Implementing and Sustaining Efficiency in Operating Theatres in an Acute Hospital: A Practice Based Research Study

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Abstract

"Implementing and Sustaining Efficiency in Operating Theatres in an Acute Hospital: A Practice Based Research Study".

Therese Callinan

Background: Improving the quality and safety of patient care is at the core of everything that healthcare providers do. However, implementing sustainable improvements in practice is challenging, a problem that was experienced both in local practice and which is frequently acknowledged in the literature. This practice-based research study focuses on one of six dimensions of healthcare quality: efficiency and examines how it can be improved and sustained in the operating theatre setting in an academic teaching hospital.

Aim: The aim of the study was to improve and sustain efficiency in operating theatres. The objectives were 1) to examine the impact of implementing interventions in practice to address the problem of delayed start times, and 2) identify the factors required to sustain improved outcomes.

Methodology: A case study design was the research methodology used in this study. There were six case studies presented in this research. Five of the six studies focused on improving theatre start times and one study relates to implementing an anaesthetic preoperative assessment service. Both quantitative and qualitative data were used to measure performance data and guide changes in practice. A Quality Improvement methodology: The Model for Improvement was followed as a systematic approach to practically implement efficiency improvements.

Results: Improved performance was achieved across all case studies which were carried out between six and 20 months. There were similarities between problems causing inefficiencies and interventions implemented with those presented in the literature as well as new findings that contribute to theory on theatre start time efficiency. Long-term sustainability of improvements was examined in five case studies between six and twelve-months post project completion using a sustainability framework by the Institute of Healthcare Improvement's (IHI). Evidence of embedded practice changes and improved performance continued however inconsistent planning for implementation and sustainment of improved performance in the longer-term impacted on sustaining outcomes achieved in a sample of the studies.

CHAPTER 1-INTRODUCTION

Improving the quality and safety of patient care is the responsibility of all healthcare providers. Scoville, R. and Little, K. (2016, p.6) referred to the “transformational challenge posed to all healthcare providers” by Maureen Bisognano, CEO of the Institute for Healthcare Improvement (IHI) in her keynote presentation at the National Forum on Quality Improvement in Health Care in 2012 where she said, “that everyone in health care should have two jobs: to do the work and to improve how the work is done”. The Health Service Executive (HSE) concurred with this view stating that “improving quality is everybody’s business and to achieve real and sustained improvements we must find new and better ways to achieve the outcomes that we want” (HSE 2016, p.2).

Creating a culture in which healthcare providers believe that they have the power, ability, and skills to create an excellent service for patients is necessary to improve areas of sub-standard quality. This requires a proactive approach to addressing for example areas of suboptimal care and treatment, reducing waiting times for patients to access treatments, providing effective up to date, evidence-based treatment and reduce the waste of money, time, and expertise through improving efficiencies.

Growing momentum for improving the quality and safety of care for patients is evident across a number of areas. In Ireland, extensive work by the HSE to develop the foundations for quality improvement has been undertaken. Frameworks to guide the implementation of quality and safety in practice have been developed (HSE, 2016), clinical care programmes to ensure evidence based, best-practice effective treatments for specific diagnostic groups have been established. Governing bodies for example the Health Information and Quality Authority (HIQA) who are responsible for defining and monitoring standards of care was formed (HIQA, 2012). In addition, training programmes specifically tailored for teaching and coaching the theory and skills on the application of quality improvement methodologies in practice increased. According to Hilton & Anderson (2018) “improvement science has given health care improvers a theoretical framework and

the applied technical skills to understand variation, study systems, build learning, and determine the best evidence-based interventions (“what”) and implementation strategies(“how”) to achieve the desired outcomes”.

To achieve a high standard of quality and safety in our health service, an understanding of the concept of quality and safety in healthcare provides a foundation to guide healthcare staff on how to make care and services better for patients. The HSE used the definition developed by The Institute of Medicine (IOM) in 2001 in their Framework for Improving Quality. The definition referred to six domains of quality which include the provision of “safe, effective, patient centred, timely, efficient, and equitable care” (HSE 2016, p.3). In essence all efforts to improve the standard of healthcare delivered to patients should align to one or more of these domains.

However, the HSE acknowledged that delivering and sustaining improvements in the complex setting of healthcare is challenging (HSE 2020, P.3). The application of improvement science theory to frontline practice can be difficult for healthcare providers as they endeavour to make effective changes to improve care and services to patients whilst continuing to deliver care.

This study will examine the practical implementation of quality improvement initiatives in the operating theatre department in a large academic teaching hospital in Dublin. The study will focus specifically on one of the dimensions of quality outlined above which is efficiency.

The Operating theatre department is where most surgical procedures are performed and is therefore considered a key resource in delivering surgical services in all major hospitals. It accounts for an average of 40% of the hospital budget (Barbagallo et al., 2015). The size and functionality of the department depends on many factors namely, the type of hospital; for example, an acute, major trauma, teaching hospital providing national, regional, or local specialty surgeries or a planned elective routine service funded either privately or publicly.

Operating theatre practice is complex and dynamic. It is delivered by specialist professionals in an intense working environment which deals with both life-threatening emergency and routine planned demands for patients whose health

status ranges from low to high risk but all of which needs to be delivered within critical timelines. It is also part of a wider hospital system relying greatly on efficient processes external to theatre in the pre- and post-operative phase.

The theatre service is challenged by demands to increase capacity to reduce the waiting time for scheduled surgery, to keep up to date with advances in technological approaches in surgery and anaesthesia and maintain services with reduced manpower levels and budget. Optimising the use of the theatre resource can be difficult due to well acknowledged inefficiencies for example late theatre start time, inappropriate scheduling, extended turnaround times, cancellations, and under-utilisation. Consequently, theatre departments must adapt and respond to external influences and demands whilst addressing inefficiencies. This has focused hospitals to work on maximising the capacity and resources available to them whilst maintaining high standards of quality care.

Nationally, there is growing emphasis on improving theatre efficiency, quality, and safety. This has been supported through programmes such as The Productive Operating Theatre (TPOT), NHS, (2009), an NHS model which was piloted in five hospitals in Ireland in 2010 and more recently the development of the Theatre Quality Improvement Programme (TQIP) in Ireland (Smith et.al 2017). These programmes have increased the level of attention on the key role operating theatres play in providing surgical services.

1.1 Study Setting

This research study is being undertaken in the operating theatre department in Beaumont Hospital in Dublin. Beaumont is an academic teaching public adult hospital with 840 beds and is the second largest tertiary referral hospital in Ireland. It has twelve operating theatres, one of which is an emergency theatre. It is the National Neurosurgery, Renal Transplant and Cochlear implant centre and is a regional Colorectal, Upper Gastro-Intestinal, Plastic Surgery, ENT and Breast Surgery centre. Approximately 10,000 operations are performed annually consisting of a mix of very complex and routine emergency and elective procedures.

1.2 Rationale for the study

Participation in The Productive Operating Theatre (TPOT) programme developed by the NHS,(2009) in 2010 led to the commencement of small-scale improvement initiatives focused on improving operating theatre efficiency in Beaumont Hospital. For example, the establishment of an anaesthetic pre-operative assessment service, commencement of Day of Surgery Admission (DoSA) for elective patients and efforts to reduce theatre start time delay and cancellations for elective urology day case procedures.

Sustaining improvements in these initiatives yielded mixed results. Outcomes achieved included an average of 56% of elective general surgery and urology inpatients having anaesthetic pre-operative assessment between 2010 and 2015. This significantly increased the number of patients having pre-assessment, however a proportion of patients presented to theatre sometimes for complex surgery without being assessed by an anaesthetist. It created delays and at times led to cancellations on the day of surgery. Day of surgery admission for elective patients was established also in 2010 with an average of 70% of patients admitted on the morning of surgery. Although a very positive initiative in reducing pre-operative length of stay, it subsequently led to problems in the theatre department affecting start times as prior to this it was practice for elective patients to be admitted to hospital on the day before their operation and the availability of a post-operative bed was not an issue on the day of surgery. Finally, initiatives to improve theatre start times in the urology service led to an improvement in start time performance and a reduction in cancellations due to bed unavailability, however this was not sustained as bed capacity on the day ward was increasingly used to admit patients from the emergency department. This led to cancellations on the evening prior and morning of surgery which affected theatre start times and utilisation in all theatres with day case procedures scheduled first.

In the past decade, Beaumont hospital became a regional centre for breast surgery, colorectal surgery, upper gastrointestinal surgery, and plastic surgery. Living organ transplant surgery was growing steadily. Laparoscopic surgery was more common as well as combined surgeries for example, breast and plastic surgery and ENT, plastic and neurosurgery procedures. These operations are more complex and of longer duration. Procedures that were of lower complexity were

redirected to a nearby elective hospital under the management of Beaumont hospital. The theatre environment was changing rapidly and unfortunately, this was happening at the same time as finances were constrained with staffing levels reduced as a measure to control spending.

These factors created a need for the theatre department to respond to the changing context. Building on the learnings gained from previous improvement initiatives in commencing pre-operative assessment, day of surgery admissions and a reduction in start time delay and cancellations in urology which all demonstrated that there was willingness from frontline staff and the potential to improve the service. Furthermore, there was a sense of urgency to respond to the growing complexity of procedures and types of operations being performed. This influenced the establishment of a comprehensive programme which set out to improve efficiencies in the operating theatre in 2016.

Initial work involved engaging with staff working in the theatre; anaesthetists, surgeons, nurses, and porter staff to discuss efficiencies in the theatre service and the priorities for focusing improvements on. Consistent in all discussions was a desire to improve theatre start times. This was described as a constant problem in theatres that scheduled day case and day of admission patients first on the theatre list. It was viewed as an inefficient use of resoursed time and was frustrating for staff who had to frequently follow up with ward staff and medical teams to get patients to theatre.

The second piece of work involved collecting performance data to get a picture of theatre utilisation and other measures of efficiency for example start time, overruns, cancellations, and turnaround time. Data on timepoints along the patient journey were collected on an electronic theatre management system but this data was not analysed continuously. There was sporadic analysis of data prior to this which showed that core utilisation was between 80 to 85%, a significant cause for underutilisation was patient cancellations due to unavailable inpatient beds and day case trollies. Theatre start time was on average 20 minutes late. Both the feedback from staff and the evidence of baseline data provided a focus for this study which was to improve and sustain theatre start time performance.

Building on practice-based learning led to a review of the literature on operating theatre efficiency to explore studies that demonstrated positive improvements in components of efficiency relating to operating theatre. There was a vast amount of literature on theatre efficiency and how it is measured all of which provided a good foundation to commence the efficiency improvement programme. However, there was less evidence of studies that demonstrated improved outcomes in theatre start times over a sustained period which was an area causing significant problems in Beaumont hospital theatres.

Learning about sustaining improvements in start time performance was of particular interest as this was a challenge in previous work in the start time improvement project in urology. Studies presented in the literature rarely discussed how improved outcomes were sustained and did not fully represent the complexities of achieving sustained outcomes in this context. This further supported the rationale for undertaking this study. It presented an opportunity to combine both the practical experience of improving and sustaining efficiencies in the operating theatre and the challenges faced, along with the aim of contributing to the literature on improving and sustaining quality improvements in practice.

1.3 Aim of the study

This study aimed to examine the impact of implementing interventions to address the problem of delayed start times in the operating theatre department and the factors required to sustain the improvements in outcomes achieved in practice.

1.4 Research Question

The research question is to: Explore what improvements in the perioperative process contribute to reducing start time delays in the operating theatre and how can these improvements be sustained across the operating theatre?

1.5 Study objectives

1. Identify the factors that contribute to improving operating theatre start time delay which is recognised as a key component of operating theatre efficiency.
2. Analyse the root cause of the problems that result in delayed start time.

3. Implement interventions from both existing research and change ideas identified locally by the frontline staff to improve start time performance.
4. Measure the impact of changes on the aim of each study which attempts to improve efficiency.
5. Review the factors that contribute to sustaining improvements in practice in the long-term.
6. Evaluate the learning from each improvement study and compare to existing research in operating theatre start time efficiency.
7. Apply a scientific improvement methodology to each study and analyse the impact of this on achieving and sustaining improvements in practice.

1.6 Study Findings

The studies undertaken all resulted in improved performance in operating theatre start times and in one study there was a significant increase in neurosurgical patients attending pre-operative assessment. Four of the six studies demonstrated sustained improved performance following project completion. Causes for start time inefficiencies previously not presented in the literature were found in three of the studies undertaken. New interventions that led to improvements in performance were evident in five of the studies. A particular area of interest was to understand how improvements are sustained in the long term. There were two key findings relating to this which are: lack of implementation planning, and lack of a sustainment plan developed as part of the quality improvement cycle. Additional new findings in these studies which contribute to theory include a) spreading improvement concepts b) detailing a step-by-step account of doing quality improvement in practice using an improvement methodology in the field of operating theatre and c) role of improvement teams in making change in operating theatre practice.

1.7 Structure of the thesis

This thesis consists of twelve chapters. Chapter two gives an overview of the literature on quality and quality improvement in healthcare and examines how efficiency is achieved in the practical setting of operating theatres. Chapter three provides an account of the chosen research methodology and chapter four describes the quality improvement methodology used to implement changes in

practice. Chapter's five to ten present six individual case studies, each focusing specifically on a quality improvement initiative. Chapter eleven discusses these findings in the context of the existing literature. Chapter twelve provides a conclusion to the study. A detailed outline of each chapter is given below.

Chapter two will present a review of the literature. It will commence with a brief review of the literature on the definitions of quality and quality improvement in healthcare. From here the chapter will focus in depth on one dimension of quality which is efficiency and provides a review of the concept of efficiency as it applies in operating theatres. Literature on the indicators used to determine levels of efficiency in theatre and the measures that are commonly used will be described. A deeper analysis of the literature on one contributor to theatre efficiency which is start time will be presented, examining how improvements are achieved, the methods used, and the long-term sustainability of the interventions and outcomes gained.

Chapter three will describe the research design that has been chosen. The research framework consisting of the development of the research question is discussed along with the conceptual, theoretical, and philosophical perspectives that underpin it. A detailed explanation of a case study design will be presented with attention given to how the characteristics of a case study approach is relevant to this study. The data collection methods of process mapping, quantitative analysis and interviews will be explained along with the analysis of the data collected.

Chapter four will describe a Quality Improvement (QI) methodology which will be used for implementing changes in practice. The QI methodology provides a systematic approach to plan, test, implement, spread, and sustain improvements in practice. The chosen methodology is the Model for Improvement (MFI). It was developed by Associates for Process Improvement and is used by the Institute for Healthcare Improvement (IHI) as their framework to guide implementation of improvement work in practice (Moen and Clifford 2010). The science of improvement which is the scientific basis that underpins the model along with three key questions and the Plan, Do, Study, Act (PDSA) cycle will be described. The phases of the model will be presented, describing a step-by-step approach as to how the systematic model is used in practice to implement quality improvements. Finally, the challenges to sustaining improvement and guidance for achieving

sustained improvements in practice will be described. The MFI methodology will be applied in each of the six case studies presented.

The following six chapters are the results of the case studies which will be undertaken in the perioperative setting. Each study will be presented in the form of a case study and will use the MFI framework to step out the sequential stages in the improvement process. Each case study will outline a specific aim to address an area of inefficiency relating to start time performance. The fifth case study differs slightly in that the aim is to establish an anaesthetic pre-operative assessment service in the neurosurgical directorate. The remainder of the studies will include, reducing theatre start times in the general and breast surgery service (case study 1), the upper gastrointestinal service (case study 2), the Day of Surgery Admission service (DoSA) (case study 3), the day ward service (case study 4), and finally the plastic surgery service, (case study 6).

Each study will describe the planning stages of the quality improvement initiative for example, team formation, identification of the problem, baseline data analysis and variation of performance and the change ideas proposed by the improvement teams that will potentially improve performance.

The following stages will involve testing of change ideas in practice, this will be done through the PDSA cycle with each cycle of change described in detail and appropriate measures to determine if the changes implemented resulted in improved outcomes. Sustainment of changes in practice will be discussed both at the end of each change project and will be reviewed a period later to determine if changes in practice are sustained long-term and the factors that contribute to this.

Each study will conclude with an outline of the learning gained. It will provide a comparison to existing research specifically relating to results achieved, causes of inefficiencies, interventions that will be tested in practice, sustainment in practice of improvements that will be made and compliance with the QI methodology theory and process. The spread of improvements and the contribution of each initiative to creating a culture of continuous quality improvement will be included.

Chapter eleven will present the findings of the six case studies implemented in the perioperative setting. A cross case analysis of the six case studies presented is

described to answer the research question which is to explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

The findings that support and strengthen existing literature and new findings specific to this study on the factors that contributed to improving and sustaining operating theatre start time efficiency will be presented.

An analysis of process issues that led to start time delays is outlined followed by the practice changes that were implemented in the perioperative process which led to improvement in start times. Spreading the learning gained on causes of process delays and the interventions that led to greater efficiencies in each case study as the improvement work progressed is a feature of this study. A description of how the studies are connected to achieve overall theatre efficiency is provided. A key focus of this study is to understand the factors that contributed to and affected long-term sustainability of improvements. An in-depth comparison of the use of a sustainment model is outlined. The contribution of the project team's role in implementing and sustaining improvements is described to emphasise the importance of the human side of change and finally, the application and benefits of applying a scientific improvement methodology in practice will be discussed. The chapter will also provide a comparison of the problems identified and interventions implemented to the findings in the literature reviewed.

CHAPTER 2- LITERATURE REVIEW

Exploring efficiency in the operating theatre as a dimension of quality in healthcare

2.1 Introduction

The vision of the HSE “is one where quality, and its measurement, is central to health service delivery” (HSE, 2020, p. 4). Improving quality and safety in healthcare has gained momentum over recent years both in Ireland and internationally. The HSE acknowledge the increasing attention and concerted efforts being made to incorporate the concept of quality as an integral part of all healthcare systems during their launch of the Quality and Safety strategy. They refer to the “strong commitment to improving the quality of care across the Irish healthcare system which is evident in the various improvement initiatives being undertaken by frontline teams to larger developments and improvement programmes at group, organisation and system level” (HSE, 2020 p. 2).

In order to achieve high standards of quality and safety, healthcare needs to be “safe, effective, efficient, patient centred, timely and cost-efficient” (Institute of Medicine, 2001, p. 3). The Institute of Medicine (IOM) describe these six dimensions as necessary to achieve high standards of quality care and service.

This study examines efficiency which is one of the dimensions of quality identified by the IOM. It will explore how efficiency can be improved and sustained in the practical context of operating theatres.

