010; by 2023, it stood at 76% (NHS England, 2023; The King's Fund, 2022).

Like many healthcare organisations that operate autonomously due to specialisation (Meijboom *et al.*, 2011), the ED must coordinate many activities across time and space, making function-based healthcare the norm rather than the integrated journey patients need. Also, ED performance is impacted strongly by problems elsewhere in the healthcare system due to its interfacing with external entities such as GP practices, social care services, emergency services, and internal wards and operating theatres (Miró *et al*. (2003); Willoughby *et al*., 2010). Consequently, addressing ED performance issues requires data-driven consideration of system-wide problems, including collaboration and behavioural aspects (Ortíz-Barrios and Alfaro-Saiz, 2020).

Performance benchmarking is a critical step in identifying the areas for improvement because it can assist in fully understanding the hospital care challenges and their impact on patient's well-being (Jia et al., 2022). Edril and Erbiyik (2019) describe 'unit' as the benchmark and the measurement of the 'unit' as benchmarking, for which many options are available (Sabir and Mustafa, 2023; Jai *et al.*, 2022). Following the identification and precise definition of the 'unit' of measurement to judge performance, Understanding and improving the operational elements is essential (Edril and Erbiyak, 2019; Adebanjo, Abbas and Mann, 2010).

Unfortunately, the pathways to effective ED performance remain unclear (Régis *et al.*, 2019; Williams and Best, 2022), with no reliable metrics available for describing ED complexity despite the many outcome measures defining crowding, capacity utilisation and throughput that currently inform patient flow strategies (Badr *et al*., 2022). While benchmarking can provide a solid foundation for healthcare improvement programmes (Salama *et al*., 2009), the published techniques rarely establish transferable best practices for hospitals or the broader healthcare sector (Dixon-Woods and Martin, 2016; Lee *et al*., 2011). Hence, the overarching research question for this study is:

How can benchmarking techniques improve patient flow in hospital emergency departments?

Two secondary questions help to address this question:

SQ1: How sophisticated is patient flow management within the emergency department?

SQ2: What factors enable and inhibit patient flow within the emergency department?

The following section outlines a systems approach for improving healthcare, followed by a rigorous assessment methodology that yields a meaningful performance benchmark and identifies the root causes of the ED's 'major pains'. The findings of field research with the ED of an Australasian public hospital are then discussed, including the implications for researchers and healthcare professionals. The paper concludes by considering the study's limitations and research opportunities.

A systems approach for assessing patient flow

While introducing industrial processes into healthcare can be perceived as an excuse to force an overworked workforce to work harder, significantly improved quality and efficiency in manufacturing and services has led researchers to ask whether similar processes might deliver improved healthcare at a reduced cost (Young *et al.,* 2004).

Womack *et al.* (1990) coined the term value stream to describe the sequence of cross-functional, sequential and concurrent activities an organisation undertakes to fulfil a customer request. Thus, a complete value stream for supporting patient care might include appointment scheduling, registration, diagnosis, and treatment through to aftercare.

Parnaby and Towill (2008) posit that a 'healthy patient' delivery system has definite boundaries, with information, resources, and patient flows entering from three sides and an outflow of successfully treated patients and accompanying information on the other. In practice, patients and information flowing across the internal functional and external organisational boundaries experience flow issues (e.g., Williams (2017) and, given the sheer variety of unpredictable healthcare value streams, monitoring system outcomes calls for an objective, universally comparable and transferable performance measure. Moreover, because external events, like policy changes, can disturb the smooth running of the system, healthcare process redesigns must incorporate ongoing careful management and control to maintain efficient and effective patient value delivery (Ellram *et al.*, 2006; Towill, 2006).

Similar to other researchers using system uncertainty to frame traditional supply chain concepts (e.g., Lee, 2002; Wong and Boon-itt, 2008), this study uses 'uncertainty' to gauge the level of sophistication/maturity of an ED value stream and compare it against a standard. Uncertainty propagates throughout the patient network, leading to poor decision-making, inefficient processing, non-value-adding activities, long cycle times and other waste (Persson, 1995). The chief advantage of uncertainty as the performance measure is that it is a *context-free* metric that enables direct performance comparisons even when the organisations are in different business and economic settings (Boehme *et al.*, 2013; 2014; Childerhouse and Towill, 2002).

Building on the work of Davis (1993), Mason-Jones and Towill (1998) developed the uncertainty circle model (UCM) to define the four primary sources of uncertainty indicated in Figure 1 that affect value stream performance.

Insert Figure 1 here

According to the UCM, four characteristics indicate a value stream's overall sophistication/maturity level (Childerhouse and Towill, 2002): *Our Processes*, *Our Controls*, *Our Supply Side*, and *Our Demand Side*.

Towill and Childerhouse (2006) demonstrated an exceptionally high correlation between material flow complexity and uncertainty for 32 real-world value streams; hence, an uncertainty 'score' is assigned to the four UCM characteristics based on the presence/absence of the four classes of symptoms that are associated with complex material flow in Table I: *Dynamic behaviour*, *Physical situation*, *Operational characteristics*, and *Organisational characteristics*. Thus, the UCM scores derive from qualitative and quantitative data obtained from patient flow mapping, structured interviews, observed ED activities, and secondary data concerning ED layout, staff roster, and patient wait times, to name a few.

Insert Table I here

Judging the uncertainty of each UCM characteristic involves a 4-point Likert scale (lowest uncertainty=1; highest uncertainty=4). Finally, because 'chains are only as strong as their weakest link', the values are combined into a codified value stream uncertainty score, or vector, using the Euclidean Norm (EN), where: $EN = \sqrt{[(\text{Our processes-1})^2 + (\text{Our controls-1})^2 + (\text{Our supply side-1})^2 + (\text{Our demand side-1})^2]}$.

In essence, EN describes how an integrated dynamic control mechanism with appropriate interfacing between the core processes of business units is critical for ensuring seamless flows of materials/patients and information (Towill, 1997). The basic premise is that entities with similar EN values will produce similar effectiveness and efficiency (Bass, 2007). Further details on UCM use in healthcare environments can be found in Boehme *et al*. (2013, 2014).

Methodology

The Quick Scan Audit Methodology

Figure 2 depicts the scope of the present study mapped onto the UCM, indicating the ED system interfaces and related uncertainty areas for investigation.