Operating theatres are recognised globally as a key resource in all major hospitals. They represent a substantial part of hospital activity, therefore maximising their efficiency and utilisation without compromising patient care is paramount. The

operating room is a pressurised, fast-paced, high risk, complex and dynamic environment, an area of intense clinical activity, relying heavily on smooth and efficient processes both internal and external to theatre.

Cardoen, et al. (2010), describe “the significant uncertainty in several activities involved in delivering surgical care, i.e., arrival times of emergency patients, lateness of surgeons and duration of surgical procedures. Oh, et al. (2011) concur stating that “any effort to improve the design or operation of theatres is a major undertaking due to the inherent complexity of the processes involved” citing further uncertainties in theatre processes caused by Intensive Care Unit (ICU) bed availability and the impact of emergency department demand on scheduled care beds. Essentially , operating theatre performance needs to be managed efficiently and effectively which according to (Cunningham, 2017)) is “crucially dependent on the cooperation of the surgical, anaesthesia, nursing and allied health professionals involved”.

The purpose of this literature review is to explore operating theatre efficiency which is a dimension of quality. The literature review will be discussed under two themes, a) the concept of quality and quality improvement in healthcare and b) efficiency in operating theatres. Section 2.2 and 2.3 will review the concept of quality and quality improvement in healthcare. Section 2.4 will examine efficiency in the operating theatre.

2.2 Definition of Quality in Healthcare

The definition of quality in healthcare most frequently used is provided by the IOM in the United States. A review of adverse events in the US, led to a published report by the IOM that became the founding document of quality improvement and patient safety in health care. It defines the six domains of “quality care” suggesting that all quality and safety efforts should be built around these core aims of healthcare which are:

1. Safe: Not harming with our care and reducing hazards.

2. Effective: Matching science to care.

3. Patient centred: Patients should be in control of their care.

4. Timely: Avoiding delays.

5. Efficient: Avoiding waste, duplication.

6. Equitable: Closing the gap of injustice in healthcare (Institute of Medicine 2001, p.3)

Many healthcare agencies have adopted these six aims as the foundations of their approach to driving improvement in patient care and the provision of services. NHS Scotland base the vision of their quality strategy on the internationally recognised six dimensions of healthcare quality by the IOM listed above (The Scottish Government 2010, p.7). Likewise, the Health Foundation in the UK refer to the six dimensions of quality from the IOM in their guide to improving quality in healthcare (The Health Foundation 2013, p.6). In the Irish healthcare setting, these six domains are referenced in the National Framework for Improving Quality, HSE (2016, P.3) and in the Safer Better Healthcare Standards developed by HIQA (HIQA, 2012). HIQA define quality as being:

> 1. Person centred - care that is respectful and responsive to individuals needs and values and partners with them in designing and delivering that care.
>
> 2. Effective - care that is delivered according to the best evidence as to what is clinically effective in improving an individual's health outcomes.
>
> 3. Safe - care that avoids, prevents, and minimises harm to patients and learns from when things go wrong.
>
> 4. Better health and wellbeing - care that seeks to identify and take opportunities to support patients in improving their own health and wellbeing (HIQA, p.7).

Incorporating the six dimensions of quality in healthcare provides a framework for setting priorities for improvement. Mondoux, (2017b) states that, "healthcare providers should view the broad definition as a compass, one that provides an overall direction in which to steer health care". Furthermore, the author also

recommends that any quality improvement effort should align to one of the aims of quality outlined above and should not negatively affect a different aim. The Health Foundation (2013, p.8) concur stating that:

> Often the dimensions are complementary and work together. However, there can sometimes be tensions between them that need to be balanced. It is important to consider different stakeholders' views about what they feel matters and what the priority areas of focus should be within an organisation.

The quality dimension that this study is aligned to is efficiency as it examines the factors that affect efficiency in start time performance, identifies interventions that improve performance and how these interventions are sustained in practice.

Moving from the concept of quality to improving quality in healthcare requires the translation of such high level aims into practice to achieve the impact required to make a difference in the provision of patient care. The following section (section 2.4) examines the concept of quality improvement and explores the transition from quality theory to improving quality in healthcare practices.

2.3 Definition of Quality Improvement in Healthcare

Transitioning from describing and understanding the concept of quality to actively working to improve quality at the point where the outcomes of improvement efforts are experienced by both patients and staff moves into a field whereby theory becomes practice. Batalden and Davidoff (2007) pioneers of quality improvement in healthcare defined quality improvement as the:

> combined and unceasing efforts of everyone: healthcare professionals, patients and their families, researchers, commissioners, providers, and educators, to make the changes that will lead to:
>
> a) better patient outcomes,
>
> b) better experience of care,

c) continued development and supporting of staff in delivering quality care.

The HSE framework (2016, p.4) has adopted this definition of quality improvement. Similarly, Jabbal, (2017, p.3) on behalf of The Kings Fund in the UK emphasise the role and responsibility of staff to constantly work towards making healthcare better for patients. This is evident in their definition of quality improvement stating that "quality improvement in health care is based on the principle of health care organisations and staff continuously trying to improve how they work and the quality of care and outcomes for patients". The author adds that a fundamental principle of quality improvement, which is an understanding that "those closest to complex quality problems for example frontline teams, patients and care givers are often best placed to find the solutions to them" (Jabbal,2017, p.3).

Furthermore, Mondoux, (2017a) differentiates between quality improvement and continuous quality improvement, stating that "continuous quality improvement posits that the improvement journey will never come to an end and that perpetual change, with the goal of achieving better outcomes for the customer/patient, should be the only constant within the organisation".

Evident across all the descriptions of quality improvement is an emphasis on frontline staff ownership of solutions to quality problems which they are supported to continuously work towards to make healthcare better for patients. There is consensus that to make quality improvements in healthcare requires a systematic approach to achieve this. Jabbal (2017, p.3) on behalf of The Kings Fund suggest that quality improvement "requires a systematic approach based on iterative change, continuous testing and measurement, and empowerment of frontline teams".

The Health Foundation,(2013) concurs, stating that a number of definitions describe quality improvement as a systematic approach that uses specific techniques to improve quality. They advise that "one important ingredient in successful and sustained improvement is the way in which the change is introduced and implemented and that a consistent approach is key" ((The Health Foundation, 2013, p. 9).

Finally, Ovretveit,(1999), defines quality improvement as “better patient experience and outcomes achieved through changing provider behaviour and organisation through using a systematic change method and strategy”. The Health foundation (2013, p.9) summarise the key elements in this definition as; “a) the combination of a ‘change’ (improvement) and a ‘method’ (an approach with appropriate tools), while paying attention to the context, in order to achieve better outcomes”. In building a culture and philosophy of continuous quality improvement, Mondoux (2017a) highlights an important goal of continuous quality improvement which is to:

> Change the institutional culture to accept experimentation and change cycles in the name of quality improvement. So, although quality improvement and continuous quality improvement are intimately related, they are not the same. The former is the process or methods, while the latter is the spirit embodied by them.

The key elements across all definitions are a mix of the combined and unceasing efforts of all healthcare professionals to change work practices and processes to improve outcomes for patients using a systematic approach leading to the creation of a culture and philosophy that embraces continuous quality improvement.

The definition of quality improvement that permeates throughout the change initiatives presented in this study is the continuous and relentless effort by frontline teams to proactively seek ways to improve the efficiency of theatre start times using a systematic approach to implement changes in practice with a key emphasis on continuing to apply a model to sustain improvements in practice.

This definition of quality improvement connects with the research question which explores improvements in the perioperative process that contribute to reducing operating theatre start time delays and how improvements in efficiency will be sustained long-term. Firstly, to achieve this in practice requires the relentless effort of frontline staff to proactively address process problems that cause delay and implement changes in practice to improve start time and secondly the research question looks to explore how improvements in efficiency will be sustained long-term, this connects with the definition above regarding the use of an approach or model to support frontline teams in sustaining improvements in practice. Using this

definition is relevant to the rationale for undertaking the study which aims to understand the contributors to sustaining improvement and from a review of studies presented in the literature on improving theatre start times in which approaches to sustaining improvement are not discussed.

There is an abundance of literature explaining the concepts of quality and quality improvement which is further supported through the development of frameworks and strategies that provides detailed guidance on taking on and implementing improvements in practice. Overtime this literature on quality in healthcare has grown and has provided theory and knowledge appropriate to the healthcare context.

Understanding the concept of quality and quality improvement in practice is the overarching aim of this study. Efficiency, as one of the six dimensions of quality will be examined in the practical setting of operating theatres to determine how it can be improved. Section 2.4 will provide a review of the literature on operating theatre efficiency.

2.4 Efficiency in the Operating Theatre

This section will provide a review of the literature on operating theatre efficiency. The approach taken is threefold; (a) how is efficiency understood and defined in relation to the operating theatre, (b) the measures that are used to reflect overall theatre efficiency and (c) capture the type of improvements that have been made to improve efficiency, specifically focusing on the methodologies used to implement the changes and if improvements were sustained long-term. The chapter concludes with a discussion on sustainability of improvement interventions implemented in practice.

Theatre efficiency is a broad concept. A substantial part of the literature on efficiency in the operating theatre centres on; minimising costs, eliminating unused time, increasing productivity, and improving quality. The subject of reducing costs is well addressed. According to Ang et al. (2016) and Wright et al. (2010) the running costs of a theatre are one of the most expensive components in secondary care, therefore maximising its utilisation whilst containing costs is important for hospitals.

Delaney et al., (2010) recognise this as especially important as waiting list demand for elective procedures continues to grow. Cost reduction as a way of improving efficiency is supported by Fong et.al. (2016) however they also recommended the importance of reducing unused time to improve efficiency.

The literature relating to maximizing the use of resourced time is vast. Most of the studies reviewed on improving efficiency are directed towards the use of time, for example: starting on time, reducing turnover time, scheduling, minimising overruns and utilising all available resourced time to perform surgery.

In Fong et.al. (2016) study, a review of thirty-nine papers on improving efficiency in the intra-operative phase found that ‘’74% of the studies used time’’ as an indicator of efficiency. The perception of time wasting as a key contributor to inefficiency is reflected in the number of studies focusing specifically on the time element of the theatre process. The aim of these studies is generally to reduce unused or unproductive time at some point in the patients’ theatre journey.

Many authors identify unused or wasted time as: late start time, which is a common issue in all theatres; list over-runs which results in a longer working day that is unplanned and under-resourced; extended turnaround times which creates gaps or down time throughout the day; poor scheduling which can lead to under or over utilisation of time, and cancellations which lead to unused resourced time. (Kimbrough et al. 2015; Javed et al. 2013; Kargar et al. 2013; Buchanan and Wilson 1996).

In addition, to the efficient use of time in operating theatre practice, some authors also prioritise the concept of productivity which ensures that the appropriate level of surgery gets done. Wright et al. (2010) amalgamated both these concepts stating that: “productivity is an evaluation of the quality and quantity of work that occurs within a block of surgical time’’. Furthermore, Pandit et al. (2009) acknowledged that productivity did need to be included in addition to efficiency when defining surgical list efficiency as; ‘’the completion of all the scheduled operations whilst utilising properly the time available’’, whilst Sanders et al. (2008) in supporting the inclusion of productivity as a component of efficiency refer to the limitations of describing efficiency solely in relation to cost reduction and maximum utilisation of time stating that it fails to’’ complete the picture of performance’’ arguing that it isn’t

enough to just measure how well a service functions, but one must also look at the output or ‘’productivity’’.

In line with increasing productivity and reducing costs, efficiency is also about ‘’doing things the right way, without affecting quality” (Arakelian et al. 2011.).In their study of theatre staff’s understanding of efficiency, staff reported that any theatre “performance should be achieved with high quality and significant and meaningful tasks should be undertaken correctly and as quickly as possible while maintaining the quality of care”. There is a dearth of evidence on the effectiveness of improving efficiency on the quality of patient care. However, Javed et al. (2013) report that an outcome in their study on improving start times for trauma patients was reduced hospital length of stay pre-operatively which they suggested improved the quality of care. Similarly, Oh et.al, (2011) when recommending that “hospitals should strive for both operational efficiency and quality patient care” when referring to the impact on the quality of patient care due to long waiting times for surgery and cancellations.

In the studies presented the definition of efficiency that is used relates to time. The unproductive use of time in theatre is frustrating for staff and highly inefficient as it involves a team of people being idle or doing repeated tasks which is inefficient work. Start time is more than a measurement as is evident in the studies undertaken which demonstrate that to start on-time require numerous process changes to be implemented and sustained in practice. The literature presented on start time improvement refer to the process changes implemented and the outcome from these in reducing delays in start time. The change initiatives undertaken in this study support the literature on process changes required and provide in depth detail of how change ideas were created and applied in practice.

2.4.1 Overall measure of efficiency in the operating theatre

The previous section referred to how efficiency is understood in operating theatres. It centres on minimising costs, eliminating unused time, increasing productivity, and improving quality. It included components and time-points of the patients’ theatre process that contribute to theatre efficiency for example, start times, turnaround time and scheduling each of which individually can shed some light on how efficient the theatre service functions.

This section reviews the literature to determine if an overall measure of efficiency is used or available. There is a vast amount of literature on operating theatre efficiency; however, there is an absence of an agreed or standardised measure of theatre efficiency cited in the literature. According to Nagendran et al. (2016) theatre utilisation is the most frequently used measure of efficiency, stating that: "operating theatre utilisation has become the principle measure of NHS operating theatre service performance''. Many professional groups and agencies defined utilisation as the proportion of allocated session time used for analgesia and surgery (Audit Commission, 2003; The Association of Anaesthetists of Great Britain and Ireland 2003; NHS, 2009 and The Royal College of Anaesthetists, 2012).

Target utilisation rates differ across the literature reviewed. Authorities and agencies have set targets for acceptable utilisation rates. The table below provides a breakdown of these targets and demonstrates the variation in definition of the target which according to Faiz et al. (2008) make benchmarking difficult.

Table 1: Chapter 2. Summary of operating theatre utilisation targets

Recommended	Year	Target	Explanation
NHS Modernisation Agency.	2002	100%	For surgery and anaesthesia excluding turnaround time. It allows for variation due to complexity.
Audit Commission NHS	2003	77%	a) 90% of all available theatre sessions should be used, (10% list cancellation rate) b) the patient should be in theatre for 90% of each available session time c) 92% of the patient hours should be used for anaesthesia and surgery.''
The Association of Anaesthetists of Great Britain and Ireland	2003	85%	85% utilisation as the minimum that should be attained, with > than 90% being highly desirable and <10% being idle time.
Agency for Clinical Innovation, (NSW Agency for Clinical Innovation, 2014)	2014	80%	This is surgery time used, anaesthesia care time before and after surgery time should bring it to 100%

The variability in setting clear targets for utilisation and providing standard definitions for efficiency by governing bodies is criticised by, Pandit et al. (2012) stating that: " a number reports from the AAGBI and The Audit Commission have examined how best to manage operating lists" however one problem exists according to the authors which is that none of them "offer an explicit definition of efficiency''. The authors suggest that one of the reasons for this is that there are many elements contributing to efficiency. They describe these as: '' cancellation

rate, under-utilisation, over-running, complication rates, and perhaps some less tangible measures such as communication and teamwork''.

Limitations of using utilisation as a single measure of theatre efficiency are expressed by Strum et al. (1999) stating that "operational inefficiencies in the use of operating rooms are hidden by traditional measures of theatre utilisation". They offer alternative measures to using utilisation solely as a measure of efficiency following their study which analysed six years of data breaking it down into under and over utilisation of theatre time. The findings suggest that this depth of analysis can be used to evaluate the quality of theatre schedules, efficiency of utilisation and allow for capacity planning.

(Oh et al., 2011) also criticises the use of a single measure of efficiency, stating that **"**a hospital that monitors its theatre performance solely on its utilisation indicator may stifle productivity as this indicator tends to favour slow surgeons and long surgical cases. It fails to evaluate the quality of service experienced by its patients". Furthermore, Pandit et al. (2007) refer to "higher rates of utilisation being claimed when list overrun time is included in the calculation, more concerning is that overrunning is a common, if not the main cause of cancellations on the day of surgery which is also inefficient".

Mayer et al. (2008) summarise that the use of overall utilisation rates as misleading when trying to identify underlying operation session inefficiencies, recommending that "the complexity of the procedures and the resource required to perform surgery are an important factor when measuring efficiency". Faiz et al. (2008) concluded: "despite the widespread use of utilisation rates there has been little research investigating its validity as a performance indicator''.

In an attempt to provide a more complete picture of performance, Pandit, et.al. (2007) developed a formula to measure utilisation which incorporated three elements: "utilisation, over-running and cancellations on a list". This formula was tested in practice. The learning from the study confirms that "a team that scheduled cases according to the predicted durations of the operations listed, suffered fewer cancellations and fewer list over-runs performed considerably more efficiently than teams that did not do so. The authors suggest that "surgical list performance is more completely described by this formula for efficiency than by the conventional measures of utilisation or cancellation rates alone".

Two years later Pandit.et.al. (2009), expanded their formula to include two additional measures: speed and patient contact. They saw the need for this as when a surgeon "who completes a number of cases and achieves high rates of utilisation but has worked at a slower pace is less efficient than a surgeon who completed a greater number of procedures at the same time, therefore being more productive". The authors however recommend that:

> the formulas produced should only be used to identify opportunities for improvement in areas such as: scheduling, reducing cancellations and unused time at the start of the day and between cases and to use any time available for extra cases (Pandit.et.al 2009).

2.4.2 Multidimensional Approach to measuring efficiency

Although there is inconsistency in the literature on metrics to measure theatre performance, many authors recommend a multidimensional approach. Macario (2006) on carrying out an extensive literature review on operating theatre efficiency identified eight metrics to measure operating room efficiency. (Oh et al., 2011) suggested "that since there is no one size fits all measure that can comprehensively assess theatre performance, multiple indicators that encompass different operational domains of theatre performance should be employed to enable a dynamic tension between different priorities". Fixler and Wright (2013) recommend that "to measure theatre performance, one needs to determine which performance indicators to measure as there can be variation between hospitals".

The suite of performance measures are standard across the literature, all recognising that given the underlying complexity in the management of operating theatres, it is inevitable that there is a multitude of performance measures reported that can be used to measure efficiency(Macario et.al 2006; Cardoen et.al 2010; Fixler and Wright 2013).

The following table demonstrates the specific measures of theatre performance and efficiency recommended by the authors mentioned in the above paragraph.

Table 2: Chapter 2. Recommended measures of theatre efficiency.

Author	Year	Measures of theatre efficiency

Macario et.al	2006	1. Excess staffing costs due to theatre allocation not being based on maximising or efficiency. 2. Start Time tardiness, should total less than 45 minutes. 3. Case cancellation rate on the day of surgery, should be less than 5%. 4. Admission to PACU delays, % delays > than 10 mins in one week. 5.Contribution margin per hour. 6. Turnover Time, defined as the time from which one patient exits theatre until the next patient enters and should be less than 25 minutes. 7. Prediction Bias, the actual duration of a case versus the predicted duration of the case. 8. Percentage of prolonged turnovers.
Cardoen et.al	2011	1. Utilisation. 2. Throughput, 3. Waiting time of surgeons, 4. Overtime costs, 5. Overruns, 6. Contribution margin, 7. Make span, 8. Cancellations, 9. Wait for surgery.
Fixler & Wright	2013	1. Out of hours surgery, 2. Same-day cancellation rate, 3. First case start-time, 4. Theatre use, 5. Percentage of unplanned closures, 6. Case duration accuracy, 7. Average turnover time, 8. Excess staffing costs.

The previous section explored if a single measure can appropriately describe the efficiency of a theatre. From the papers reviewed, utilisation is one of the most frequently used measures discussed. Limitations in using a sole measure are reported as it cannot provide a complete picture of how well a theatre is performing. A multidimensional approach is offered whereby dimensions of efficiency presented in the table above are recommended.

In this study start time performance is the key measure reported to support answering the research question which is specifically directed towards improving and sustaining start time performance. Each study presents a baseline measure of start time to firstly get a picture of performance and outcome measures to compare the impact of process changes on start time. If utilisation were the only measure of efficiency used in the theatre setting where this study is undertaken, there may be less interest in improving inefficiencies like start time as an average late start of 20 minutes would show a theatre utilisation rate of over 95% which is better than all the recommendations cited above. However, start time was consistently raised by

staff as the greatest cause of frustration and inefficiency in the theatre. It is a consequence of inefficient processes and pathways in the perioperative preparation of patients for surgery.

Continuing to measure start time performance is discussed when exploring the factors that support sustaining improvements in practice. A small sample of the literature presented on start time improvement studies includes measurement in the sustain phases of the change initiatives. This is a significant finding in this study as consistent measurement of start time performance contributed to sustaining improvements in the more recent studies. The following section will explore samples of studies that measured specific components of theatre efficiency.

2.4.3 Studies measuring time points in the theatre process.

This section relates to efficiencies at specific time-points in the theatre process. These time-points are identified in the literature as stages where inefficiencies are most likely to occur for example: start times and turnaround time. A sample of studies that examined measurement of various time-points along the patient pathway is presented.

Saha et al. (2009) measured turnaround time, by undertaking a prospective observational study where seven-time intervals on the patient's perioperative journey were recorded over twenty-two gynaecology theatre lists. The study found that in "43% of cases, the anaesthetist had to wait a median of seven minutes (maximum 17 Min) for the patient to arrive and the surgeon had to wait a median of 22.5 minutes between cases which increased turnaround time".

Wong et al. (2010) undertook a prospective study recording delays in elective neurosurgical cases over 9 years. They found that "more than half (51.4%) of all cases had at least 1 delay". Findings also included that when "an initial delay in start time occurred that this was associated with a subsequent delay". They also found that "waiting for equipment is the most common cause of delay and pre-operative imaging as the 2nd most frequent cause of delay".

Pandit et al. (2012) explored if delayed start time is a useful measure for surgical theatre efficiency. They used a modelling system to analyse 7,000 theatre lists to assess if start times and finish times correlated. Gap times were also analysed to see if these affected theatre efficiencies. They found that "efficiency did not decline

markedly unless a late start accounts for more than 20% of scheduled list time". They concluded that "start times do not predict either when an operating list will finish or if it will run efficiently".

Perkins et al. (2014), in a retrospective assessment of one surgeon's cases over 6 months (180 cases) at a paediatric tertiary hospital, measured time-points on the patient journey and compared these against performance measures in existing literature. The study found that "turnaround time was considerably longer and recommended a focus in this area to improve theatre efficiency".

Furthermore, Ang et al. (2016) in a prospective study observing turnaround time between cases quantified delays in turnaround time in 33 operations over twelve days in orthopaedic trauma theatres to estimate the cost incurred. The common causes for increased turnaround time delays included: "delays in sending for patients and problems with patient transport". Costing the impact of this, showed that "461 minutes of delay occurred over 12 days which was equivalent to a loss of £950".

This section presented a sample of studies that solely measured specific time-points of the patient journey to get a picture of performance at specific stages in the operative process. The result of measuring these stages in the process lends to defining potential focus areas where improvements could be made, mainly in time saving and optimum use of resources and capacity. Measurement is a key activity in improvement, at the start of a project to guide and define the improvement that is required and throughout the study to monitor the impact of the intervention. However, measurement alone does not lead to improvement in performance, this requires action and changes in practice to improve efficiencies. This study presents numerous iterations of changes to processes to answer the research question on what improvements lead to reducing start time delay.

The following section will provide an in-depth review of studies that have attempted to make improvements specifically in start time efficiency. The review will examine the type of interventions made, the methodologies used, the outcome of the study and the long–term sustainment of improvements gained.

2.4.4 Studies on improving Start Times in theatre

This section will review the literature on improving start times in the operating theatre as a contributor to improving efficiency. Although start time is frequently referred to in the literature as an area of inefficiency, the number of studies reported that have focused on improving start times is limited. Eleven studies reporting improvements in start times will be presented in detail focusing on; the causes of start time delay if provided, the interventions implemented, the outcome of changes made in practice, the duration of each study, the methodologies used to implement changes in practice, and the long-term sustainability of improvements.

2.4.4.1 Study 1

Overdyk et al. (1998) in their study based in Medical University of South Carolina, aimed to improve theatre efficiency through reducing start time delay. The causes for delay in start times were “registration, transportation, lack of preoperative evaluation and unavailability of staff”.
Interventions included: -

a. Multidisciplinary education, defining target start times for patient arrival in theatre, anaesthesia start time and surgical incision times and causes for delay.
b. Re-assigning existing nurses and ancillary staff to the preoperative area to increase pre-operative assessment and surgical work-up pre-operatively.
c. Rerouting patients to less congested areas based on admission status which improved transportation and registration time.

The findings of the study showed: -

a. A reduction in delayed start time for the 1st case by an average of 22 minutes.
b. A significant reduction in the delays due to unavailability of surgeons and anaesthetists due to reports being submitted each month to the Head of services which outlined the causes of delay for each team.

c. Additional benefits included a reduction in turnover time which decreased by an average of 16 minutes.

The duration of the study was not specified, however from analysing data presented it appears that study was undertaken over 1 year. Evidence on sustained outcomes longer than that time is not included. The methodology used was a prospective study comparing pre- and post-intervention start times following the implementation of the three interventions described above.

2.4.4.2 Study 2

This study was undertaken by Wright et al (2009) in a children's hospital in Toronto Canada. The aim of the study was to reduce late theatre start times which at the time 6% of theatres started on time. The causes for delay in start time were: - surgeon and anaesthetist unavailability, lack of preparedness of patients, need for pre-operative sedation, parent attending induction and consent form not signed.

Interventions included: -

a. Additional staff were assigned to the same day admission unit to ensure that patients were prepared and in the preoperative area by 7:15 am.
b. Electronic patient records were made available to the anaesthetist in each operating room to allow them access to the electronic charts for the patients undergoing surgery the next day.
c. Changing the entry point for all patients to the hospital from five same day admission units into one single area located in the presurgical anaesthesia clinic.
d. Commenced an 0735-huddle involving a meeting of the staff surgeon, anaesthetist and nurses to discuss the cases for the day, including any special considerations.
e. Feedback on on-start times to each theatre.

The findings of the study showed; -

a. An increase in theatres starting on time from 6% to 60%.

The methodology applied was not discussed and the duration of the study was nine months, Sustainment of improvements post project end was not discussed.

2.4.4.3 Study 3

Javed et al. (2013) study in the Royal Preston Hospital aimed to improve start times on a trauma list by planning for the next day's list which identified a predetermined first patient that they called the 'Golden Patient' (GP).

The intervention included:

Implementing the golden patient concept which the authors defined as: ''a pre-selected first patient on the following day trauma list who is surgically fit, appropriately investigated, who has a clear surgical plan, is anaesthetically assessed and sent for early in the morning''.

The findings of the study showed: -

a. A reduction in late starts by 30 minutes per list with the mean operation start time going from 10:03am to 09:33am.
b. A reduction in the number of cancelled operations by 55%. This was achieved through multidisciplinary planning, communication, and scheduling on the evening prior to surgery.

The study took place over a 2-month period. Similar to Overdyk (1998) study, the methodology used was a prospective study comparing pre- and post-intervention start times following the implementation of a pre-determined patient first on a trauma list. Sustained improvement achieved was not discussed however due to the duration of the study reported long-term sustainment could not be explored.

2.4.4.4 Study 4

Panni et al. (2013) undertook a study at the University hospital of Florida with the aim of reducing start time delay across the theatre complex where an average of 10 delayed starts per day out of 13 theatre lists planned was experienced. Late theatre start times was "culturally accepted where it was normal practice that a patient would arrive in the theatre at 07:30 even though official start time was 07:15".

Interventions included: -

a. Standardising the perioperative process by implementing a pre-operative checklist with specific items that needed to be performed prior to the patient arriving in theatre.

b. Appointment of a facilitator who was responsible for intervening whenever there were any missing items needed for a specific patient. This facilitator would:

    come on duty at 6:30, review all first patients listed to ensure the checklist was complete, if items were missing, they would contact the relevant team i.e., Anaesthesia, pre-operative team to sort out, they would phone every 5 minutes until the problem was sorted and escalate to the manager or relevant consultant if the problem was not being addressed.

The findings of the study showed: -

a. Delayed starts steadily reduced over each month from 10 to 4.95 late starts per day after 6 months which was a 49.2% reduction.

The methodology used involved implementation of an intervention which included a checklist and appointment of an operating theatre facilitator to address the causes for delay. Measurement of first case start times was monitored throughout the project. The duration of the study was 18 months. Sustainment of improvements was achieved as the start time remained at approximately 4.25 average delayed first case starts 18 months later.

2.4.4.5 Study 5

In Trivedi et al. (2013) study in Riverside County Regional Medical Center in California, the aim was to increase on-time theatre start. In 2008, “40% of lists started on time”. The causes for delays were in line with other studies, cited above as; “lack of appropriate patient preoperative preparation (including lab work, surgical consent, updated history and physical examination), wrong equipment, patient tardiness, and surgeon unavailability”.

The interventions included: -

a. Development of a protocol which consisted of a number of steps that had to be followed on the morning of surgery. It focused mainly on the timing the patient had to arrive in the theatre department and times when specific members of the interdisciplinary surgical team had to carry out final assessment for surgery. The purpose of this protocol was early identification of individuals responsible for delays in first case start times.
b. Development of a reporting process whereby delays were escalated to the individual managers associated with the delay.

The findings of the study showed: -

a. An increase in on-time start rate from 40% up to 97%.

The methodology used in this study applied engineering principles to the perioperative process. The authors believed that many improvement interventions

in healthcare are based on practices in the manufacturing and engineering services and viewed the perioperative process as like a manufacturing process consisting of multiple steps with potential for breakdowns to occur''.

Consistent with other studies cited above they followed similar steps as part of the improvement process, which included: problem identification, measurement, analysis, design of solutions, and interventions were applied to address the problem of late theatre starts.

The duration of the study was 2 years**.** However, sustaining the changes was not possible. Trivedi et.al (2013) state that "once the goals were met the workflow protocol was abandoned and no measure had been instituted to evaluate long-term sustainability". The authors confirmed that a recent survey of on-time starts for scheduled first cases had fallen to pre-intervention levels. They attribute this to "not building in assessment measures to continue evaluating progress post-intervention, critical trends in delayed start times were missed and it became increasingly difficult to determine what factors contributed to a reversal of the progress achieved". This is the only study reviewed in which sustainability of improvements is discussed.

2.4.4.6 Study 6

Saw et al., (2015) undertook a vast study in a Tertiary care academic teaching facility and a level one trauma centre with 793 beds and 43 operating rooms between 2007 and 2014. The aim of their study was to improve first case starts across all services by bringing the First Patient into Room (FPIR) at 07:30 am and to hand over care of the patient to the surgical team 20 min after FPIR, which they defined as First Case On Time (FCOT). The main causes for delay in start times included: - anaesthesia-related delays, issues with patient consents, late arrival, incorrect surgical booking, and lack of site marking.

Interventions included -

a. Standardising the process that the nurse circulator should complete the patient evaluation prior to assisting the surgical technician with room preparation.
b. Educating patients to arrive two hours prior to the case's start time.
c. Encouraging the admitting nurse to prioritise admission of patients requiring preoperative lines or other anaesthetic adjuncts such as regional blocks.
d. Anaesthetists were asked to be present at the patient's bedside by 06:45 for completion of anaesthesia consent, pre-anaesthetic review or update, block site verification and marking if indicated, and line and block placement.
e. A preoperative checklist was also created to comply with The Joint Commission standards for preoperative requirements and to clearly delineate preoperative responsibilities.

The findings of the study showed:

a. Increase in FPIT from 66.9% to 84.6%
b. Increase in FCOT from 55.9% to 67.6%.

The methodology applied involved the establishment of a Patient Flow subcommittee to study factors responsible for first case delays, establish goals for first case starts and turnover times, and to create strategies for improvement. Interventions were implemented and baseline start time data was compared post implementation of interventions.

Improvements were sustained up to 2014, five years post implementation of interventions. This is the longest reported evidence of sustained improvements in the studies presented in the literature.

2.4.4.7 Study 7

van Veen-Berkx et al., (2014) reviewed data from three University Medical Centres (UMC) in the Netherlands who had implemented interventions to improve operating theatre start times. Each centre focused on different interventions, which will be described below.

Interventions and Findings included: -

In UMC (2)

a. A specific team was assigned to provide feedback directly when theatres started too late, in person, and on the spot every morning, by walking around. Team members consisted of a theatre coordinator, anaesthetist, surgeon, theatre nurse, and anaesthesia nurse.
b. The theatre nurse, instead of the anaesthesia nurse, became responsible for the transport of a patient from the holding area into the theatre. Meanwhile, the anaesthesia nurse could continue preparing the theatre for surgery.
c. During morning hours, a post-call anaesthetist was assigned to avoid late starts caused by the fact that 1 anaesthetist covers 2 theatres simultaneously.

The findings of this study showed: -

a. Reduction in start time from 18 minutes to 11 minutes between 2007 and 2008 and continued years later.

In UMC (3)

Interventions include: -

a. New agreements between the theatre and ICU departments were implemented. Previously, early in the morning deliberation on PACU and ICU availability caused delay for the first patient scheduled for major surgery requiring postsurgical ICU. The change involved the theatre no longer had to wait to start the procedure until an ICU bed was officially released. If there was no ICU capacity available, an extra temporary ICU bed was created, and the theatre could start without delay.

b. The day shift starting time of anesthesia nurses was changed from 7:30 am to 7:15 am to generate extra time to prepare the theatre.

The findings of the study showed: -

a. Late theatre starts reduced from 45 minutes in 2006 to 27 minutes in 2007 and was further reduced in the following years.

In UMC (5)

Interventions include: -

a. A change in practice whereby the anaesthetist had to be physically present while the anesthesia nurse brought the patient to the theatre; In 2007 this was no longer required because of protocol changes.
b. New agreements between theatre and ICU departments were implemented, similar to the “ICU bed release” policy in UMC3.

The findings of the study showed: -

a. Reduction in delayed start times from 15 minutes in 2006 to 9 minutes in 2007.

This study is reported differently as it was a review of data on the impact of interventions. The methodologies applied in each study is not discussed.

2.4.4.8 Study 8

This study was undertaken by Kimbrough et al. (2015) in the University of Louisville Hospital. The aim of their study was to improve First Case on Time (FCOT) which was 39.3% at the time. The causes for start time delay included missing documentation, incomplete testing or absent surgeons and resident.

The interventions included: -

a. Reassigning staff to the pre-operative phase to improve the timing of patient readiness for surgery by resolving the bottlenecks along the process.
b. Improving patient compliance with preadmission testing before surgery date with informed consents as well as history and physicals obtained.
c. Parallel processing pathways were introduced whereby patients received anaesthesia procedures before entering the operating room.
d. Preference cards and case carts were updated for surgeons to ensure that the theatres were prepared with the appropriate equipment.
e. Appointment of a dedicated nurse anaesthetist to co-ordinate the daily schedule and serve as an intermediary between theatre staff,

anaesthetists, surgeons, and pre-operative care units. Their main role involved communication and addressing constraints and bottlenecks as they arose.

The findings of the study showed: -

a. An increase in first case on time from 39.3% to 82.7%
b. An overall increase in utilisation from 72.6% to 75.9% which reached 80% during peak time.
c. Increase in the total number of patients per month from 647 to 701.

The methodology used to implement the change was the ‘’Theory of Constraints’’ (TOC). The authors describe the TOC as:

> according to the philosophy of this method, systems can be held up at bottlenecks and process improvements occur by concentrating efforts on these areas. The theory outlines a simple, logical approach to these problems. After identifying the constraint, there is a stepwise progression from improvements through the use of existing resources, to realigning the overall system to alleviate the constraint, to considering entirely new actions. Inherent in this methodology is the ability to address constraints as they arise (Kimbrough et al., 2015).

The duration of the study was 24 months. The authors note that improvements in performance was sustained when they reviewed a further 9 months of data which showed that the percentage of FCOT remained at > than 80% and theatre utilisation continued to improve. They contribute this to applying the TOC methodology which ensures that the improvement process is continuous.

2.4.4.9. Study 9

Bender et al. (2015) set out to improve theatre efficiency via an inter-professional approach. The aim of their study was to focus initially on improving first case on time and patient readiness. They also focused on improving scheduling of unscheduled patients over the weekend.

The interventions included: -

a. Establishment of an operating theatre governance committee,
b. Created 4 six-sigma teams (Scheduling, daily flow, preoperative services and instruments and supplies),
c. Focused on first case on time initially- examples cited were hiring additional transporters and accessible electronic paperwork.

The findings of the study included: -

a. An increase in first case on time from 32% to 72%,
b. Patient readiness increased from 59% to 96%,
c. Utilisation increased from 56 % to 68%,
d. Activity increased by 9%,
e. Overtime decreased from 7% to 4%
f. Staff turnover reduced from 28% to 11%.

They applied LEAN Six-sigma methodology. The study took place over 3 years, showing strong evidence of sustainability.

2.4.4.10. Study 10

Han et al., (2016) aimed to prevent delays in first case start times in the Neurosurgical Service. This was a surgical resident led initiative in which the surgical team tested an intervention to improve the preoperative workflow.

The interventions included: -

a. Accurate site markings,
b. Consenting the patient 30 minutes before the scheduled theatre start time.