Insert Figure 2 here

Gauging value stream sophistication/maturity involves an onsite investigation by a team of researchers to accurately determine the sources of uncertainty. This study utilised a robust supply chain diagnostic method termed the Quick Scan Audit Methodology (*QSAM*) to examine the hospital's degree of control over ED patient flow processes.

As indicated in Figure 3, the theoretical foundations of *QSAM* are process control engineering, systems thinking, and industrial dynamics. Initially developed to provide a rapid, repeatable mechanism for establishing supply chain effectiveness in the European automotive sector (Childerhouse and Towill, 2004; Lewis *et al.*, 1998), the *QSAM* has since been deployed globally in a range of industrial settings, including healthcare, e.g., Boehme *et al*. (2013, 2014). Figure 3 reflects its utility within the ED context.

Insert Figure 3 here

During the *QSAM Start-up* phase, team preparations for the onsite audit include a formal presentation to host organisation managers and staff to secure support and access to needed data sources. Preliminary discussions aim to understand the mission, vision, and objectives, agree on the target value stream(s), and identify a 'champion' to work alongside the lead researchers. The *QSAM Execution* phase typically involves five days to audit a medium-sized organisation's value stream(s), including three full onsite days. Audit protocols help to ensure that the team members' assessments are reliable (Naim *et al.*, 2002). In the *QSAM Exploitation* phase, the organisation's managers receive guidance via a formal feedback presentation and discussion and a written report detailing the organisation's benchmark status, improvement opportunities, and recommended development pathways. The process benefits the researchers by delivering rich research data and insights into management practices. A detailed description of the *QSAM* method applied in hospitals is in Boehme *et al*. (2013; 2014).

Research rigour

The *QSAM* employs five data collection tools to exploit knowledge from as many data sources as possible; for example, patient flow judgements use a combination of case study-type metrics and statistically significant data. This mix of quantitative and qualitative data provides an in-depth understanding of triangulated data, Table II. Codifying the uncertainty sources involves every team member and a broad range of researcher expertise to achieve consensus on patient flow maturity (Childerhouse and Towill, 2011).

Insert Table II here

Non-participant observation enables the researchers to understand the value stream operating within its broader organisational context. Also, a structured questionnaire completed by the in-house project champion identifies the various stakeholder interactions. Semi-structured interviews with managers, ED staff, and ward and operating theatre staff focus on patient flow performance and improvement opportunities. Secondary data sources include strategic plans, patient throughput data, layout plans, and KPI fulfilment (Boehme *et al*., 2013).

Data analysis

The unit of analysis for this study is the emergency department of a public hospital, which arguably is a sub-system of the broader hospital system. The selection was random since it relied on finding a hospital where senior management perceived the value of the ED audit would outweigh the staff time and effort involved. The increasing demand for ED care in Australasian hospitals is a worldwide problem that keeps EDs under constant strain, including in developing countries (Ortíz-Barrios and Alfaro-Saiz, 2020).

Due to the service aspect and the need for insights and clarity around staff responsibilities and interactions, the researchers pay close attention to patient flows and use a role-activity model (Shukla *et al*. 2014; 2017) to gain an accurate and detailed graphical representation of sequential, parallel and collaborative processes with multiple interacting roles.

The value stream uncertainty data associated with the four UCM characteristics (*Our processes*, *Our controls*, *Our supply side*, and *Our demand side*) are collected and rated, and the uncertainty symptoms are classified (Childerhouse and Towill, 2002; Towill, 1999). As described earlier, subjective measures combine case study-type metrics and statistically significant data to inform judgments of value stream uncertainty, and the researchers aim to exploit knowledge from as many data sources as possible. Around 40 hours of onsite ED investigation per researcher strengthens the assessment.

Systems thinking then analyses uncertainty causes to yield a cause-effect visual representation of ED patient flows (Mabin *et al.*, 2006). Identifying the root (initiating) causes of the 'major pains' and the barriers to process integration helps the research team to identify any non-value-adding activities and improvement possibilities. The cause-effect diagram also fulfils the systems thinking perspective of Edwards and Ram (2006) and has several strengths:

- It can serve as a guide for identifying effective 'high leverage' improvement initiatives (least cost/effort to achieve maximum benefit)
- It is invaluable during the final feedback session with the organisation when the research team seeks clarification and endorsement of its findings
- It provides an essential focus for debate and understanding between physicians, technicians, nurses, and managers so that recommended changes to the ED process can translate into informed agreements (Lindberg *et al.*, 2003).

In the final step, the analysis results, including the combined UCM score (uncertainty vector) and cause and effect diagram, are presented to the organisation for feedback and validation of findings. A detailed *QSAM* data collection and analysis overview is in Boehme *et al*. (2013).

Findings

The process map developed to gain site familiarisation and understanding of the current ED processes is shown in Figure 4, indicating a typical patient flow pathway.

Insert Figure 4 here

The case hospital has around 60,000 patient visitation to the emergency department annually, and this number is increasing due to regional growth. Core activities involve patients entering the hospital via the ED (walk-in or patient transport via ambulance), patient diagnostics within the ED, and transfer to ward/theatre or discharge (Rivard-Royer *et al*., 2002; Shih *et al*., 2009).

An administrative assistant registers the walk-in patients at a reception area, while ambulance staff register patients before arriving at the ED. Triage nurses then assess the severity of the patient's presenting condition. Category 1 patients requiring urgent attention are placed in an examination room, whereas the examination of Category 2-5 patients takes place on the general beds as depicted in Figure 4. The five triage categories are (1) resuscitation, (2) emergency, (3) urgent, (4) semi-urgent and (5) non-urgent. After the initial assessment, nursing staff may order diagnostic tests, X-ray examinations, and the like and prepare the patient's notes. Upon receipt of the results, a doctor reviews the notes and test reports and decides whether to admit the patient for further assessment or discharge them from the ED. The internal processes/patient pathways do not change once the patient leaves the waiting area.

SQ1: How sophisticated is patient flow management within the emergency department?

An uncertainty 'score' was assigned to each of the four UCM characteristics: *Dynamic behaviour*, *Physical situation*, *Operational characteristics*, and *Organisational characteristics* (earlier Table I). The degree of complexity involved subjective assessment of the associated complexity symptoms identified from patient flow mapping, structured interviews, observed ED activities and supporting documentation. The hospital champion subsequently verified this subjective assessment.