The findings of the study showed: -

a. A decrease in start time from 9.67 minutes to 7.17 minutes.

Following the programme, the start time was an average 8 minutes for the following 3 months. The methodology used was a comparative study comparing pre- and

post-intervention start times following the implementation of changes to the pre-operative workflow. The duration of the study was 3 months.

2.4.4.11. Study 11

Ramos et al., (2016) undertook a study in Hospital das Clinicas of the University of Sao Paulo one of the largest public hospital in Latin America. The aim of their study was to reduce late theatre start times which at the time, 62% of lists started late with an average delayed start of 56 minutes.

The causes for start time delay included: lack of an ICU bed post-op, a change in the theatre schedule (e.g., due to a patient lacking clinical conditions for surgery, or the need for an emergency patient to bypass an elective surgery), theatre room not being ready, team delays, a delay in the inpatient unit, and the lack of anaesthetic pre-operative assessment.

The interventions included: -

a. Introduction of an operational checklist to streamline the patient pathway.
b. At the theatre reception area, the day shift starting time was adjusted from 7am to 6:30am
c. Developed a new method of scheduling for elective surgeries that needed a post-surgical ICU bed to control major surgery demand and reduce same-day cancellations.
d. The theatre and the ICU department leadership agreed on starting 30% of surgeries that requested a post-op ICU bed independently of the official bed release.
e. Changed the rule that required that the anaesthetist had to be in the theatre for the patient to be brought from reception into the theatre.
f. Surgical site marking was performed in the inpatient units, not in the theatre.
g. Designed a procedure-specific preference card for some specialties.
h. Created a team of assistants who were responsible for assisting theatre nurses with non-clinical duties.

i. The theatre medical coordinator, the anaesthetic coordinator and the hospital clinical director provided direct feedback to theatres that started late and oversaw the reasons for late start times.
j. All surgical specialties' supervisors were advised that all elective patients should have an ambulatory pre-operative evaluation.
k. Established an "OR command cockpit", where theatre nurses in charge could monitor patient arrivals and surgeries starts.

The findings of the study showed: -

a. Late starts decreased from 62% to 31%,
b. Minutes late reduced from an average of 56 minutes to 34 minutes,
c. Utilisation rates increased from 70% to 73%,
d. Proportion of cases running late reduced from 9% to 7%.

The improvement methodology used was Lean Six Sigma. The duration of the study was one year. Sustainment of improvements post the end of the project was not discussed.

The following section will analyse the studies presented above to explore the common causes for inefficiency resulting in late start time, the types of interventions made to start time performance and the impact of the interventions. The methodologies applied to implement the changes and sustainability of improvements will also be examined.

2.5 Analysis of studies on improving theatre start time

2.5.1 Common causes of delayed start times in the operating theatre

The specific causes for delay in start times were reported in six studies (Overdyk et al. 1998: Wright et.al 2009; Trivedi et.al 2013; Saw et.al 2014; Kimbourg et.al 2015 and Ramos et.al 2016). All of the studies identified lack of pre-operative evaluation and delays with surgeons and anaesthetists arriving late to theatre. Overdyk et al. (1998) added patient registration and transportation as causing delays in their hospital. Wright et.al (2009) study was in a children's hospital, they found parents

attending induction and administering sedation pre-op to cause delays. Trivedi et.al (2013) and Saw et.al (2014) added the problem of patients arriving late to the hospital. Finally, Ramos et al. (2016) experienced three specific problems, (i) lack of an ICU bed post-op, (ii) a change in the theatre schedule and (iii) the theatre room not being ready.

There are common causes for delays in start times presented in the literature which were also identified in the studies presented in this research. A concern described in the rationale for this research was the impact that unavailable post -op ward or day ward bed capacity had on start time performance. This was consistent in the studies undertaken but is not referred to in the literature published. Ramos et.al (2016) referred to ICU bed capacity as being an issue, however frequent lack of general type beds and day-case trollies affects many theatres which was one of the findings in this study.

Furthermore, scheduling patients in the order that the clinical team preferred, which included the wider operating team requirements i.e., anaesthetists and nursing, an increase in the number of long complex procedures which required start time to be adjusted for the operation to be commence earlier in the day and the manual systems for transporting healthcare records along the patient pathway affected start time. Likewise, this was not evident in the literature. This gap in literature contributes to forming the research question which explores the improvements that lead to a reduction in start time delay within the complex setting of operating theatres.

The eleven studies that reported improvements in start time performance were analysed under the following headings: interventions, outcome, methodology applied and if the outcome of the study was sustained. These are presented in Table 3 below. The information is presented in this manner to determine if there is commonality in:

(i) Interventions applied in practice.
(ii) Interventions resulted in improved performance.
(iii) Improvements were sustained.
(iv) Factors that contributed to sustainment.
(v) A formal improvement methodology was applied.

Table 3: Chapter 2. Studies on improving operating theatre start times.

Author	Interventions	Outcome	Methodology	Sustainability
Overdyk et.al (1998)	1.Multidisciplinary education. 2. Re-assigning existing nurses to pre-operative assessment and surgical work-up. 3. Rerouting patients to less congested areas.	1. A reduction in delayed start time by an average of 22 minutes. 2. A significant reduction in the delays due to unavailability of surgeons and anaesthetists. 3. Reduction in turnover time by an average of 16 minutes.	Comparative study comparing pre- and post - intervention start times	Not discussed Study duration 12 months.
Wright et al (2009)	1. Additional staff assigned to the same day admission unit to ensure that patients were prepared and in the preoperative area by 7:15 am. 2. Electronic patient records were made available to the anaesthetist to allow them access to the electronic charts for the patients undergoing surgery the next day. 3.Changing the entry point for all patients to the hospital into one single area 4. Commenced a 07:35 huddle to discuss the cases for the day, including any special considerations. 5. Feedback on on-start times to each theatre.	1. An increase in theatres starting on time from 6% to 60%.	Comparative study comparing pre- and post - intervention start times.	Not discussed Study duration 9 months.
Javed et.al (2013)	1. Introduction of 'The golden patient' concept.	1. A reduction in late starts by 30 minutes per list. 2. A reduction in the number of cancelled operations by 55%.	Comparative study comparing pre- and post- intervention start times	Not discussed. Study duration was 2 months
Panni et.al (2013)	1. Implementing a pre-operative checklist. 2. Appointment of a facilitator who was responsible for intervening whenever there were any missing items needed for a specific patient.	1. A reduction in the number of late starts from 10 to 4.95 (50%).	Comparative study comparing pre- and post- intervention start times.	18 months. Sustainment not discussed
Trivedi et.al (2013)	1. Establishment of a multidisciplinary committee. 2.Development of a protocol which consisted of steps that had to be followed on the morning of surgery	1. An increase in on-time start rate from 40% up to 97%.	Applied engineering principles to the perioperative process.	24 months, however, once the focus was taken off the delays reverted to previous performance levels.
Saw et.al (2014)	1. Standardised the process that the nurse circulator should complete the patient evaluation prior to assisting the surgical technician with room preparation.	1.Increase in FPIT from 66.9% to 84.6% 2. Increase in FCOT from 55.9% to 67.6%.	Comparative study comparing pre- and post- intervention start times	Not discussed Study duration 1 year

	2. Educating patients to arrive two hours prior to the case's start time. 3. Admitting nurse to prioritise admission of patients requiring preoperative lines or other anaesthetic adjuncts such as regional blocks. 4. Anaesthetists to be present at the patient's bedside by 06:45 for completion of anaesthesia consent, pre-anaesthetic review or update, block site verification and marking if indicated, and line and block placement. 5. A preoperative checklist was created to comply with The Joint Commission standards for preoperative requirements and to clearly delineate preoperative responsibilities.			
van Veen-Berk et al (2014)	UMC (2) 1. A specific team was assigned to provide feedback directly when theatres started too late, in person, and on the spot every morning. 2. The theatre nurse, instead of the anaesthesia nurse, became responsible for the transport of a patient from the holding area into the theatre. 3.During morning hours, a post-call anesthetist was assigned to avoid late starts caused by the fact that a. anaesthetist covers b. theatres simultaneously. UMC (3) 1. Scheduling to control the workloads of PACU and ICU departments introduced. UMC (5) 1. Shift in responsibilities from a practice whereby the anaesthetist had to be physically present while the anesthesia nurse brought the patient to the theatre; in 2007 this was no longer required because of protocol changes. 2. New agreements between theatre and ICU departments were implemented, similar to the “ICU bed release” policy in UMC3.	UMC (2) Reduction in start time from 18 minutes to 11 minutes UMC (3) Reduction in late theatre starts from 45 minutes to 27 minutes. UMC (5) A reduction in delayed start times for 15 minutes to 9 minutes.		UMC (2) & (3) Years post implementation Study duration 1 Year
Kimbour	1. Multiple Pre-operative	1. Increase in first case	Theory of	Study duration 24

g (2015)	initiatives which focused on patient's readiness, parallel processing and theatre preparation. 2. Appointment of nurse co-ordinator whose key role was multidisciplinary communication, problem solving.	on time from 39.3% to 82.7%. 2. Increase in utilisation from 72.6% to 75.9% which reached 80% during peak time.	Constraints.	months. Sustained improvements 9 months post project completion.
Bender (2015)	1. Established governance structures 2. Created 4 Six-Sigma teams. 3. Focused on start times-increased number of transporters and electronic access to paperwork.	1. Increase in first case on time from 32% to 72%. 2. Patient readiness increased from 59% to 96%. 3. Utilisation increased from 56 % to 68%. 4. Activity increased by 9%. 5. Overtime decreased from 7% to 4%. 6. Staff turnover reduced from 28% to 11%.	LEAN Six-sigma.	Study duration 3 years.
Han et.al (2016)	1. Accurate site markings. 2. Consenting the patient 30 minutes before the scheduled theatre start time.	A decrease in start time delay from 9.67 minutes to 7.17 minutes.	Comparative study comparing pre- and post-intervention start times.	Study duration 3 months. Sustainability long-term not discussed.
Ramos et.al (2016)	1. Introduction of an operational checklist. 2. Adjusted the day shift starting time from 7am to 6:30am. 3. Developed a new method of scheduling for elective surgeries that needed a post-surgical ICU bed. 4. Changed the rule that required that the anaesthetist had to be in the theatre for the patient to be brought from reception into the theatre. 5. Surgical site marking performed in the inpatient units, not in the theatre. 6. Designed a procedure-specific preference card for some specialties. 7. Created a team of assistants who were responsible for assisting theatre nurses with non-clinical duties. 8. The theatre medical coordinator, the anaesthetic coordinator and the hospital clinical director provided direct feedback to theatres that started late and oversaw the reasons for late start times. 9. All surgical specialties'	1.Late starts decreased from 62% to 31%, 2.Minutes late reduced from an average of 56 minutes to 34 minutes, 3.Utilisation rates increased from 70% to 73%, 4. Proportion of cases running late reduced from 9% to 7%.	Lean Six Sigma	Not discussed 5 Years post commencement of interventions

	supervisors were advised that all elective patients should have an ambulatory pre-operative evaluation. 10. Established “OR command cockpit”, where theatre nurses in charge could monitor patient arrivals and surgeries starts.			

2.5.2 Types of interventions implemented

Regarding the interventions implemented, there were some commonalities among the studies. For example, some of the authors focused on reassigning staff to the pre-operative process to streamline patient preparation and address delay issues as they arose (Overdyk et.al 1998; Wright et.al 2009; Panni et. al 2013 and Kimbourg et.al 2015). Panni (2013) Kimbourg (2015) appointed nurse facilitators to the theatre department to address constraints and bottlenecks and improve multidisciplinary communication. van Veen-berkx et.al (2014) and Ramos et.al (2016) allocated responsibility to a team consisting of a nurse, anaesthetist and surgeon to monitor start time each morning, feedback to each theatre and address delay issues. Interventions that focused on patient readiness were tested by Javed (2013) and to a lesser extent by Han et.al (2016). Saw et.al (2014) changed the process for anaesthesia whereby they had to review the patient in the pre-admission area early in the morning. Trivedi et.al 201); Panni et.al 201) and Ramos developed protocols and checklists to streamline patient readiness.

Saw et.al (2014) and Ramos et.al (2016) focused a lot of their improvements in the theatre. From changing frontline staff start times, processes on patient evaluation and anaesthetic presence in the theatre prior to patient arrival. Both van Veen-Berk and Ramos worked on protocols for post-op ICU bed availability.

2.5.3 Outcome of the studies

All studies reported significant improvements in start time performance. Overdyk et. al (1998); Javed et.al (2013); and van Veen-Berk et al. (2014) achieved a reduction in their start time by between 9 and 30 minutes. Other authors doubled the number of theatres that started on time in their studies (Wright et.al 2009; Trivedi et.al 2013; Panniet.al 2013; Kimbourg et.al 2015 Bender et.al 2015 and Ramos et.al 2016) while Saw et.al (2014) increased the percentage of FPIR by almost 20%. Han (2016) achieved a small reduction in late start time.

2.5.4 Sustained improvement, approaches and methodologies

There are different improvement methodologies applied across the eleven studies reviewed. Overdyk et.al (1998); Wright et.al (2009); Javed et.al (2013); Panni et.al (2013); Saw et.al (2014) and Han (2015) applied a pre- and post-intervention methodology where they, measured pre intervention start time delays, implemented changes, and measured the impact of these post changes.

The remaining studies used formal methodologies, Kimbrough et al. (2015) applied the principles of the 'Theory of Constraints' which also yielded excellent improvements in start times over a sustained period of almost 3 years. Trivedi et al. (2013) introduced engineering principles; achieving an increase in on-time starts from 40% to 97% which was sustained over 2 years; however long-term improvement was not maintained which they attribute to not building in assessment measures to continue to evaluate the programme. Both Bender et al. (2015) and Ramos et.al (2016) used a LEAN Six-Sigma approach to implement a number of interventions which also resulted in improvements in efficiency across a number of measures. Both studies were carried out over the longest timeframe 3 years and 5 years respectively and continued to demonstrate strong evidence of sustainability at the time of publication.

In summary, the studies demonstrate that improvements in theatre start time performance can be achieved. The interventions tested are similar and are appropriate to addressing the causes of delayed start time. These findings demonstrate opportunity for improvement along with some guidance on possible interventions that could lead to improved performance in this study. The studies that applied a formal quality improvement methodology demonstrated a longer-term approach to improving efficiency and showed stronger evidence of sustainability.

Eight of the studies presented were carried out between 12 months and 5 years. Four of the studies refer to sustainment of outcomes in practice (Trivedi et.al 2013; van Veen-Berk et al 2014; Kimboury et.al 2015 and Ramos et.al 2016), however it is not described in detail in the studies how sustained improvements were achieved which reflects a gap in the literature and an opportunity to contribute to building knowledge in this field. The studies presented in this research focus on sustaining

improvements achieved in practice in an effort to answer the research question which explores the factors that contribute to sustained improvement in start time performance in operating theatre.

2.6 Conclusion

A review of the literature examined two themes, a) the concept of quality and quality improvement in the healthcare setting and b) efficiency as one of the domains of quality in the operating theatre. The two-pronged approach taken in the literature review connects efficiency with quality and most importantly looks at how it has been improved and sustained in practice. Linking both concepts strengthens the purpose for improving efficiency. More importantly applying the learning from the review of the literature to the practical healthcare setting of operating theatres connects the theory of quality with frontline practice.

Section 2.3 provides a review of the literature on the definition of quality, emphasising the six aims of quality devised originally by the IOM to support efforts to provide: safe, effective, patient centred, timely, efficient, and equitable care. Section 2.4 examined the concept of quality improvement, emphasising the need for unceasing efforts of all healthcare professionals to continuously work on improving quality using a systematic approach, all the while embedding a culture and philosophy of quality improvement into the of the heart of the organisation.

Section 2.5 narrows the focus on quality, specifically looking at one dimension of quality which is efficiency and applies this concept to the front-line practice of operating theatres. The review explores the meaning of efficiency in operating theatre and looks at the measurement of efficiency detailing an overall measure that is commonly used and offers a broader set of measures to provide a complete picture of performance. Finally, the literature review examines in depth studies presented that have improved efficiencies in operating theatre start times which has been identified as a common measure of theatre efficiency.

This detailed analysis of the research on improving theatre start times demonstrates strong evidence that improvements are achievable providing a motivation to drive quality improvement in this area. However, evidence regarding the causes of delayed start time that are provided in the literature presented do not

completely reflect delay issues in the studies in this research and therefore require different solutions to be implemented. Furthermore, sustaining improvement in practice which is a challenging part of the quality improvement cycle does not get sufficient attention in the literature presented to guide frontline staff working in operating theatres to sustain performance when faced with the complexities of the service. For this reason, there is an opportunity in this research study to build knowledge on how start time can be improved and address the knowledge gap on the factors that contribute to sustaining improvements in operating theatres.

CHAPTER 3 - RESEARCH METHODOLOGY

3.1 Introduction

Chapter 3 outlines the research methodology that will influence and guide the structure and approach of the study. A case study design has been chosen as the most appropriate methodology to explore (a) improvements in the perioperative process that contribute to reducing start time delays and (b) how can these be sustained across the operating theatre?

This chapter will describe in detail the research framework from the development of the research question including the concepts, theory and philosophical perspective that underpin it to the appropriateness of choosing a case study design. This will be discussed in detail linking the characteristics of a case study to the actual research being undertaken. The data collection methods are described, these include process mapping, quantitative measurement of start time performance in graphical format and informal interviews with staff. Finally, the process for analysing the data will be described.

3.2 Aim of the research

The overall aim of the research study is to examine the impact of implementing interventions to address the problem of delayed start times in the operating theatre department and the factors required to sustain the improvements in outcomes achieved in practice.

3.3 The Research Framework

In carrying out a scientific research study a number of factors shape and guide how the research is designed and approached. A research framework supports this, pulling together all the characteristics that produce scientific research that is valid and reliable and of a standard that creates knowledge from which one can learn.

The following section will describe the research framework. According to Mason (2005 , p.24) “a research framework provides a structure consisting of a set of actions or principles that are chosen to best answer the research question and how to position it”. Robson (2011, p 70) adds that a framework for research design concerns the various things which should be thought about and kept in mind when carrying out a research project, referring to these as the components of a research design. These include.

1. The research question,

2. The purpose of the study,

3. The conceptual framework- the theory about what is going on, what is happening and why, the system of concepts, assumptions, expectations, and beliefs.

4. Methods or techniques that will be used to collect the data,

5. The sampling strategy- who will you seek data from.

3.3.1 The Research Question

Articulating the research question is recognised as a challenging part of undertaking a research study but is of significant relevance in guiding and planning the research. Both Stake (2003, p.15) and Yin (2003, p.7) acknowledge the challenges in defining the research question and importance of getting it right. Stake states that: ‘perhaps the most difficult task of the researcher is to design good questions, research questions that will direct the looking and the thinking enough and not too much’.

Yin (2003, p.7) concurs that it is probably the most important step to be taken in a research study stating that: “the key is to understand that questions have both substance for example, what is my study about and form, meaning am I asking a who, what, where why and how question’’.

In attempting to articulate the research question, the aim of the study and the paradigm it sits within all contribute to creating the research question. To link the

research which is to examine how the implementation of improvements in operating theatre start times are sustained with the practicality of doing this on the ground triggered questions that the study is attempting to answer. These include: -

1. What is an efficient operating theatre and how is efficiency measured?

2. Taking start time as the focus area to improve efficiency, what are the causes of delay, and how can start times be improved?

3. What are the specific interventions required to improve the current problem of late starting time in the theatres?

4. Did interventions implemented reduce delays?

5. Could the improvements be spread across the theatres?

6. Were the improvements sustained?

8. What factors contribute to sustaining improvements in a complex healthcare environment?

9. What was the impact of making improvements in theatre efficiency?

Articulation of the research question has become clearer over the course of the study; however, this may change or may need to become more specific as the study progresses. This is not unusual according to Mason (2005 , p.24) who states: “that in qualitative research, decisions about design and strategy are ongoing and are grounded in the practice, process and context of the research itself”.

The potential for learning from the practical application of improvements in start times and how this can contribute to theory, led to a consolidation of the list of questions above and produced one research question which is:

What improvements in the perioperative process contribute to reducing start time delays in the operating theatre and how can these improvements be sustained across the operating theatre?

3.3.2 The purpose of the study

Central to the research framework or strategy is the purpose, what the study is trying to achieve. The purpose or aim of this research is to improve operating theatre efficiency. Based on the findings in the literature review which identified key performance areas which demonstrate efficiency, one of these components of efficiency which is improving theatre start times has been chosen as the purpose of the study.

3.3.3 The Conceptual Framework

Yin (2003 , p.27); Stake (2003 , p.16) and Robson (2011 , p.67) recognise the importance of theory in undertaking a research study recommending the development of a conceptual framework to structure and organize how the research is carried out. A conceptual Framework explains the main things to be studied, the key factors, constructs or variables and the presumed relationships among them.

Yin (2003, p.21) suggests that adhering to the five components of a research design will force you to begin constructing a preliminary theory related to your topic of study. A theoretical perspective asks which approach do you use to know something or according to Robson (2011 , p.66) " is developing a theoretical understanding of a problem, therefore asking what is going on and how it might be understood".

According to Robson (2011 , p.68) inputs to the conceptual framework come from a variety of sources;

1. Previous research,
2. Pilot studies,
3. Theory and what you think may be relevant,
4. Your intuition and hunches,
5. Views of others.

The goal according to Yin (2003 , p.21) is to have a blueprint for your study and this requires theoretical propositions that will provide strong guidance on what data to collect and strategies for analysing the data. For this reason, theory development prior to the collection of any data is an essential step.

In linking this to the research study, the first stage in theory building has been to draw from the experience of staff on what factors are the causing delays and taking this to another level of theory building by measuring and analysing specific perceived causes of delay. This provides guidance on where the changes are required to prevent such delays. The next level of theory building will be measuring the impact of implementing changes to the perioperative process and what factors helped either sustain or inhibit the improvements.

As well as recognising the theoretical component of the research framework, the philosophical perspective also contributes to the thinking and planning of how the study will be carried out.

According to Saunders and Tosey (2013) “how a researcher views the world, her or his taken-for-granted assumptions about human knowledge and about the nature of the realities encountered, inevitably shape how a research question is understood and the associated research design”.

The main influence on the researcher’s philosophy is her or his personal view of what constitutes acceptable knowledge and the process by which this is developed. The authors refer to the layers of research design and explain the philosophical position which underpins a research study. This is also referred to as a research paradigm which according to Saunders and Tosey (2013) is: “a set of common beliefs and agreements shared between scientists about how problems should be understood and addressed”

There are a number of research paradigms for example, positivism, constructivist/ interpretivist, pragmatism, subjectivism and critical realism (Saunders and Tosey 2013). Understanding which of these paradigms the research study fits into depends on how the researcher views the world or in practice the environment in which the research is taking place within. Research paradigms are characterised through their ontological, epistemological, and theoretical perspectives. The position that is most closely aligned to this research study is critical realism.

Saunders and Tosey (2013) describe critical realism as a philosophical position associated with scientific enquiry. Realism states that reality exists independent of the mind and that what a researcher’s senses show her or him is the truth, although

the researcher is influenced by world views and their own experiences. A researcher reflecting a critical realist position means that there is a need to find out both what is immediately experienced and the structures and relationships that lie beneath this; in other words, to consider the underlying complexity.

In summary, the study involves an in-depth analysis of perioperative flow to gain insight into the underlying complexities of the structures and relationships that lie beneath the reality of what is experienced by inefficiencies in the theatre department. Therefore, this perspective falls within the critical realism philosophical position. (Henning 2004, p. 15) supports this stating that when composing a theoretical framework for your study for example is it positivist/interpretivist/constructivist or critical, a study with the intention to improve and change hints at a critical paradigm.

3.3.3.1 Ontological and Epistemological Perspective

The researcher's ontological perspective or social reality, meaning how you see the very essence and nature of things in the social world is described by Mason (2005) as asking simply; "what is reality?" The reality in this research study is that there is a longstanding problem with theatres not starting on time. This is inefficient in that it results in a waste of time and money; it creates unnecessary stress for staff working in the area and can potentially result in patient cancellations.

Epistemology asks how I can know reality. "It is concerned with how we gain knowledge or how we get to know something and different methods of gaining knowledge" (Mason 2005 , p.16). Existing knowledge tells us that problems are caused by several factors both inside and external to theatre which require a wider system approach to address the problem.

As the study progresses, the knowledge gained from an in-depth analysis of the root causes of the problems and the impact of the changes implemented may alter how the reality is perceived and understood and could potentially bring the study to another level. How the current situation is understood and the information that exists about components of the problem all influence how the research study is planned.

3.4 Chosen Research Design

The research design for this study is a case study. The use of case studies according to Robson (2011,p.135) “is evident in a variety of disciplines for example, sociology, medicine, anthropology, archaeology, business studies, education, organisational behaviour and psychology”. Stake (2005, p. 1) states that: “a case study is expected to catch the complexity of a single case, in which one looks for the detail of interaction with its contexts”.

Yin (2003 , p.13) defines a case study as: “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence”.

Flyvbjerg, Denzin and Lincoln (2011) refers to the multiple definitions of case study and uses a straightforward definition from Merriam-Webster’s dictionary as follows: “Case study is an intensive analysis of an individual unit stressing developmental factors in relation to environment”. The authors explain this definition of case study using four key points: it focuses on a specific unit set within tight boundaries, it is intensive comprising more detail, richness, completeness and variance’ which they refer to as ‘depth’. A case typically evolves over time, often as a string of concrete and interrelated events and concludes that case studies relate to the environment which he defines as context.

There are many definitions of a case study in the literature, but common to all definitions are the key characteristics which will provide a framework to answer the research question in this study.

The reasons for choosing a case study design to support answering this research question centre around its ability to capture real-life context including the complexities within which the case is occurring over time within the environment in which the study is being undertaken. It is specific, meaning that it focuses on one area or issue, this is in line with the Model for Improvement that is used in the studies as a systematic approach for implementing quality improvements on the ground. It defines the aim of what one is trying to improve and works within the scope or boundary of that. Its intensiveness resulting from its use of multiple sources of evidence creates a deep understanding of the problems with theatre

start times, examining what is causing delays from a qualitative and quantitative perspective, which interventions improve start times and how is this achieved and sustained. It creates a real opportunity for learning due to its depth and richness.

The following section expands in greater depth on the qualities and characteristics of case study design and links its relevance to the research question.

3.4.1 Study context.

Case study is used to explore real life experiences and situations, when the phenomenon and the context in which it occurs are of interest especially when the boundaries between phenomenon and context are not clearly evident (Yin 2003, p.13). The author explains “one would use the case study method because you deliberately wanted to cover contextual conditions, believing that they might be highly pertinent to your phenomenon of study”. Being context specific is central to case study research.

Similarly, Eisenhardt (1989) states that case study design “helps develop explanations of social-psychological and social- structural processes, meaning that, attitudes, relationships, hierarchies and power all get emphasised or come through in the research”. Kane (2012) states that; “the appeal of the case study design lies in the way that the design emphasises as significant the context in which the phenomenon is occurring, allowing the competing processes and influences to feature significantly in the research”. The author refers to case studies as facilitating the ’illumination of issues’.

This research study is essentially about implementing change or process improvements in the operating theatre, looking specifically at improving start times. Reflecting on previous experience of quality improvement initiatives in the operating theatres, the greatest learning has been how the working environment, relationships, culture, hierarchy of multi-professional groups that work in the department and the reliance of smooth systems flow between services aligned to the theatre have all featured significantly in the process of implementing change. This learning should not be ignored in any attempts to make improvements to the efficiency of the service. A case study design will help capture and make sense of the relevance of the context within which the change is occurring. Operating

theatres provide a rich environment to explore the ‘how’ of improvement and sustainability in a dynamic complex environment.

3.4.2 Study site culture

Flyvbjerg (2006) refers to “the importance for the researcher to be close to real-life situations with its multiple wealth of details. He claims this is important for the development of a nuanced view of reality”, meaning that it can capture the real-life situation and the subtleties which influence the culture of change. For this study it is necessary to understand the culture that the study is trying to make improvements within. Being immersed in the study site allows a learning and understanding of how the theatre system functions, the factors that prevent efficient processes, the relationships between the multiple specialties both within and outside of the department and the openness and desire for change. Acknowledging this and determining whether the culture is open to and supports the process of change will be significant in this research study.

3.4.3 Building knowledge

McLeod (2017) refers to case study research as representing a source of knowledge that is highly relevant to practice. Similarly, Corcoran, et.al (2004) state that “case studies can be used as a mechanism to transform and improve practice”. The approach to this research is to undertake a case study on reducing start time delays. Within this study there will be six sub-studies all specific to the purpose of reducing delays but may involve different approaches for different specialties. This will develop; sub-case by sub-case a deeper understanding and learning of how to improve efficiency in an operating theatre through reducing start time delays.

The objective of the study is that learning will be gained through implementing and measuring the impact of several process improvements to reduce start time delays, from the perspective of the actual intervention but will also incorporate the contextual factors that either contribute to or inhibit the improvement. The learning and expertise will contribute to developing a framework or approach on effecting change specific to the culture of the theatre department. Building knowledge from the various case studies on improving operating theatre start times will produce overtime understanding and eventually theory on how to improve efficiency in a complex environment.

3.4.4 Research applicable in practice

Corcoran et al. (2004) stated that the purpose of a case study is to provide a critical analysis of practice that will result in the transformation of practice in others. In this study learning from the individual case studies will be used locally to drive efficiency improvement; this makes the research useful and applicable in practice. McLeod (2017) defines this as providing a pragmatic approach to the research.

Experience gained from working on implementing improvement projects is that different specialties working in theatre require different approaches to make improvements. Some models of good practice are beginning to emerge and are broadly applicable; this makes the research useful, practical and applicable in practice. Flyvbjerg (2006) refers to the usefulness of research and states “that when there is great distance to the object of study and lack of feedback that this easily leads to a stultified learning process”, which in research he states: “can lead to ritual academic blind alleys, where the effect and usefulness of research becomes unclear and untested”.

One could expect that elements of the learning gained from the study could be replicated in the broader hospital setting or at the very least to help start to answer some questions on effecting change in a complex and dynamic environment.

3.5 Classification of Case Studies

According to Yin (2003, p.38-39) the primary distinction in designing case studies is between single and multiple case designs. This needs to be decided prior to data collection. A single case design is appropriate in a number of circumstances, such as:

1. To represent the critical case used to confirm, challenge, or extend a theory,

2. To represent extreme or unique cases,

3. It is used for representative or typical cases, used to capture the circumstances and conditions of everyday common situations,

4. To represent a revelatory case, used to observe and analyse a phenomenon previously inaccessible to research,

5. To represent a longitudinal case, studying the same single case at two or more different points in time (Yin 2003, p.39).

Yin refers to these as the rationale for doing single case studies. The same case study may involve more than one unit of analysis; this is referred to as an embedded case study. This occurs when within a single case, attention is given to a subunit or subunits. One of the pitfalls according to Yin (2003, p.42) of an embedded design are “when the case study focuses only on the subunit level and fails to return to the larger unit of analysis”.

In this research study a single embedded design is appropriate. The case is improving operating theatre start times through making improvement in six specialties which are similar to subunits. These subunits can add to the significant opportunities for extensive analysis over time, enhancing the insights into the case. The study is exploratory in nature in that it will focus on exploring the causes of delayed start times and how the problem can be improved, and the improvement sustained. Stake (2005, p.31) refers to instrumental case studies in that “they provide insight on an issue and help to refine theory”, the theory generated from this case will produce knowledge on the causes of inefficiencies around theatre start times and contribute to a model for making and sustaining improvements in the operating theatre.

3.6 Judging the Quality of Case Study Designs

Flyvbjerg (2006) refers to the case study paradox meaning “that even though case study has been used for a long time in the disciplines of psychology, sociology, history, education, management etc that as a methodology it is generally held in low regard”. The author identifies five misunderstandings of case study as a viable design. These ‘five misunderstandings’ are presented as follows:

1. General, theoretical (context-independent) knowledge is more valuable than concrete, practical (context –dependent) knowledge.

2. One cannot generalise on the basis of an individual case; therefore, the case study cannot contribute to scientific development.

3. The case study is most useful for generating hypotheses; that is, in the first stage of a total research process, while other methods are more suitable for hypotheses testing and theory building.

4. The case study contains a bias toward verification, that is, a tendency to confirm a researcher preconceived notions.

5. It is often difficult to summarise and develop general propositions and theories based on specific case studies: (Flyvbjerg, 2006)

Yin (2003) highlights four tests that have been commonly used to establish the quality of any empirical social research, these include, a) construct validity, b) internal validity, c) external validity, d) reliability. Yin applies these tests to case study as a design to strengthen the validity of case study research, this helps present a counter-argument to the misunderstandings that Flyvbjerg (2006) has highlighted.

3.6.1 Construct validity

According to Yin (2003, p.34) “construct validity is problematic in case study research if the study investigator fails to develop a sufficiently operational set of measures and that subjective judgments are used to collect data”. The author encourages the researcher to be very specific about what they are studying and that the selected measures demonstrate what one is trying to report on. To address this problem the author identifies three tactics to increase validity when doing case studies: -

1. Use multiple sources of evidence, in a manner encouraging convergent lines of inquiry during data collection,

2. Establish a chain of evidence, relevant during data collection,

3. Have the draft case study report reviewed by key informant (Yin 2003, p.34).

In this study both quantitative and qualitative measures will be used. The quantitative measures will focus specifically on trends in start time performance,

pre- and post-improvement. Other measures may be deemed necessary from the process mapping exercise for example causes for delay, capacity and demand for pre-assessment service, pre-operative admission, and assessment of patients. Qualitative data will be collected as part of the Plan, Do, Study, Act (PDSA) cycle whereby staff will provide feedback on the impact of the changes being tested.

3.6.2 Internal validity

Internal validity is only a concern for explanatory case studies, where the researcher is trying to determine whether one event led to another and may exclude other factors that may have caused something to change. Another concern is the investigator making inferences which may arise from interview data collected as part of the study. A research design needs to anticipate these questions and use analytical tactics for example pattern matching and explanation building to address internal validity. When measuring improvements in start time delay, detailed impact of each intervention will be measured as opposed to combining all interventions and doing one general measure.

3.6.3 External Validity

This deals with the problem of knowing whether a study's findings are generalisable beyond the immediate case study. Flyvbjerg (2006) refers to this stating that "one of the misunderstandings about case study research is that one cannot generalise on the basis of an individual case; therefore, the case study cannot contribute to scientific development". Yin (2003, p.36) concurs stating that "critics typically state that single cases offer poor basis for generalising but argues that case study relies on statistical generalisation where the researcher is striving to generalise a particular set of results to some broader theory". However, he cautions that "generalisation is not automatic and recommends that a theory must be tested by replicating the findings where the theory has specified that the same results should occur, this could then be accepted as providing strong support for the theory". The study will consist of six subunits referred to above; replicating the same improvement methodology across a number of specialties will strengthen the validity of the findings.

3.6.4 Reliability

The objective according to Yin (2003, p.37) is to be sure that if a later investigator followed the same procedures as described by an earlier investigator and conducted the same case study, the later investigator should arrive at the same findings and conclusions, the emphasis is on doing the same case study over again. This practice would help address some of the misunderstandings raised by Flyvbjerg (2006). Replicating the same study by a different researcher and coming up with the same findings would strengthen the reliability of the study and avoid the risk of bias. The tactics identified by Yin (2003, p.37) used to overcome this concern is to use a case study protocol, documenting the procedures followed in the case and input this into a case study database. In this study, trialling changes in a number of theatres or specialties using the same approach or framework would strengthen the reliability of the study.

3.7 Data Collection Methods

According to Yin (2003, p.99), “case studies typically use both qualitative and quantitative methods of data collection”. A variety of data collection strategies can be used for example, structured and semi-structured interviews, observation studies and statistical analysis. Case Studies allow for different perspectives through a variety of data collection methods. Stake (1995) reinforces this point, claiming that “adopting multiple data collection and analysis methods help further develop and understand the case as it emerges through making use of naturally occurring sources of knowledge, such as people or observations of interactions that occur in the physical space”. This qualitative approach “explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information.

To answer the questions posed, multiple sources of evidence are needed. Each method of collecting data needs to answer a specific question. Using multiple sources of evidence benefits this study, for example, a quantitative analysis of theatre performance data provides a general picture on how the service is performing in relation to compliance with starting on time. However, limiting this process improvement study to the analysis of data will just provide a general view,

the data needs to be delved into to examine more deeply the variances that exist in the patient process that prevent starting on time. Such depth of analysis requires the following three methods of data collection which will be used in this study.

1. Process mapping.
2. Start Time Performance data.
3. Unstructured Interviews.

Table 4: Chapter 3. Summary of data collection methods

Data Required	Data collection method	Source of information
Start time performance	Recording of start time per theatre, presenting this information on a 'Run chart'	Electronic Theatre system
Causes of inefficiencies/start time delays,	Process mapping and audit of delays causes	Staff providing the service both internal and external to theatre
Impact of interventions tested in practice	Study phase of the PDSA Cycle where feedback on the qualitative impact of the change is recorded	Staff involved in the change project both internal and external to theatre

This project is about improving process flow. From these different perspectives one could begin to understand whole system flow, relationships, the culture, and environment that change is being made within. Case study facilitates bringing all this learning into the research, it allows an illumination of the real story, and it is only through knowing and understanding these complexities that improvements that are useful and specific can be implemented.