For this study, the Euclidean Norm (EN) = $\sqrt{[(4\text{-}1)^2 + (4\text{-}1)^2 + (3\text{-}1)^2 + (4\text{-}1)^2]}$. Figure 5 indicates (with an X) the codified (EN) uncertainty score (5.6) for the case ED's patient flow value stream and eight other Australasian hospital value streams (labelled 1 through 8) involving pharmaceutical supplies (Boehme *et al*., 2014). It also indicates the range of EN values obtained for various first-tier European automotive supplier value streams (Childerhouse and Towill, 2004), highlighting the utility of the nondimensional uncertainty vector as a valuable benchmarking tool for cross-industry performance comparisons.

Insert Figure 5 here

The supply chain diagnostic indicated that the process, control, and demand uncertainties each had a high level of uncertainty and the supply uncertainty a medium-high level. Consequently, Figure 5 indicates that overall the case ED procedures mirror the 'Baseline Integration' maturity level as described by Stevens (1989), corresponding to a situation in which there has been little attempt to integrate activities even within an individual functional silo.

The critical drivers of system uncertainty within the ED appeared to be:

- Compartmentalisation (lack of integration within the ED function)
- Emphasis on cost/time reduction over genuine performance improvement
- Individualism – lack of collaboration within small teams/units and between nurses, clinicians and professional staff
- Reactive patient services caused by poor demand visibility
- Highly complex and inconsistent patient and information flow patterns
- Multiple and complex stakeholder involvement within the hospital and the broader healthcare system

These factors strongly indicate an absence of systems thinking within the case ED, where a single cost-reduction-focused KPI dominates decision-making, and the principles of flow, simplicity, and waste minimisation were almost absent. While it is unreasonable to suggest that the case hospital situation and the reasons are universally applicable, a statement by the Australian government indicates that the hospital is representative of other regional hospitals in that country (Gerring, 2009).

SQ2: What factors enable and inhibit patient flow within the emergency department?

Mason-Jones and Towill (1998) demonstrate that while the uncertainties associated with *Our supply side* and *Our processes* can be reduced considerably via lean thinking principles that reduce lead times and increase quality, understanding total system behaviour is required if the uncertainties associated with *Our controls* and *Our demand side* are to be mitigated.

Systems thinking underpins the causal diagram shown in Figure 6. Such a rich picture of specific barriers and improvement opportunities developed by the research team does not reflect a single person's opinion, thereby achieving researcher triangulation.

Insert Figure 6 here

The diagram depicts the ED value stream operating within its broader organisational context and indicates the predictor variables and causal interactions (Childerhouse and Towill, 2004). Using systems thinking, the data collected during the onsite field investigation reveals the often hidden underlying problems and issues giving rise to readily observable surface symptoms and, most importantly, identifies the root causes of poor ED performance related to patient flow (indicated by the dashed outlines).

The diagram also reveals the root causes of poor ED performance: *Changing Public Sector Policy*, *Regional Origins*, *High Jnr/Snr Staff Ratio*, and *Lack of Training*. The effects of these root causes combine to create two significant areas of concern: *Poor Bed Management* and the *Risk of a Critical Patient Incident*.

Notably, linkages between the root causes and the two significant areas of concern originate from different parts of the ecosystem. For example, many staff highlight how the government sets hospital performance targets as an outcome of constantly changing public sector policy. As the ED manager pointed out:

> *"We need to discharge patients within four hours. Our funding is tied to this."*

Unsurprisingly, when the government mandates a discharge rate, in this case of *92% of patients within 4 hours*, it becomes a primary focus for ED staff. It was also clear that this preoccupation with a single efficiency-related KPI was having unintended effects on the quality/performance of the broader hospital system. For example, patients were routinely placed into an emergency short-stay assessment 'ward' within the ED to achieve the 4-hour maximum length of stay (LOS) target, significantly impacting seamless patient flow through the hospital system.

As one clinician reported:

> *"This 'ward' is best described as a holding pen. Highly specialised clinicians from other wards don't trust the ED's assessments, which are often conducted by junior staff. That's why they are so reluctant to take new patients on unless they have run their own diagnostics. Getting these experts down to the ED is a real struggle."*

Lack of trust in the ED's assessments means patients are frequently 'discharged' into the artificial ward until completion of a second diagnosis, which can extend the LOS by up to five days.

Another issue identified is that nurses and clinicians with minimal operations management exposure manage and run the ED, resulting in uncoordinated materials control. Lack of training is a root cause that limits IT capability and managerial skills and stifles attempts at continuous improvement. As the head nurse stated:

> *"We are always chasing up the materials critical for patient care."*

Staff rostering tends to be informal, and patient information is entered manually into several different software applications, which reduces available clinician time and creates communication problems, especially during handovers. In essence, because no one is responsible for ensuring patient flow across the whole ED process, significant problems are created when requesting routine X-rays and laboratory results, for example. Moreover, the managers consider the ED demand random, so poor resource use and high staff/patient stress levels persist, partly due to a lack of data analysis.

One nurse described the patient's experience:

> *"How would you feel if you had registered [in the ED] and nothing happened for hours? When it is your turn, they make you go backwards and forwards all the time from/to the ED waiting room and diagnostic stations to free up bed space. Patients often deteriorate psychologically, sometimes discharging themselves because they can't take it anymore."*

The hospital's status has recently elevated from that of a regional hospital with limited resources, but the organisational culture has only slowly adapted. The presence of internal sub-cultures, inefficient use of staff time and resources, and lack of material control continue to result in poor bed management and extended wait times. Moreover, the high proportion of junior staff creates further waste and increases the risk of a critical patient incident.

Such a convoluted, non-integrated process is detrimental to collaborative working, undermines the hospital's reliance on meaningful measurements, and hinders the ability to develop effective information management systems. The fact that advanced medical practices would enable some patients to be handled entirely within the ED with more investigations and treatments that increase the waiting time but avoid expensive hospital admissions adds further doubt to the wisdom of management's focus on a single KPI (The King's Fund, 2022). As the ED Manager pointed out:

> *"An emergency short-stay assessment ward (ESSA) is the only feasible way to achieve 92% discharge within 4 hours."*

Ultimately, the hospital's failure to agree on meaningful, process-focused KPIs has reduced government funding, making it even more challenging to meet targets.

Discussion

One broad approach to achieving effective and efficient patient flow is the theoretical concept of seamless patient flow borrowed from the manufacturing context (Parnaby and Towill, 2008). A previous QSAM study focused on pharmaceutical supply to eight hospitals (Boehme et al., 2013). In the present study, process mapping of the patient journey and root cause analysis of the significant problems (Al Owad *et al.*, 2018; Miró *et al.*, 2003), backed by a high level of uncertainty score (Mason-Jones and Towill, 1998), demonstrated that achieving an integrated ED value stream within the context of the Australasian case hospital system is an aspirational goal.