3.7.1 Process mapping

One of the first exercises to help understand what creates delays in theatre start time involves a detailed analysis of the process flow for patients prior to and when they arrive in the operating theatre. Process mapping is a tool that can assist in visually displaying a component of a patient journey to examine and question the value of each step in the process. Process mapping is used extensively in the manufacturing industry and is becoming a frequently used tool in healthcare.

Johansson, McHugh, Pendlebury and Wheeler (1993, p.86) defined a process as, "a set of linked activities that take an input and transform it to create an output', recommending that ideally, "the transformation that occurs in the process should

add value to the input and create an output that is more useful and effective to the recipient either upstream or downstream". The author describes a process as" a specific group of activities and subordinate tasks which result in the performance of a service that is of value". The authors highlight the importance of laying out a process in sequence so as to be able to see the logic flow and therefore gain understanding of the process (Johansson et al. 1993 ,p. 86).

Some authors differentiate between core business processes and sub-processes or the ones that support it, however in practice Maull et al. (1995) state that "each process as a whole can be broken down into smaller components or sub processes, so that these components can be examined to see whether they add value and if so, how much from an external customer perspective".

In an acute hospital setting many processes are referred to as complex. Johansson et.al (1993, p. 86) talks about the "discovery phase of trying to identify delays within a process", suggesting that:

> When one is starting to map the process for the first time that using a technique known as 'quick mapping' which provides a high-level view and helps start to breakdown the complexity of the process to make it more easily understood (Johansson et.al 1993, p. 86).

The author recommends a quick map as a:

> First- cut representation of the processes that will need to be refined as the effort progresses. A quick map takes a big picture of the process in a macro sense, bounds it and lays it out". If the process is simple, you can begin the search for targets for reengineering. In a more complex process, you have to drop very far down into the process before a likely target for reengineering is found (Johansson et al. 1993 , p. 86).

3.7.1.1 Studies that used Process mapping to improve Operating Theatre efficiency

The use of process mapping to improve patient flow in the operating theatre is not a new concept. Buchanan and Wilson (1996) presented a project based in Leicester General Hospital where process mapping was used to:

> develop fresh insights and solutions to improve efficiency in patient flow through theatre. It was a lengthy and iterative process involving repeat interviews with staff, scrutiny of a range of documentation and the production of the main steps in the trail. It took a wider view of the patient trail recognising that problems may arise outside of the theatre; referred to it as the 'whole activity chain'.

Leicester hospital is a 740-bed acute hospital with ten operating theatres. In this project the process was seen as too complex to map therefore sub-processes were mapped, nine in total. Buchanan and Wilson (1996) highlighted the most interesting features of the patient trail derived from the mapping exercise. In summary these include.

1. Complexity of the patient trail with the typical patient being "handled" by 50 or more members of hospital staff not all of whom meet patients,
2. Variability in procedures,
3. High interdependence when moving the patient from one stage to the next,
4. Low visibility between staff who are not always knowledgeable about what happens (in general – or to a specific patient) at other steps in the trail,
5. Poor feedback and communication with no central ownership of the process as a whole,
6. Unprotected theatre lists which are subject to alteration and renegotiation.

The authors report that staff held an “episode view” of their activity rather than a “process view” and that one main strength of the process mapping perspective is “its ability to encourage a horizontal, cross functional analysis to broaden this perspective”.

In summary process mapping is a tool to identify bottlenecks, provide a picture or sequence of events that illustrate the path of a patient. Questioning the value that each step adds challenges the necessity of each action. This in turn creates opportunity to identify areas for improvement. As a method of data collection, process mapping pinpoints areas on the patient pathway that need to be analysed further to determine their value and the performance level in this specific area.

In case study 1, the flow of patients throughout the day was mapped over three days. It highlighted the gaps in activity and causes for late start times and extended turn-around time. This data was used to explore the factors causing start time delay which was a priority for the surgeon, anaesthetist and theatre nurse to focus improvements on. Later in this study, when start time performance deteriorated the process on the morning of surgery was mapped to identify new causes for delay. Likewise, in case study 2 and 6 the steps required to be completed prior to the morning of surgery so that the patient could go directly to theatre once they were admitted were mapped out with responsibilities assigned. In case study 4 on the surgical day ward, the process from the time the patient arrived at the ward on the morning of surgery until they went to theatre to examine the order of the patient preparation phase. Finally, in case study 5 the neurosurgery department mapped the process from the time the patient was allocated a date for surgery to incorporate an anaesthetic assessment appointment within this timeframe.

3.7.2 Quantitative data collection of start time performance

Measurement is a critical part of testing and implementing changes and tells whether the changes implemented are leading to improvement. The Model for Improvement refers to measurement as a key element for improvement (Langley G et al., 2009, p.27). According to the IHI improvement takes place over time. Determining if improvement has really happened and if it has lasted requires observing patterns over time. Run charts are graphs of data over time and are an example of a tool used for assessing the impact of change. They help in determining when changes are truly improvements by displaying a pattern of data

that you can observe as you make changes (Langley et al.,2009, p.435). Run charts will be used in this study to measure both the baseline start time performance and the impact of improvement interventions.

3.7.3 Interviews

Henning (2004 p. 52) stated that:

> the main aim of interview data is to bring to our attention what individuals think, feel and do and what they have to say about it in an interview, giving us their subjective reality in a formatted discussion, which is guided and managed by an interviewer and later integrated into a research report.

Yin (2003, p. 89) emphasises the strength of interviews claiming that:

> one of the most important sources of case study information is the interview because most studies are about human affairs and that these human affairs should be reported and interpreted through the eyes of specific interviewees and well-informed respondents can provide important insights into a situation.

However, he does caution that interviews should always be considered verbal reports only and as such, “they are the subject to the common problem of bias, poor recall, and poor or inaccurate articulation. A reasonable approach is to corroborate interview data with information from other sources”. (Yin 2003, p. 92)

Yin (2003) suggests that:

> Although you will be pursuing a consistent line of inquiry, your actual stream of questions is likely to be fluid rather than rigid, concluding that ‘case study interviews require you to operate on two levels at the same time.
>
> 1. Satisfying the needs of your line of inquiry while simultaneously,

2. Putting forth friendly and non-threatening questions in your open-ended interviews.

For this study, the purpose of using interviews as a source of data is to gain an in-depth knowledge from staff working both in the operating theatre and in the services that support it of their experience of causes of delay on the morning of surgery, how these are dealt with, the frequency that they occur and their ideas of how the problem could be addressed. For this study, the interviews will be more a guided conversation rather than structured queries. The improvement methodology being used involves feedback on the impact of changes tested in practice as part of the PDSA cycle.

3.8 Data Analysis

3.8.1 Qualitative content analysis.

Henning (2004, p.105-107) steps out the process of analysis starting with, open coding which involves the researcher reading through the entire text to get a global view of the content. Some themes will start to come through at this stage. Following this, units of meaning are identified. At this stage codes are applied to the units of meaning or segments, the codes are then grouped together or categorised with themes emerging which will be used in the discussion of enquiry. Once all the data has been coded and categorized, it is important to go back and look at the ‘ whole’ of the story according to Henning (2004 , p. 106) and to ask a number of important questions, one of them being, how does it address the research question? Once it is felt that the themes represent a reasonably researched chunk of reality, then each theme can be used as a basis for an argument in a discussion around them (Henning 2004, p. 107).

Informal interviews with staff involved in the improvement project and with those that contribute to the perioperative process will be a form of data collection that will be used in this study. The information gained will be documented in the PDSA template as the study progresses. It will involve: planning the study , the improvement team will develop a plan for the actions required to prepare for the study, the second phase involved doing the work in practice and key to learning about how the intervention worked in practice and determining if it led to

improvement requires the study phase of the PDSA cycle which includes analysing the quantitative data and also feedback form staff involved in the change so that the next course of action can be acted upon. This happens repeatedly throughout the PDSA cycles of each case study.

3.8.2 Analysis of data from Process maps

Analysing data from a process map, usually involves the team of people involved in the process reviewing the overall process to identify the bottlenecks, delays or hold-ups and then asking why this happens. The reasons can vary from there being too much work involved in a particular step or there are not enough resources allocated to the stage of the process or some steps are unnecessary. What one is trying to determine is does each step add value for the patient. This can require further in-depth analysis of specific steps or actions that may need to be mapped out in more detail.

In this study, analysing the findings from the process mapping involves the improvement teams reviewing the processes mapped and discussing the potential causes for inefficiencies within the process and the pinpoint of where to focus improvements on.

3.8.3 Analysis of quantitative data on Run charts

Quantitative data in the initial stage of this research will look at start time delays recorded in minutes late per theatre list. The data will be recorded on a run chart over a defined period. It demonstrates a trend or pattern on start time performance. The median range is used as an overall measure. The aim is that a baseline start time performance will be measured prior to any interventions and post intervention recording of start times will also be completed to get a picture of the impact of the intervention. This will be a first step in quantitative analysis, other types of charts may be required to get a more detailed picture of the problem or solution as the study progresses.

3.8.4 Triangulation of data

A major strength of case study design is the use of multiple sources of evidence. In case study research a process of triangulation is used to combine all the data gleaned from the data collection exercise. Yin (2003, p.107) stated that “the

greatest advantage of using multiple sources of evidence is the development of converging lines of inquiry; a process of triangulation" which the author recommends claiming that:

> When you have really triangulated the data, the events or facts of the case study have been supported by more than a single source of evidence, warning that when you have used multiple sources of data but not actually triangulated the data, you typically have analysed each source of evidence separately and have compared the conclusions from the different analyses-but not triangulated the data Yin (2003, p.107).

Johansson et al. (1993) concluded that "one major feature of case study methodology is that different methods are combined with the purpose of illuminating a case from different angles which is achieved by triangulation".

This study involves the culmination of data from measuring start time performance pre and post interventions, attendance, and impact of implementing an anaesthetic pre-operative assessment, causes for delay or inefficiencies with the findings from process mapping exercises and the improvement teams' feedback on the impact of interventions tested in practice.

3.9 Conclusion

This chapter outlines the research framework, which will be used to structure, guide, and plan the study. It describes key stages in the research process which include developing the research question and the theoretical and philosophical perspective that contribute to developing the question. A review of Case study design is presented. The appropriateness of choosing a case study is discussed. Emphasis is given to how the characteristics of a case study approach will help bring out the story of change, highlighting the many factors that help implement and sustain it. The data collection methods deemed appropriate as this stage in the study are outlined, these include process mapping, quantitative measurement of start time performance and informal interviews. The analysis of the data is discussed also. The next chapter will describe a quality improvement methodology

called the Model for Improvement which has been used to practically implement efficiency improvements in the operating theatre.

CHAPTER 4 - QUALITY IMPROVEMENT FRAMEWORK

4.1 Introduction

The previous chapter discussed case study methodology which is the chosen research design for this study as it was deemed the most appropriate approach to best answer the research question which is to; explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can improvements be sustained long-term?

This research presents six individual case studies from chapters five to eleven. Each case study aimed to improve and sustain efficiency in operating theatre start time performance with one study focusing specifically on establishing an anaesthetic pre-operative assessment service in neurosurgery following analysis of start time performance in this specialty.

The studies were analysed to determine the interventions that resulted in improvement and the factors that contributed to sustainment in practice. Implementing changes in practice requires a systematic approach to plan, test, implement, spread, and sustain improvements in the operating theatre department. A Quality Improvement (QI) methodology provides a systematic approach for implementing changes in practice. This chapter will describe the QI methodology applied in each of the six case studies presented.

Using a QI approach to implement improvements is highly recommended. The HSE Quality framework (2016) recommends the use of " formal well-established methods when attempting to improve the quality of care and service", HSE (2016, p.15). Alderwick et al. (2017) refer to the variety of QI methodologies that can be used stating that "there are a range of different methods and tools, such as Lean, Six Sigma and the Institute for Healthcare Improvement's Model for Improvement that can be used in healthcare". They suggest that there is "no clear evidence that one approach is superior to others". Dixon-Woods and Martin (2016) concur and recommend that "it is important that the method chosen is applied consistently

across an organisation. Therefore, using an explicit quality improvement method, and adhering to it strictly, are vital".

This supports the use of formal QI methods when making changes in practice. The same QI approach was followed in each case study which is recommended in the literature above. Consistency of approach enhances knowledge of the method and development of skills through repeatedly applying this QI approach in practice. As mentioned by Alderwick et al. (2017) there is a variety of QI methodologies but there is no evidence that one is superior. Therefore, the methodology used fits well within the healthcare context and is used as the QI approach in Beaumont hospital, therefore staff are familiar with applying it in practice.

The quality improvement methodology applied is the Model For Improvement (MFI). This model was developed by Associates for Process Improvement and is used by the Institute for Healthcare Improvement (IHI) as their framework to guide improvement work.

Throughout chapter 4, a detailed description of the MFI will be presented. Key features of the model which include, the science of improvement which is the scientific basis that underpins the model along with three key questions and the Plan, Do, Study, Act (PDSA) cycle are described. The phases of the model are presented, describing a step-by-step approach as to how the systematic model is used in practice to implement quality improvements. Finally, the challenges to sustaining improvement and the guidance for achieving sustained improvements in practice are described.

4.2 Development of the Model for Improvement.

According to The Health Foundation (2013, p.16) "most of today's quality improvement methods were developed in industry and have been adapted for use in other sectors, such as health. These industrial approaches have been used within healthcare for the past 30 years". Many of the methods developed in the 20th century can be traced back to production quality control principles and are based on theories developed by pioneers of quality such as Edward Deming's, Joseph Juran and Walter Shewhart's works in the automobile industry. The Model for Improvement (MFI) is grounded in the work of these quality pioneers and has been

“implemented and shaped in practice by the staff and faculty of the Institute for healthcare improvement”.(Scoville and Little 2014, p.4).

In the healthcare context, Dr Donald Berwick, a Boston paediatrician, established the National Demonstration Project (NDP) on Quality Improvement in Health Care in 1987. He spent “time studying and working on the application of industrial models of quality improvement in healthcare and could see the possibilities of the application of industrial improvement method in healthcare” (Boaden et al., 2008 p.28). One pivotal outcome of the NDP was the founding of the Institute for Healthcare Improvement (IHI) in 1991.

The IHI’s early focus was on general quality improvement methodologies, tools, and education for health care professionals. In the mid-1990’s the IHI collaborated with the Associate for Process Improvements (API). Members of the API had worked with Deming, continuing to develop Deming’s PDSA cycle into the Model for Improvement, adding the three guiding questions and insisting on prediction as a necessary starting point for useful tests (Moen and Clifford, 2010).

> The IHI took the lead in promoting and translating industrial quality improvement methods to healthcare practitioners in a determined effort to close the chasm between unreliable common care practices and the evidence-based guidelines emanating from medical science. The scientific method has evolved, based on the learning from its application within healthcare practice. (Scoville and Little 2014, p.23)

The reason for choosing the MFI methodology to implement quality improvements in the subsequent case studies is because it was: developed specifically for healthcare. Overtime it has been shaped in practice by the IHI who have adapted it to blend with the culture and complexity of the healthcare context, it supports learning from experience and practice, it provides guidance on implementing changes in complex systems and is deeply rooted in reality. Scoville and Little (2014, P.6) describe the IHI philosophy “is to share their best ideas, in the belief that the field can most rapidly and effectively advance healthcare quality through collaboration, it has grown in an atmosphere of transparency and a spirit of’ all teach, all learn”.

4.3 The Science of Improvement

The Model For Improvement is based on the science of improvement, which is an applied science that emphasises innovation, rapid-cycle testing in the field, and spread in order to generate learning about what changes, in which contexts, produce improvements (Scoville and Little 2014, p.5). According to Langley G et al. (2009, p.75) the science of improvement is characterised by the combination of: a) expert subject matter knowledge and b) profound knowledge. Profound knowledge consists of; systems theory, psychology, statistics and building knowledge. Deming states that these “two types of knowledge are vital for developing changes that result in improvement”(as cited by Langley G et al. 2009, p.75).

4.3.1 Subject Matter Knowledge

Subject matter knowledge is acquired through formal and informal learning and reinforced with experiences. Ronald Heifetz as citied by Hilton and Anderson (2018, p.5) reinforces the value of subject matter knowledge when recommending to “give work back to people, to define and solve problems believing that people working closest to the system can often be in the best position to identify and solve problems”. Bennett and Provost (2015) describe Deming’s value of involving people in improvement efforts as the “the highest-level compliment to subject matter expertise in the pursuit of improvement” which recognises people’s ability in both identifying the problem and contributing to the solution.

In the context of operating theatres which is the setting for implementing process changes to improve efficiencies in start time performance, engagement and inclusion of staff who contribute to the perioperative patient pathway is essential to gain their understanding of the root cause of the problems that lead to suboptimal performance and the impact of inefficiencies on how they provide the service. They are best placed to provide this knowledge as they experience it in real life and most likely can offer solutions to the problems. Involving appropriate staff was key to all stages of the improvement cycle in each of the case studies undertaken. The appropriate team formation, building the willingness for change and including frontline staff feedback in each of the testing phases of the interventions is evident across all the studies.

4.3.2 Profound Knowledge.

Secondly, Deming refers to; profound knowledge which he states denotes deep insight that comes from: “the interplay of theories of systems, variation, psychology and knowledge. Such deep insight provides the knowledge to make changes that will result in improvements in a variety of settings”(as cited in Langley G et al. 2009,p.75). Scoville and Little (2014, p.12) in describing profound knowledge stressed that:

> Predictably successful improvement requires skills and knowledge that extend across a wide range of disciplines in four interdependent domains:
>
> 1) Appreciation for a System,
>
> 2) Theory of Knowledge,
>
> 3) Psychology,
>
> 4) Understanding Variation.
>
> In Deming’s words, Profound Knowledge provides a map of a theory by which to understand the organisations that we work in.

4.3.2.1 Appreciation of the system

The first domain of profound knowledge is appreciation of the system. A system as defined by Langley G et al. (2009, p.77) is an “interdependent group of items, people or processes working together toward a common purpose. The common purpose aligns the parts of the system, while interdependence considers the relationships and interactions among them”. Knowledge and understanding of how the system works or having an ‘appreciation of the system’ as Deming refers to it is an essential component in contributing to successful improvement.