Because the connections between the above concepts have no empirical proof, the following testable propositions are offered for practitioners when they seek to adopt a systems-thinking approach to address convoluted decision-making and workplace dysfunction:

P1: A visual inventory management system will manage material flow proactively

A recent review (Lanza-Leon *et al.*, 2021) of the use of Kanban in healthcare revealed that its application tends to be limited to pharmaceuticals/medication flows (Mouaky *et al.*, 2018; Papalexi *et al.*, 2016), vaccinations (Lim *et al.*, 2017), supplies to operating theatres (Patterson, 2012), and radiology (Donnelly *et al.*, 2016), and medical supplies to wards (Bendavid *et al.*, 2010).

Moreover, while best practices like Lean and Six Sigma can reduce wait times, improve the quality of patient care, and increase operational efficiency and effectiveness (Niñerola *et al.*, 2020; Tiapa *et al.*, 2020), many initiatives fall well short because implementation is patchy (Borges *et al*., 2019). This unevenness makes it essential to implement operations management techniques like Kanban and system-wide RFID tracking (Landy and Beaulieu, 2010; Sánchez, 2018; Williams, 2017).

Thus, managers should explore every opportunity to extend visual inventory management systems to cover the ED and other areas of the healthcare system.

P2: Standby hospital support services will enable consistent patient flow

A simulation-based study of such essential ancillary services as X-rays, Labs, and Ultrasound concluded the need for an optimisation model to ensure the adjustment of resources in bottleneck areas like the ED and outpatients (Ahmad *et al.*, 2020).

Thus, to support 24-hour ED operations and prevent backlogs, ancillary services like laboratory testing and X-rays should offer a continuous standby service. Even offering evening support would help reduce the number of logjams.

P3: Cross-functional (multidisciplinary) rostering will increase clinical awareness of ED's needs

Holden *et al.* (2015) highlight the importance of culture, employee involvement, and management support when embedding lean thinking in EDs. Similarly, Drupsteen *et al*. (2013) highlight the positive effects of cross-functional healthcare integration on patient flow when, for example, ward and surgery clinicians are rostered for ED duties together. However, such initiatives often require a cultural change to alter perceptions about how EDs should operate.

A recent systematic review also reported that multidisciplinary work undertaken within EDs reinforces teamwork and standardisation of activities (Souza *et al.*, 2021). Thus, offering ancillary and support services like lab turnaround, in-patient room turnaround (room cleaning), and the availability of social work, physical therapy, and occupational therapy evaluation on weekends would also allow a more rapid turnover of in-patient beds (Kelen *et al.*, 2021).

P4: Understanding patient perceptions of ED and early patient triage will ensure that appropriate cases enter the ED system

A defining characteristic of emergency care is the undifferentiated case mix, as patients may attend the ED without prior testing or categorisation of their medical condition and health needs. They may also decide to attend the ED when a general practitioner or pharmacist could treat their relatively mild, non-urgent condition. In light of a recent review indicating that strategic thinking and individual patient behaviour have received minimal attention (Behrens *et al.*, 2023), understanding why people increasingly attend the ED instead of better-suited alternatives should be a hospital priority if pressure on the ED is to be alleviated. Also, early physician-led triaging of patients on arrival at the ED will enable appropriate signposting to alternative services, such as 24-hour GP care, thereby reducing the numbers entering the ED system.

P5: Demand forecasting will allocate appropriate resources

EDs tend to arrange staffing levels around departmental pressures rather than arrival patterns and are frequently busiest in the afternoons/early evenings due to uncleared earlier queues. These backlogs result in patients waiting longer to be treated or longer for a bed, consuming excessive resources related to communication, monitoring, and ongoing care (Higginson *et al*., 2011). Although many studies illustrate how to forecast ED arrivals and occupancy levels (e.g. Whitt and Zhang, 2019; Gul and Celik, 2020), such techniques are not widely adopted.

Routine production of demand forecasts and occupancy levels will help the ED to match its resources with expected demand.

P6: Effective decision support will free up clinical staff time

Data from 567 US hospitals shows that IT investment is associated with swift and even patient flow and improved standards of patient care (Devaraj *et al.*, 2013). Fully integrated clinical decision support (CDS) systems offer a 'single truth' and reduce the administrative burden. Conversely, a fragmented CDS only allows limited information sharing and may require multiple data entry points, increasing the risk of error or patient information loss.

The growing adoption of the Electronic Health Record (EHR) offers the opportunity to integrate CDS systems and enhance the sorting, collecting, and presentation of information that improves patient care (Garg *et al.*, 2016). Organisations like the Centers for Medicare and Medicaid Services have promoted using CDS to increase implementation (Bates *et al.*, 2014; Patterson *et al.*, 2019).

An appropriate level of investment in integrated clinical decision support (CDS) systems will help reduce wasted clinician time and create trust in the system's information (Bhakoo and Chan, 2011).

P7: Cross-functional and whole-system performance measures will positively impact the quality of ED care

Expecting a single measure to offer a complete picture of ED performance is unrealistic. McKone-Sweet *et al.* (2005) point out that misaligned incentives and not focusing on cross-functional KPIs are barriers to implementing formal operations management and improvement practices in healthcare.

Sharing accountability for meeting agreed cross-functional, whole-system KPIs between the ED, wards, and operating theatres will help create shared responsibilities and trust between the parties.

P8: Translating government policy into meaningful ED practices will increase patient flow

Hospitals are free to interpret government policies and associated KPIs; hence, the areas identified for improvement lie within the control of hospital managers and clinical staff. Research has shown the implications of ambiguity (lack of consistency, clarity, and causality) for performance measurement and practice in complex multi-stakeholder organisations. Ambiguity suppresses open, participative and inclusive controls and discourages stakeholder collaboration and communication (Ojiako *et al.*, 2023).

Because a one-size emergency department cannot suit every patient (Williams, 2017), a systemic analysis headed by senior management should aim to translate government policy into locally implementable, quality ED practices and processes that demonstrably improve patient flow (Holden, 2011). Figure 7 illustrates where the above principles, tools, and techniques should make the ED patient flow more swift and seamless.