Engaging in quality improvement, consideration needs to be given to the following:

- interdependence within the system,
- boundaries of a system,

- impact of previous solutions on current problems,
- constraints or bottlenecks within the system and
- acknowledging the 'central law of improvement; which means that every system is perfectly designed to deliver the results it produces (Langley G et al. 2009, p.78).

Efficiency and productiveness of operating theatres relies heavily on the pre-operative and post-operative theatre pathway. This was evident in the literature reviewed and is supported in the improvement studies undertaken. System awareness and understanding is fundamental to pinpointing process issues or constraints and the actions that affect start time performance at various stages in the patient pathway. It is helpful to know that previous attempts at improving theatre efficiency have been tried as this can be built on and will contribute towards knowing which type of change is required. This in-depth knowledge will also contribute to identifying potential unintended consequences in other parts of the system.

Each of the studies undertaken incorporates a wider system approach through involving staff from services that support the complete surgical pathway, for example: staff working in admission/registration and healthcare records departments, anaesthetic pre-operative assessment service, day case surgery ward and day of surgery service for elective inpatient admission were part of or contributed to the improvement teams throughout the studies. Furthermore, stepping out or process mapping of the stages in the patient pathway when opportunities for improvement were being identified enhanced the teams understanding of the wider system.

4.3.2.2 Understanding Variation

The second domain of profound knowledge is understanding variation in the process or problem being addressed. According to Langley G et al. (2009, p.75) Walter Shewhart was one of the pioneers in developing the theory to understand variation. To begin to measure variation, one must firstly plot data over a period of time. Langley (2009, p.79) adds that through analysing the trends in the data,

patterns can be observed. The data is either predictable or unpredictable. Statistical theory can be used to develop a means to differentiate between both. The method comprises two definitions which are:

a) Common cause variation: meaning causes are inherent in the process overtime, they affect everyone working in the process and all outcomes of the process. This is known as a stable process in statistical terms in that it implies that the variation only is predictable. In practice it means that improvement can be achieved only by fundamental change to the process (Langley G et al. 2009, p.80).

b) Special cause variation: causes are not part of the process or system all the time; they do not affect everyone but arise because of specific circumstances, The variation from one period to the next is unpredictable" (Langley G et al. 2009, p.80).

A process whose outcomes are affected by both common and special causes is called an unstable process. If the special causes for variation can be identified and addressed then the system becomes statistically stable, from here changes can be identified and implemented to improve performance. Shewhart developed the control chart method to determine whether variation in a system is dominated by common or special causes (Langley G et al. 2009 p.81).

Snee (2008) describes "statistical thinking as a philosophy of learning and action based on the following fundamental principles:

- All work occurs in a system of interconnected processes.
- Variation exists in all processes.
- Understanding and reducing variation are keys to success".

In the context of the improvement studies that will be undertaken, there is a need to understand performance specific to the areas being focused on. In all the studies, data was collected, plotted on a graph and variation analysed. This contributed

towards gaining knowledge on current performance for example, start times and if either common cause or special cause variation occurred. This was understood from collecting and analysing the causes for delayed start time for example to answer if there were common causes which could be addressed through quality improvement efforts. The purpose of measuring performance and variation continued throughout the improvement phases of testing changes in practice to determine if variation reduced and therefore performance improved.

4.3.2.3 The Human side of change

The third domain of profound knowledge is understanding the human side of change. Deming in his system of profound knowledge acknowledged the importance of the human side of change stating that all change occurs in human systems, in which people interact with each other(Langley G et al. 2009, p.83). Hilton and Anderson (2018, p. 5) stated that:

> For improvement to succeed, leaders need to understand and master the broad area of psychology and interpersonal relationships and acknowledge that people are a fundamental source of value regardless of their identity or position and it takes work and expertise to create a culture that respects and motivates them to meaningfully contribute to the solution.

This fundamental contributor to profound knowledge reinforces the importance of people that both contribute to the perioperative service and are affected by inefficiencies in the service being essential to understanding and solving process issues.

4.3.2.4 Building Knowledge

The fourth domain of profound knowledge is building knowledge. Langley G et al. (2009, p.81) explains that the greater the knowledge of the system and how it functions, the better the prediction and the greater likelihood the change will result in improvement. Scoville and Little (2014, p.12) stated that the:

> Theory of Knowledge refers to the development of practical knowledge of what works. It is grounded in predictions about the results to be achieved

> through system changes. Knowledge is gained through a process of stating a theory, making a prediction based on the theory, comparing observations with predictions, and revising or abandoning the theory accordingly. The explicit goal of the science of improvement is to increase such knowledge.

Skilfully building knowledge by making changes and observing or measuring results is the foundation of improvement. Langley G et al. (2009, p.82) claim that by:

> Repeating learning cycles, the theory becomes useful for predictions in future circumstances. The Plan, Do, Study, Act (PDSA) cycle which is part of the model for improvements approach to change supports repeated learning from tests of change carried out in practice.

In summary, the theory behind the science of improvement provides a foundation of continuous quality improvement. The science amalgamates subject matter expertise gained from the lived experience and learning of people working in the system along with knowledge and understanding of how the systems works, its processes, their interdependencies and boundaries of the process and the effect each part of the process has on the next. In addition, the use of measurement to understand variation assists in seeing where the problem affecting quality arises and guides the focus for improvement. The human side of change; recognises the value and importance of people in change, and how they need to be included, motivated, and supported in the adaptive change process. Finally, seeing quality improvement as a learning opportunity to examine what changes in what contexts result in improvement, this is achieved through building knowledge by repeated testing of changes in practice to determine what leads to improvement. This is the science behind the model for improvement.

In all the studies undertaken, involvement of frontline staff from the theatre department and the wider system and services that support theatre is well described. The use of both quantitative and qualitative data was used to measure baseline performance, analyse causes for inefficiencies and monitor the outcomes of changes in practice. The learning gained as each study progressed is used to

guide further improvement interventions for example following the first two studies, the knowledge on factors that were both impacting and improving start time performance led to spreading of this knowledge into two additional initiatives. This also demonstrates the will and commitment of frontline staff to making improvements in practice.

4.4 The Model for Improvement

The MFI incorporates three questions and the PDSA cycle. The combination of both is fundamental to making improvements. The three questions are:

1. Aim: What are you trying to accomplish?

2. Measurement: How will you know a change is an improvement?

3.Theory of improvement: What changes can you make that will result in an improvement? (Langley G et al. 2009, p.24)

The three questions draw from the science of improvement which the Associates of Process Improvement have built their quality improvement method on. Each question includes elements of the scientific model.

Question one: The aim of the improvement pulls in the subject matter expertise in identifying what needs to be improved; knowledge of the system, processes and problems which have been measured and grounds the aim in the context in which the improvement is intended.

Question two focuses on measurement and studying variation in the system. This is gained through collecting and analysing data which provides a deeper understanding of the problem and finally question three focuses on what changes can you make that will result in improvement. It involves predicting the change ideas that will lead to improvement in practice. It also builds a knowledge base, allowing better predictions and more specific and relevant tests of change.

4.4.1 Question 1. What are you trying to accomplish?

The intended outcome of an improvement project is articulated in the form of an aim statement which according to Bennett and Provost (2015) “should be time-

specific, measurable and define the specific population of patients, system or processes that will be affected". Furthermore, guidance from Green, De Kock and Provost (2019, p.8) recommends that good aim statements are "specific, measurable, ambitious, achievable, time-bound and relevant" , also commonly abbreviated into SMART aims.

Identifying a clear aim of the quality improvement initiative starts in the planning phase. An extensive study of a problem before the trial is attempted helps agree and articulate what improvement one is trying to accomplish. According to Provost and Murray (2011, p.5 and 6), investing time at this early stage ensures and supports the following:

1. A common understanding amongst the team of what one is trying to improve.
2. Providing a mechanism to think through all aspects of the proposed improvement.
3. Aides in the selection of the teams.
4. Helps in the selection of processes to be studied.
5. Clarifies the magnitude of the improvement project.
6. Defines the timeframe of the improvement work.
7. Reduce variation in activities from original purpose.
8. Identify the appropriate targets.
9. Create the will for change.

Once there is a clear aim for the improvement which is a summary of what the improvement is trying to accomplish, the next stage is to plan what measures will

be required to know if the changes made have been implemented and have resulted in improvement.

4.4.2 Question 2. How will you know a change is an improvement?

According to Green et al. (2019, p.7) this question in the Model for Improvement speaks to measurement. To know if the changes made have led to an improvement there is a need to produce measures that would demonstrate that the aim has been achieved. Firstly, a baseline measure of current performance prior to making any change in practice is necessary. As different changes are introduced, the impact of each change on the outcome measure can be visualised. An overall measure of the intended aim is known as an outcome measure. (Green et al. 2019, p.10).

To determine if the changes planned impacted on the outcome, a process measure provides this information. It is a measure of the introduction of the intended changes to determine which of the changes led to improvement(Green et al. 2019, p.10). This happens as changes are tested in the rapid cycle testing process. This is key for learning and building knowledge about what changes work in each setting and provides teams with feedback to see if the changes being taken are having the desired impact.

Although improvement is about making changes to processes and systems, measurement plays a key role in all improvement efforts. Provost and Murray (2011, P.6.) stated that “the purpose of measurement is for learning and not comparison”.

The MfI introduces us to the principle of testing out changes while monitoring outcome and process measures to determine if the changes are leading to an improvement before being implemented in practice. Testing also allows the necessary modifications to the original idea before it is made permanent. (Green et al. 2019, p.14)

Provost and Murray (2011, p.7) recommend “that as improvements are made over time, in order to facilitate learning and communication, measures should be displayed on run charts or Shewhart control charts”. Run charts as described by Green et al (2019, p.108) “are easy to produce, easy to interpret and enable

visualisation and understanding of the typical performance (median) of a process over time but the extent to which it fluctuates above and below this centre line".

4.4.3 Question 3 What changes can you make that will result in an improvement?

Bennett and Provost (2015) defined a theory of knowledge as:

> A view of what theory and ideas are empirically relevant for managing and improving the system of interest. In a practical context, this knowledge is best articulated as a testable prediction of the activities and infrastructure necessary to achieve a desired outcome.

More simply it can be referred to as the knowledge and beliefs that people have which has developed overtime from their experience of working in the system, understanding the quality problem that exists and how it could potentially be addressed. This becomes their theory and, in an effort, to improve the quality of a particular area, the improvement team identify changes that they predict will solve a problem. However, according to Langley G et al. (2009, p.15) "not every change will result in an improvement". Therefore, prior to any changes being tested in practice, the improvement team need to firstly examine and measure the process and problems affecting the system to confirm the actual problem.

With this knowledge, the improvement team identify some change ideas that they predict could potentially address the problem. This prediction creates change ideas that can be tested in practice. Green et al. (2019, p.10) refers to "the change ideas and predictions and suggests that this question in the model for improvement directs the thinking to changes that could be made that may help achieve the aim".

Developing a change that will help accomplish a project aim usually requires making a fundamental change to the system. Provost and Murray (2011, p.8) suggest that there are two types of changes, first order changes and second order changes. Examples of the types of changes that are required include:

> First order changes; changes that are needed to keep the system performing at current levels and, second order changes; changes that are needed to improve

the system or create a new system. Most improvements need second order changes because they require:

1. Design or redesign some aspect of the system.
2. Fundamentally alter how the system works and what people do in the system.
3. Often result in improvement in several measures simultaneously.
4. Have an impact that is felt far into the future. (Provost and Murray 2011, p.8).

The authors also point out “that the importance is not the size of the change but the impact of the change. Big improvements can often be realised by making small changes directed at the right part of the system”.

At this stage answering the three fundamental questions have been explored. There is a workable aim, greater insight into the problem has been gained and ideas for change have been put forward. A set of planned measures have been identified to determine if the change has resulted in improvement. Amalgamating the learning so far starts to build the theory specifically about the problem and the potential solutions.

In all the case studies there was a SMART aim developed and each of the three questions are answered. There is a description of the process problems affecting efficiency, the ideas that frontline staff put forward that they predicted would lead to improvement and baseline and outcome measures.

4.5 The Plan Do Study Act (PDSA) Cycle

Following the project planning and initial theory building phase the model for improvement uses the Plan, Do, Study, Act (PDSA) cycle as part of the framework for improvement. According to Reed and Card (2016), PDSA is one of the “many quality tools and methods that focuses on the crux of change which is translating of ideas and intentions into action. Changes are tested and amended through iterative PDSA cycle. Such changes comprise the content of improvement”.

The PDSA Cycle consists of iterative tests. Small tests of change are carried out in rapid cycles in the real work settings to learn which interventions result in improvement. A PDSA cycle is not limited to one test, it can take numerous PDSA cycles to confirm that an improvement has been achieved. 'As stated by Reed and Card (2016):

> The cycle tries small tests of change, in ramps of increasing scale whereby each cycle builds on the current knowledge about the changes being considered to answer specific questions required to implement the change into standard practice. It can take numerous small-scale changes to achieve the intended aim. This ramping up of PDSA's overtime can accumulate into large scale improvements.

The intended outcome of a PDSA is learning and informed action. Parry, (2016) states that the theory driven rapid cycles allow for formative evaluation to determine if a change is an improvement. The authors identify the core components to be evaluated following each test to determine the outcome of the changes: for example: "achieving the intended goal, content theory, execution theory, data measurement, learning and dissemination". These components will maximise the chances that the results and learning derived from the evaluation of an improvement initiative can be clearly communicated. These five core components tie in with the model for improvement.

1. Goal- What are you trying to accomplish?
2. Content theory and logic model- What changes will we make that will result in improvement?
3. Measurement and Learning- How will we know that the change is an improvement?

The PDSA cycle consists of four steps: the planning phase which involves: planning the details of the study including the implementation and measurement plan and making predictions about the outcome. The second phase, the 'Do' phase involves conducting the plan and collecting data, thirdly, the study phase , initial

predictions are compared against the data collected and finally the fourth stage involves taking action based on new knowledge in the act phase (Provost and Murray 2011, p.8).

4.5.1 The Planning phase

Prior to running a test of change in practice, Provost and Murray (2011, p.9) recommend that the planning phase should include decisions on:

- Who will schedule and conduct the test?
- Exactly what changes will be made?
- Where will the test be conducted?
- When will the test be done?
- What data will be collected to answer the questions in the cycle?

4.5.2 The 'Do' phase

During this phase, the test is performed, and the data is collected and analysed.

4.5.3 The Study phase

During this phase, a comparison of the predictions with the results of the data take place.

> This point is where learning occurs and where the degree of belief about the change can be increased. If the results of the test match the predictions, our degree of belief about our knowledge is increased. If the predictions do not match the data, we have an opportunity to advance our knowledge through understanding why the prediction was not accurate (Provost and Murray 2011, p.10).

4.5.4 The Act phase

In the Act phase, the team must decide on the next course of action. This includes, according to Provost and Murray (2011, p.11) asking:

1. Is further testing needed to increase the degree of belief about the changes?
2. Do alternative changes need to be tested?
3. Do we need to learn about other implications?
4. Do we need to modify the proposed change or develop an alternative change?
5. Are we ready to implement the change on a full-scale basis?
6. Should we drop consideration of the proposed changes.

The decision on the next course of action will develop the next PDSA cycle. After each cycle, knowledge is built by an iterative process allowing the theory to be revised. With this new theory, a subsequent cycle commences and the process of making predictions, testing the predictions using data, improving the theory based on results, making predictions based on the revised theory and so on (Provost and Murray 2011, p.8)

Iterative testing is a feature of each of the case studies. The steps in the PDSA cycles are detailed with between three and seven PDSA's in each study. It helped plan the changes and placed emphasis on the importance of each part of the cycle which is recommended in the literature. As the studies progressed, knowledge was built on using PDSA as a method for testing changes prior to implementation.

4.5.5 Challenges with PDSA's

Reed and Card (2016) cited one of the main problems encountered in using PDSA is the "misperception that it is simple to apply and that it can be used as a standalone method". The authors recommend that PDSA's need to be used as part of a suite of quality improvement methods, the exact nature of which may be

influenced by the broader methodological approach that is being followed (eg, model for improvement, lean). This brings us back to the importance of detailed planning incorporating all elements of improvement science prior to testing changes in the PDSA cycle.

Furthermore, the authors warn that a:

> successful PDSA process does not equal a successful quality improvement process or project. In complex systems, the process of change rarely progresses in simple linear ramps. The conduct of a PDSA can reveal other related issues that need to be addressed in order to achieve an important goal (Reed & Card, 2016).

Three of the six studies experienced the challenges of making change in complex systems. Improved performance was affected by issues which were outside of the level of responsibility or authority that the improvement teams had to influence decisions. Referring to improvements as “rarely progressing in linear ramps” as described by Reed and Card (2016) connects with the studies undertaken. Three of the case studies were more straightforward, predictable and were carried out in a planned fashion. They did require, frontline staff commitment, the development of good change ideas and a constant focus but there was a certainty that once all these elements were in place that the improvement was more achievable.

Reed and Card (2016) recommend that:

> While frontline staff with little training or support may successfully address some quality problems, the complexity of many problems demands greater organisational support, with direct involvement of senior managers to facilitate adequate planning.

The presence of senior managers outside of the theatre department and services involved in the improvement initiative was not a strong part of the study. The complexities faced were due to balancing both scheduled and unscheduled care demands. The hospital was under pressure to manage both demands and risks

and decisions were prioritised a senior level. This is discussed in greater depth in the relevant case studies.

4.6 Implementation of improvements in practice

Once the change is working well, the guidance from the Green et al. (2019, p.96) is to “increase the scale and test again, as this happens, further adaptations may be required. The change in scale may automatically expose the change to a range of new conditions”. At this point if no further adaptations are required the authors advised to:

> deliberately expand testing to include different conditions and make as many adaptations as necessary. Essentially, you continue to run tests, adapting and increasing the scale and testing under different conditions until there is good evidence that the change results in improvement (Green et al. 2019, p.96).

It was difficult to create different conditions in three of the case studies that could be described as challenged by the complexity of the system. The main problems related to lack of post-operative beds or trolleys. In reality, normal work requires that the system keeps running as efficiently as possible even when changes are being tested in practice. Creating a problem scenario like this would have affected the start of theatre and would not have been accepted in practice. It was three months into the first project before the problem of bed availability was affecting the first study.

At this point the change is ready to implement. Provost and Murray (2011, p.11) describe this requirement for scaling up testing stating, “that over the course of the improvement journey, small tests are refined until they reach the stage that the changes are deemed an improvement and can be implemented in practice”. They differentiate between cycles for testing and cycles for implementing change suggesting that cycles for implementing change require: “processes to be developed to support the change as it is being implemented” which according to the Green et al. (2019) could entail providing training in a new skill or process.

Furthermore, according to Provost and Murray (2011) “failure is not expected when the change is implemented”. The multiple cycles of testing allows knowledge to increase and minimise risk and consequences of failure as early “teething problems” have been ironed out through adaptation and retesting (Green et al., 2019).