Insert Figure 7 here

Conclusion

This study has investigated how patient flow in hospital emergency departments can be improved using benchmarking and process improvement techniques borrowed from the manufacturing sector.

The considerable ED value stream uncertainty detected within the Australasian healthcare environment results from process immaturity and weak inter-functional integration. Process mapping of the patient journey and root cause analysis identified the most pressing problems and critical inhibitors of seamless flow (Miró *et al.*, 2003). In particular, reduced patient flows arise from senior management's devotion to overly simplistic government targets, clinical staff lacking basic operations management skills, and fragmented information systems unable to accurately determine patient demand and cross-functional ED performance. High junior/senior staff ratios exacerbate the resulting lack of inter-functional integration, and poor use of staff time and resources also increases the risk of a critical patient incident.

Implications for theory

Our research is the first study to operationalise Parnaby and Towill's (2008) theoretical concept of the seamless healthcare system for acute care, particularly emergency care. It is also the first to benchmark the maturity of ED processes in the Australasian public health sector against other industry and healthcare settings using manufacturing sector principles, techniques and tools. Inductive qualitative methods were used because no guiding framework existed at the outset, and the critical constructs were unknown.

In contrast with most of the patient flow research that employs traditional modelling techniques to forecast and simulate ED patient load, LOS, and crowding (Wiler *et al.*, 2011), our study uses the uncertainty circle model to inform operational decisions concerning LOS issues (Mason-Jones and Towill, 1998). Similar to Volochtchuk and Leite's (2022) findings, it notes that the underlying performance barriers are organisational (ever-increasing costs, scarce resources, healthcare regulations), technical (inability to generalise techniques, lack of reliable data), and behavioural (clinical staff resistance).

Implications for practice

There is general acceptance that hospitals are complex adaptive systems, and hospital management must respond holistically to complex LOS/crowding challenges (Buttigieg *et al.*, 2018). Our study illustrates how managers can use systems thinking and a context-free performance benchmark to identify effective interventions for *their* ED situation.

Implementing process improvements is challenging, irrespective of the techniques applied during implementation. According to Bhasin and Burcher (2006), less than 10% of companies succeed in implementing process improvements in their operations. The main reason is the lack of understanding of the impact of inherent barriers on the process. Regardless of the difficulties, it is clear that senior managers should prioritise investments in human resources and technology to support value-stream decision-making and communicate a supply chain vision and improvement strategy (Parnaby and Towill, 2008).

Study limitations and opportunities for research

A study of this scope inevitably has limitations. Investigating a single case hospital requires further *QSAM* studies to confirm the generalisability of the findings and expand the dataset on patient flow maturity. In addition to the testable propositions outlined above, it is crucial to understand the technical, clinical, and cultural issues that persistently cause business process management tools and flowcharts to be ignored or abused (Pope and Burns, 2013). Increasing the scope of the study beyond the ED and its immediate interfaces would increase understanding of the end-to-end patient journey and the performance of intra-organisational and inter-organisational value streams. More research is also needed to evaluate operations management approaches in natural healthcare settings (Williams, 2017); for example, would adopting lean and agile approaches increase flexibility and responsiveness and reduce healthcare costs (Aronsson *et al.*, 2011)? Finally, the *QSAM* yields a holistic understanding of the ED and associated patient flows and reveals the critical leverage points for the organisation to enhance patient flow. The method requires further development to capture the patient pathway in finer granularity and account for the complexity of patient journeys.

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Figures

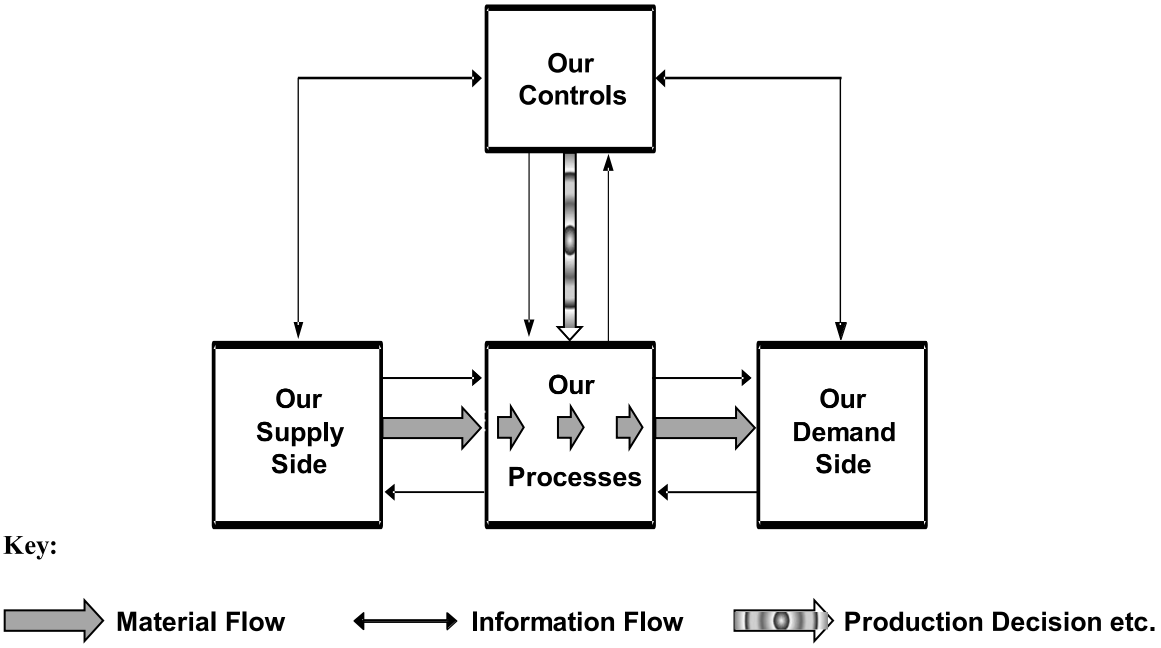

Figure 1: Uncertainty circle model (Mason -Jones and Towill, 1998)

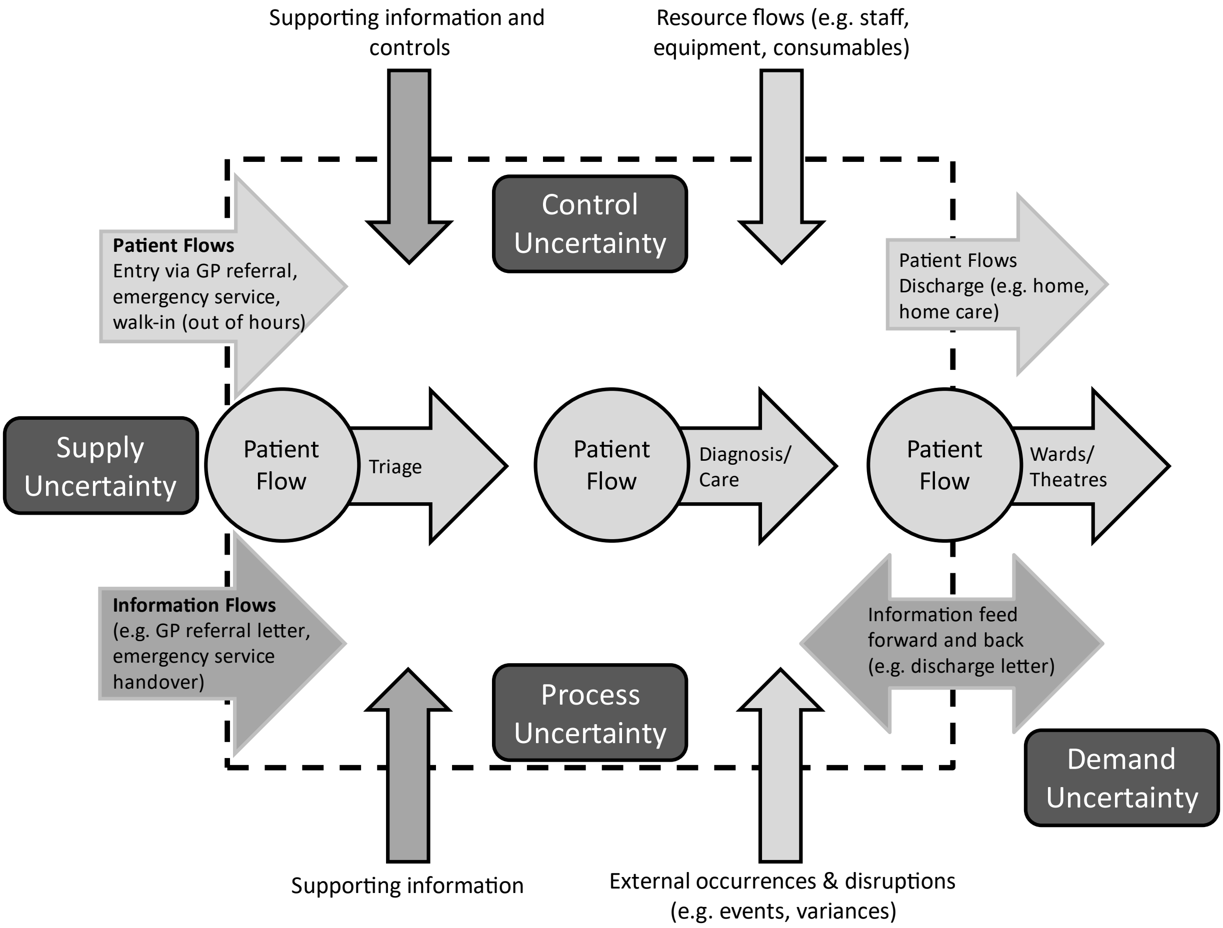

Figure 2: Study scope (Adapted from Parnaby and Towill, 2008)

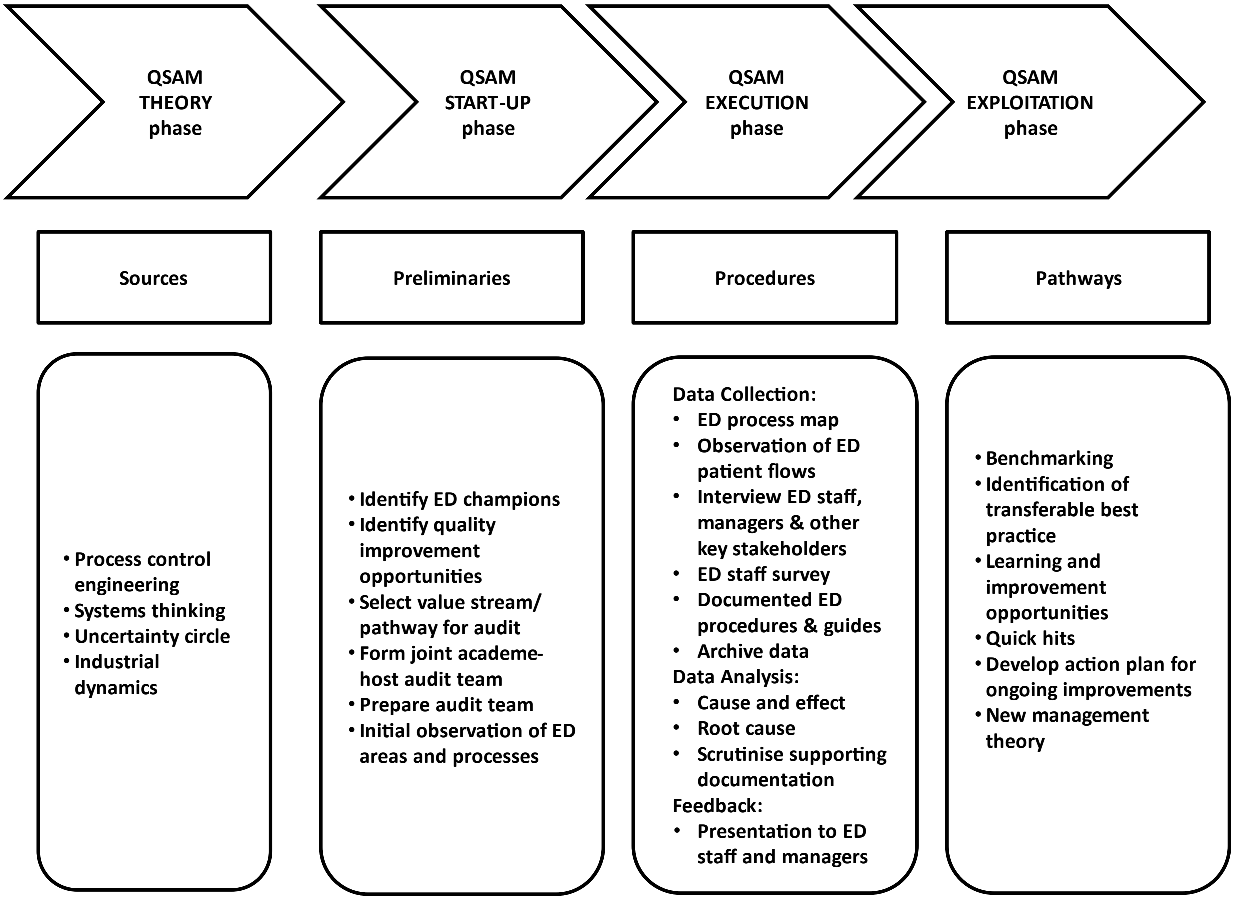

Figure 3: Emergency Department QSAM overview (adapted from Böhme *et al.*, 2014)

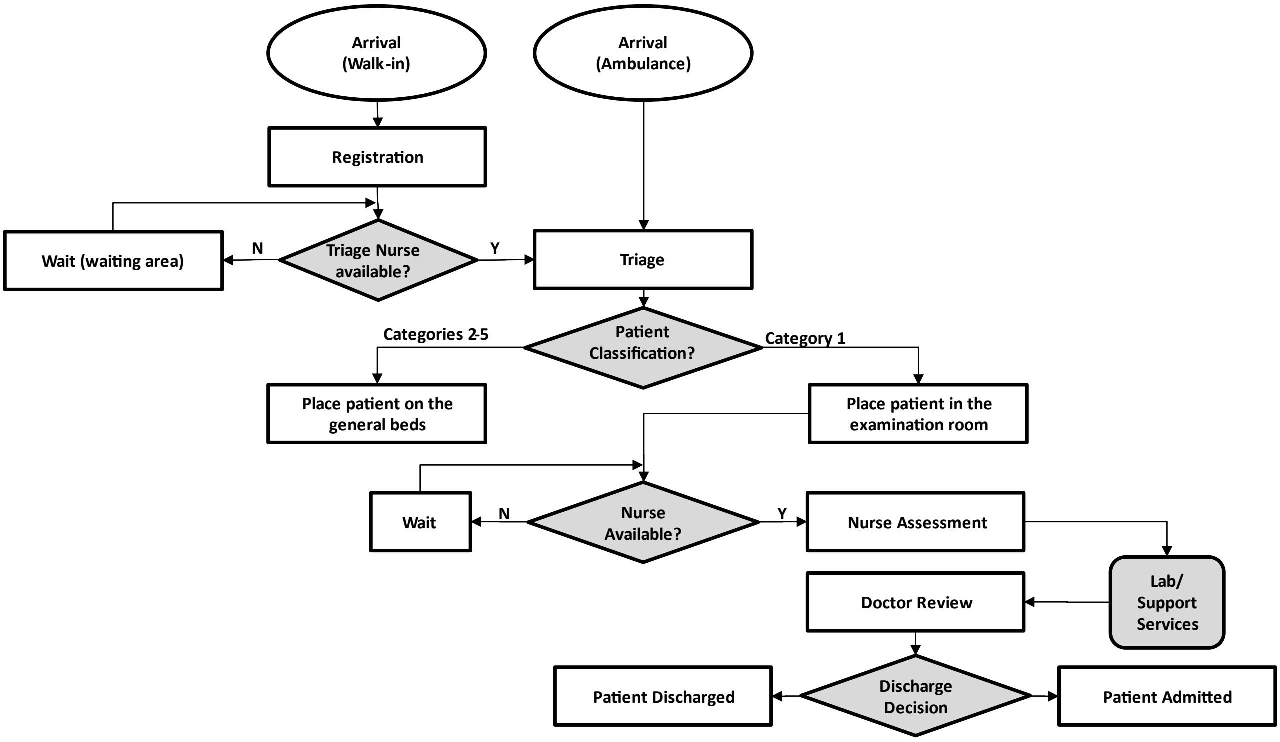

Figure 4: ED Patient flow within an Australasian hospital (Authors)

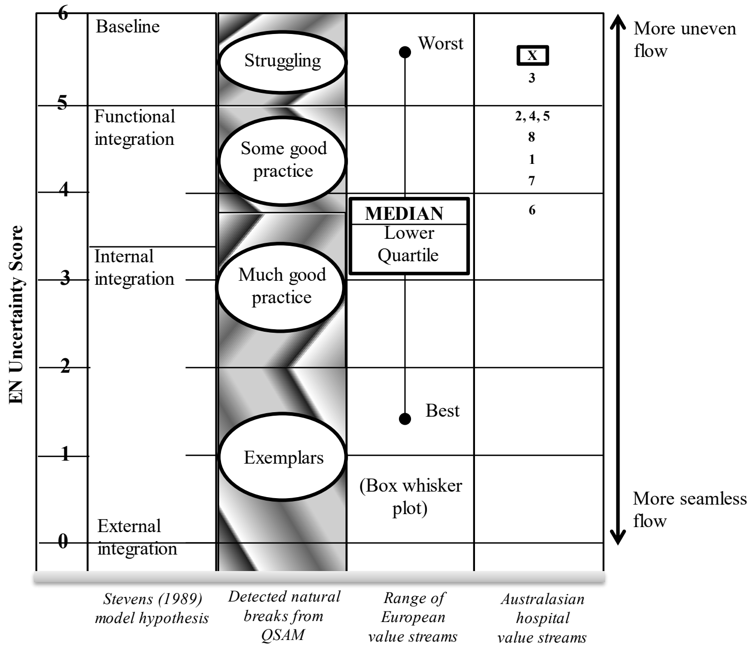

Figure 5: Benchmark comparison of ED patient flow (Authors)

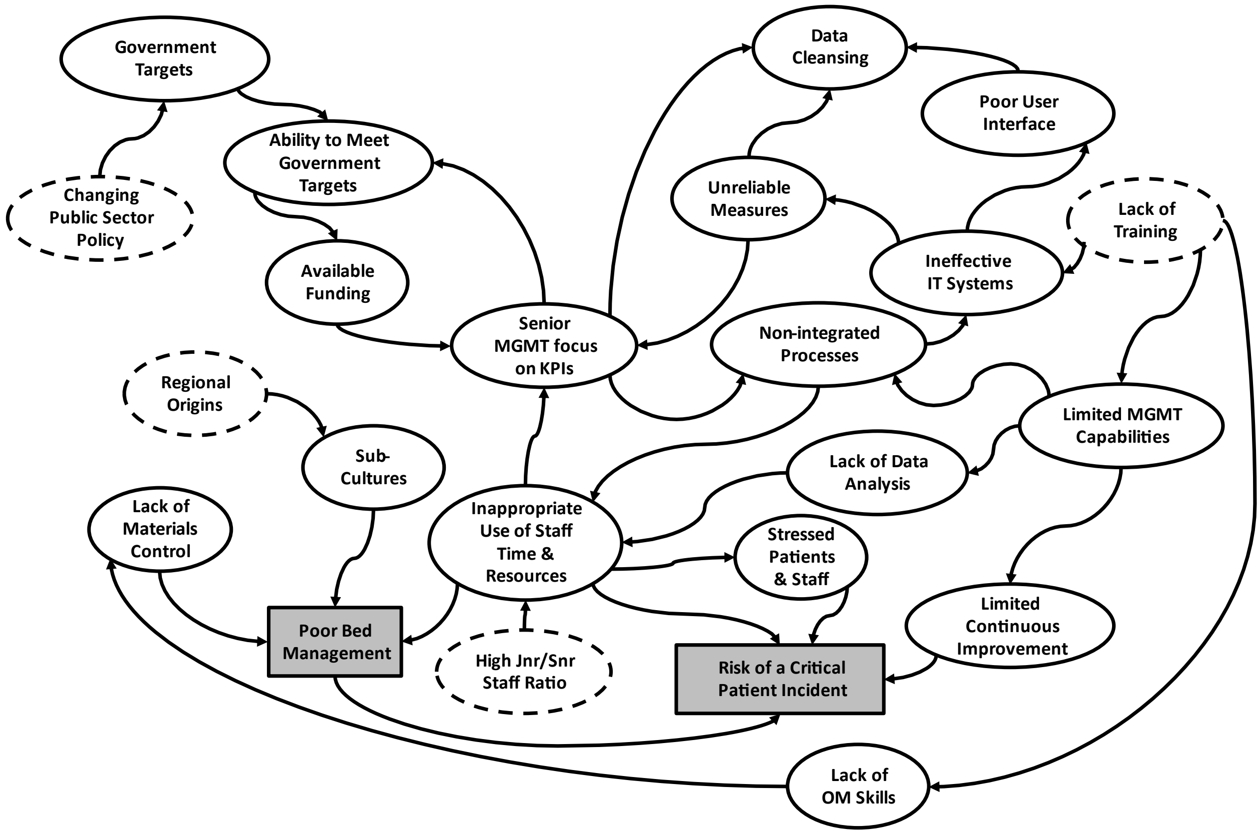

Figure 6: Root cause analysis of ED patient flow (Authors)

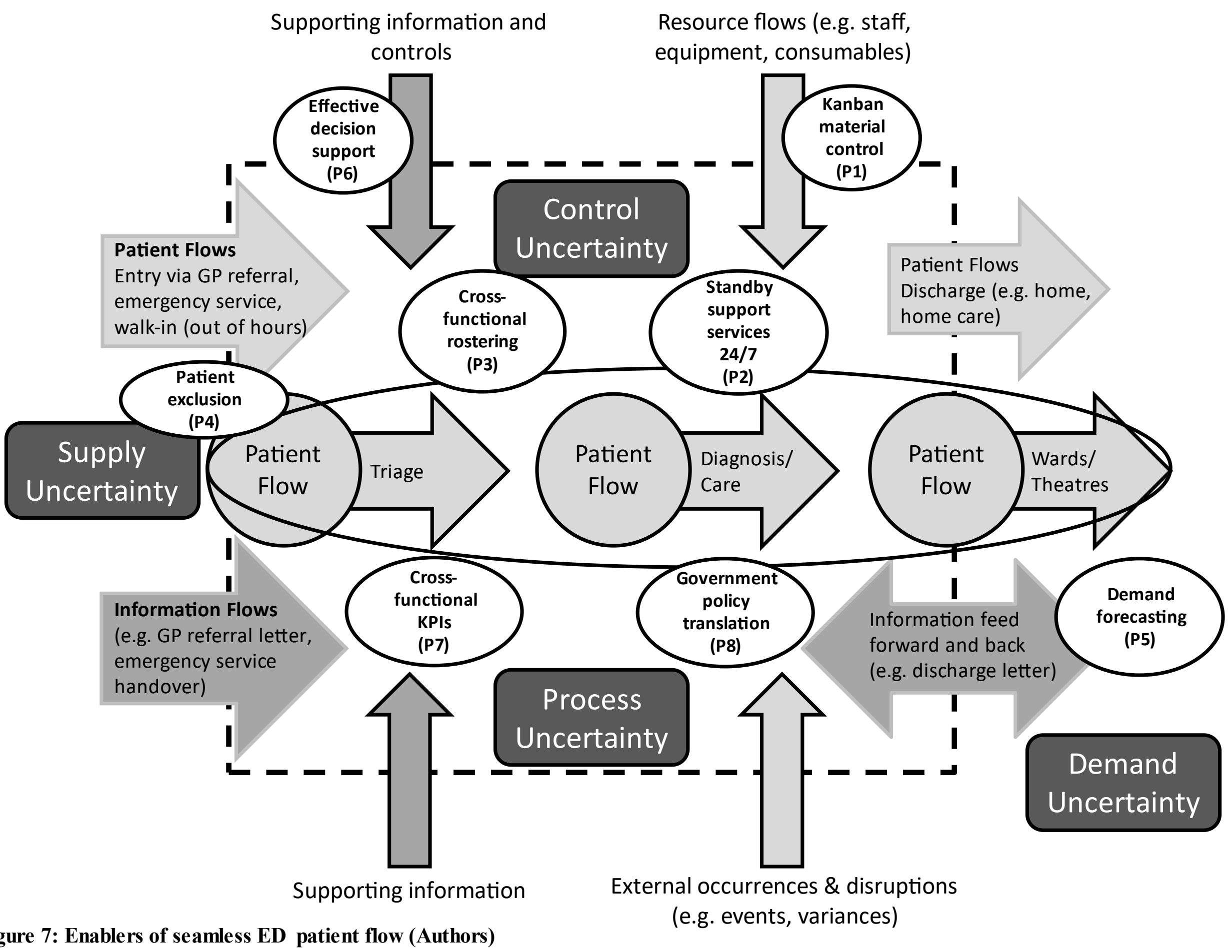

Figure 7: Enablers of seamless ED patient flow (Authors)