However increased resistance to the change is to be expected as the changes affect more people, Green et al. (2019, p.176) stated that one of the fundamental differences between testing and implementing are: “everyone now needs to conform and sign up to the new way of working” They add that it is no longer optional or just for those who volunteered to be part of the testing practice. The benefits of staff being involved and fully engaged in the testing and review process and the benefits of changing are clearly visible; can make implementation an uneventful step. They recommend that: “supporting staff through this transition, keeping communication channels open, reiterating the benefits of the change, and giving reassurance to those performing new duties is an important role for managers during this time”.

Provost and Murray (2011,p.) point out that cycles for implementing change take longer than cycles for testing change, Green et al. (2019, p.176) concur and add that:

> the scale of tests will be larger during the implementation phase, stating that when making complex changes, implementation may involve further testing using the PDSA cycle. This testing is not designed to establish the worth of the changes, but to ensure they are working effectively for everyone, every day of the week.

The case studies undertaken did not put the same emphasis on implementation as was the case for testing if the changes led to improvement in the PDSA cycles. This led to some of the improvements not being sustained in the long term. There is reference within the studies of the move from testing through PDSA’s to implementation being fluid without formal acknowledgement that the process or practice was going to change and how this would be achieved and sustained

permanently. Although many changes in practice were embedded, the systems of standardising practice, making the change the new way of working, the support required to do this, monitoring performance and observing for unpredictable and untested process changes were not in place in the first three studies. The knowledge gained regarding the requirements for implementing and sustaining improvements in practice was applied to the latter studies which were better supported to implement and embed changes in practice.

4.7 Sustaining Improvements in practice

The NHS (2007) define sustainability as:

> when new ways of working and improved outcomes become the norm. Not only have the process and outcome changed, but also the thinking and attitudes behind them are fundamentally altered and the systems surrounding them are transformed in support. As a result, when one looks at the process or outcome one year from now or longer, one concludes at minimum that it has not reverted to the old way or old level of performance. Further, it has been able to withstand challenge and variation; it has co-evolved with other changes in the context, and perhaps has actually continued to improve over time.

However, change and improvement takes effort with Maher et.al (2013) stating that “too often changes are not sustained over time, suffering from ‘initiative decay’ or ‘improvement effect evaporation. This results in a waste of resources”. Therefore, to sustain improvements in practice several factors have been identified which contribute to this. These factors have been grouped under the following headings.

4.7.1 Supporting the human side of change.

Green et al. (2019)identified the need:

> to connect with hearts as well as minds as initially when change is introduced, not all members of staff necessarily embrace it, but they are

> usually compliant. They understand what is expected of them and their behaviour conforms to these expectations. However, they may not have internalised the “rightness” of the change.

The authors recommend “that individuals need frequent supervision and monitoring to maintain the new system, however, this is resource-intensive and is unlikely to be sustainable”. They offer potential solutions which may be advantageous for example if “the change is described in such a way as to engage with individuals’ values and beliefs, they are much more likely to persist in the change irrespective of whether anyone else is watching”. They also point to the need to celebrate stating that “it is important to reinforce successful behaviour with recognition and have a marker to remind people that the new way is better than before”.

Silver et al. (2016) suggest that:

> even when quality improvement methods are properly applied, the success of a project still depends on contextual factors adding that some improvement leaders believe that the challenge is not starting improvement work but rather continuing the work after the initial enthusiasm has dissipated.

As a result, the authors recommend “the use of improvement huddles which are regular 10- to 15-minute meetings among all staff to create an opportunity to support the continuity of the interventions in practice, to anticipate problems and review current performance”. They suggest that regular meetings should occur daily to weekly, which is necessary to maintain the rhythm and momentum for sustained improvement.

The IHI Sustainability Framework recommend that people need to be informed about the change and trained and supported in the new way of working stating that sustainability “requires that everyone in the system knows what to do and why, how, and when to do it, and how to adjust when necessary” (Scoville et al., 2016).

4.7.2 Standardising work

Green et al. (2019, p.177) recommend that “there is a need to make it hard not to follow the new process, this can happen in a few ways for example, build in constraints, affordances, and differentiation”. Secondly, they include:

> the need to remove the old systems, believing that even though members of staff may be overtly supportive of the new system, some may be tempted to resort back to the old, especially soon after implementation when the previous system still feels comfortable and easier to use (Green et al. 2019, p.178).

In addition, Silver et al. (2016) recommends that “standard work includes a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities.” In summary standardising the new way of working requires the change to become embed. According to Green et al. (2019, p.178) this includes “making measurement systems permanent, developing standard operating procedures to reflect the changes in practice, teaching new approaches when inducting newly appointed staff, including new roles in job descriptions, incorporating new activity into individuals’ personal objectives, etc”. This activity may be introduced as part of implementing a change.

4.7.3 Continue to measure

Green et al. (2019, p. 178) highlighted the need to continue to measure, stating that ***“***this is so important in providing an objective means of informing the team if they are managing to sustain the improvement”. They add it is enough to “continue tracking the outcome measure as this indicated if you are achieving the original aim advising that “if this starts to deteriorate you can investigate further”.

Silver et al. (2016) refers to the importance of visual management in sustaining improvements recommending “the use of a performance board to communicate the outcome of quality improvement efforts to staff”. They add that it “displays the aim or strategic priority at the top of the board, and the rows depict monthly/quarterly

and daily/weekly results (using run charts), along with sources of variation and the current improvement activities to address them".

Scoville et al. (2016, p.7) referred to quality control stating that:

> this involves monitoring the system of production for stability, detecting emerging process problems and taking steps to address them (special causes)**.** It is fundamentally about ensuring that a process remains stable ("in control") over time and is performed by those closest to the process.

Scoville et al. (2016, p.8) illustrated the continuous cycle from PDSA to Standard work, Doing, Monitoring and Adapting (SDMA) throughout the improvement journey. Finally, the NHS Scotland recommended that measurement should "focus both on numbers and on experiences which ties into the need of keeping communication lines open throughout the cycle of improvement"(The Scottish Government, 2010).

4.7.4 Develop robust systems

Previously when describing PDSA cycles, it was noted that changes should be tested under a range of conditions before they are implemented. However, Green et al. (2019, p.179) stated that:

> new systems are not created around exceptions but around what usually happens. This means there are usually some exceptional conditions under which the change may not perform optimally or of which we have no previous experience. For this reason, they advocate the need to "build contingencies for known exceptions.

Systems may need to be modified or additional processes to be introduced to ensure productivity during these times. They suggest that to avoid difficulties when operating new systems in these exceptional circumstances, this needs to be planned for, warning that "there is a risk the new system appears worse than the old one and staff decide to revert to old practices"(Green et.al, p.176). Scoville et

al. (2016, p.8) referred to this action as “adapting” as part of the SDMA cycle for sustainability. It requires constant monitoring to pre-empt problems and subsequently testing changes through PDSA cycles to stabilise the improvement. This reflects the continuous improvement cycle, whereby the culture for constantly looking for opportunities to improve becomes embedded.

4.7.5 Plan to continually improve.

The healthcare environment is complex and is constantly changing. According to Green et al. (2019)

> new processes can quickly become old processes that do not support the levels of performance experienced. Having learned how to set goals, identify change ideas and measure to see if changes are an improvement, there is a need to continually apply these techniques in response to patients’ needs, known best practices and policy changes.

Along with applying a methodology, it is paramount to create a culture that supports continuous improvement. This is evident in the use of words such as ‘constant effort’ and ‘rework’ which implies that systems are complex and require an ability to continuously adapt to constant changes. The Japanese named their approach to continuous quality improvement ‘kaizen’; the continuous search for opportunities for all processes to get better (Mondoux 2017).

Furthermore, the author believed “that continuous quality improvement is an institutional philosophy and culture which relies on the ongoing and everlasting need to embrace change processes to improve patient care”. The key emphasis is on the continuous approach to make healthcare better through understanding the system and processes that require improvement, identifying problems leading to poor quality, making improvements, adapting to constant changes inherent in complex systems whilst acknowledging that this effort and mindset is required to create a culture for quality improvement. It requires continuous personal effort which incorporates the human side of change in the improvement culture.

Similar to a weak implementation plan, developing a sustainment plan was not undertaken with the same effort and focus as the planning and testing stages of the earlier case studies (1,2 and 3). It did impact on sustaining improvements in practice which is discussed in each of the studies. There has been a significant body of knowledge specifically relating to implementation and sustainment gained from the application of an improvement methodology in practice across six initiatives in the one setting, which has contributed to the theory and practice of making improvement in healthcare.

4.8 Conclusion

This chapter has outlined the chosen improvement or change methodology that will be applied in practice to the case studies that set out to make improvements in operating theatre efficiency. The chapter begins with the history of the MFI and how improvements in industry contributed to its establishment and evolvement. Following this a step-by-step approach to implementing quality improvements in a complex system like healthcare are described. In summary, it consists of three fundamental questions which provide the groundwork and preparation for the study followed by the PDSA cycle which tests change ideas in practice to determine if the changes result in improvement. Implementation and sustainment of improvements in practice is a recognised challenge, the chapter finishes with guidance to achieve sustained improvements.

The next section will present six individual case studies in which the MFI will be used to describe the improvement process. The case studies will be described using Standards for Quality Improvement Reporting Excellence (SQUIRE) guidelines,(Ogrinc et al., 2016). The SQUIRE guidelines provide a framework for reporting new knowledge about how to improve healthcare.

CHAPTER 5- CASE STUDY 1

Introduction to case studies

The next section presents six case studies which are examples of improvement initiatives undertaken in the perioperative setting. The studies represent a sample of initiatives undertaken between 2016 and 2019. The six studies have been chosen to include for the following reasons: a) willingness within specific theatre teams to improve performance, b) the duration of the studies which allowed for evaluation of long-term sustainment, c) a mix of service and specific team interventions and d) a sample of complex and non-complex improvement initiatives.

Case studies one and two (chapters 5 and 6) came from consultant surgeons with a keen interest and willingness to improve theatre performance in the early stage of the improvement programme. This allowed the studies to run over a sufficiently long enough period to evaluate if interventions were sustained in practice and what factors contributed to achieving this. Learning about sustaining improvement is a key focus of this study and is incorporated into the research question.

Case studies three and four (chapter 7 and 8) follow on from the first two studies. The learning gained from the first two studies with individual consultants was spread widely into the day ward and the DoSA service. These studies were included to demonstrate how small changes can be scaled up and have greater impact in improving efficiency and quality in healthcare within services that relate to theatre. These initiatives led to improved performance across theatres not just on one theatre list.

The findings from a review of start time delays in the DoSA service in 2019 showed that the focus needed to return to specific teams as the impact of improvements on the service in general was positive, efforts needed to turn to working with individual teams. The Plastic surgery team was a service where opportunity existed to make improvements and a group of consultant Plastic surgeons were interested and committed. This led to the commencement of a pre-admission service which is presented in case study six (chapter 10).

The fifth case study represents an improvement initiative in the neurosurgical service. Three of the twelve theatres in the department are allocated to planned neurosurgical procedures along with access to the emergency theatre as required. There were three improvement initiatives underway in this service, these include: a) walking patients to theatre, b) implementing daily multidisciplinary communication huddles, and c) establishing a pre-operative assessment service. The latter was chosen to present in case study five. It reflects a multidisciplinary initiative involved in establishing a new service and is done so over a long enough period of time to learn about numerous change cycles and long-term sustainment.

The studies that were chosen to reflect the change process over a one-to-three-year period, include improvement initiatives that are complex and more straight-forward, both of which are important to demonstrate and learn about the challenges and difficulties to making improvements in the quality of healthcare and also that improvements are achievable and can be spread when the right conditions exist and a consistent approach to change is implemented.

Additional improvement initiatives ran concurrently with the studies presented. Examples include: the Vascular service who focused on streamlining pre-operative pathways for complex procedures, the Colorectal service contributed to the improvement efforts in the DoSA service, and a significant piece of work was undertaken to implement a reporting tool into the electronic theatre system which produced weekly performance analysis of efficiency measures. This work extended to include a capacity and demand analysis which was used to guide planning for nursing resources. These three studies were not included as they did not progress into sustained implementation of changes in practice although they were hugely beneficial in supporting findings on the causes for inefficiencies, collating data and using data for planning of the theatre service to meet demands for complex and long theatre procedures.

5.1 Introduction to case study 1

The launch of an efficiency improvement programme in the operating theatre department in mid-2016 created an opportunity to work with clinical teams to improve areas of inefficiency that impacted on the productive use of theatre capacity. Discussions with clinical and support staff regarding inefficiencies

experienced on the ground commenced. Quantitative data on key performance indicators of efficiency in theatre for example: start time, cancellation rates and utilisation were collected and analysed. A combination of qualitative and quantitative findings led to the commencement of focused improvement initiatives in the operating theatre.

This case study presents a quality improvement initiative in the Breast and General Surgery service. The service specialises predominantly in breast cancer, thyroid, and adrenal gland surgery. Common general surgical procedures such as hernia repair and gall bladder removal are also performed. Most operations in this specialty are urgent in nature with a target for cancerous breast surgery procedures being performed within two weeks of diagnosis. An average of four patients are planned for surgery on each theatre list which is scheduled for eight hours. Most patients are admitted on the morning of surgery to either the Day of Surgery Admission unit (DoSA) or the surgical day ward.

Frequent delays at the beginning of the theatre day were common. Data analysis of start times supported this showing a median delay of 16 minutes per theatre list with 21% of theatre lists starting on time. Delays in start time were caused by: -

- Inappropriate first patient scheduled,
- Change of list order on the morning of surgery,
- Patients not medically admitted on time,
- Patients required consent and blood tests on the morning of their operation.

The impact of late theatre starts are threefold: (i) it leads to overruns into the evening which are un-resourced, (ii) unused theatre capacity (under-utilisation) and (iii) cancellations. Delayed start times result in unproductive work for clinical teams. In this case repeated phone calls between the theatre department to the wards and the medical team to determine if the patient is ready for surgery was common.

Over recent years the greatest challenge for this service has been the cancellation of non-urgent patients due to unavailable bed capacity and late notification of bed availability on the morning of surgery for patients admitted to the day surgery ward

and DoSA unit. Theatre utilisation consistently runs at an average of 85% unless there are cancellations due to bed availability.

A consultant surgeon in this service had a keen interest in improving theatre start times. Together with the consultant anaesthetist and theatre nurse manager they reviewed data on theatre start time performance and causes for delays and proposed to trial changes to the current pre-operative process to improve theatre start times. This led to the commencement of an improvement initiative focused on improving start time performance. The theatre team identified two interventions that they believed could contribute to reducing delays. These included: -

1. A review of medical charts of patients scheduled for surgery on the following week by the consultant anaesthetist, consultant surgeon and theatre nurse manager to identify potential clinical risks and plan pre-operative management to ensure the patient was clinically ready for surgery.
2. Identify an appropriate non-complex patient who was pre-operatively assessed by the pre-assessment service to be scheduled first on each list.

5.2 Methodology

An improvement methodology: The Model for Improvement (MFI) developed by the API and implemented by the (IHI) was applied in practice to plan, test, analyse and implement the improvement interventions. The MFI incorporates three questions and the PDSA cycle. The combination of both is fundamental to making improvements.

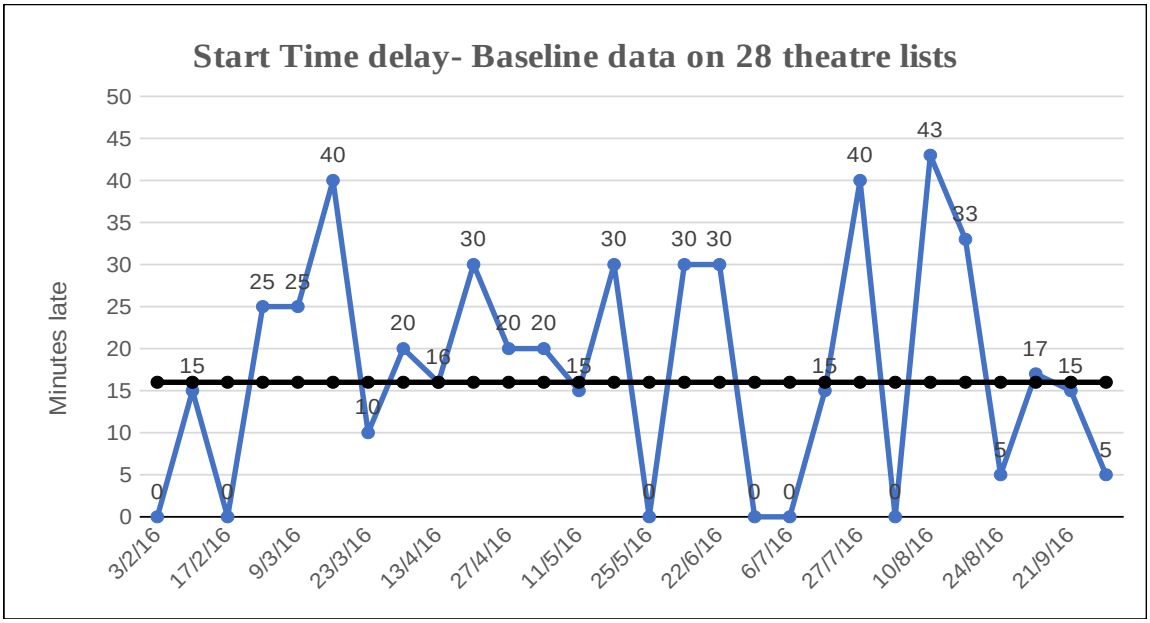
5.2.1 Question 1. What are you trying to accomplish?

The aim of the study was to reduce start time delay for the first patient scheduled on the weekly theatre list in the General and Breast Surgery service from 16 minutes to 5 minutes between October 2016 and May 2017.

5.2.2 Question 2. How will you know a change is an improvement?

To answer this question requires measurement to compare baseline data with post intervention data to determine if improvement in start time has been achieved. Retrospective data measuring eight months of theatre start times was collated showing a median start time delay of 16 minutes. Subsequently an exercise, mapping the patient's journey through theatre on three theatre lists was carried out with the team. It highlighted causes of delay in patient flow throughout each day, which included: inappropriate first patient scheduled, change of list order on the morning of surgery, patients not being medically admitted on time and patients requiring consent and blood tests on the morning of their operation as being the main reasons for delay. Figure 1 shows the start time delay in minutes over an 8-month period with a median delay of 16 minutes.

Figure 1: Case Study 1. Theatre Start time baseline data.



Baseline data was used to compare the impact of interventions on start times. The measurement plan sets out the data that will be collected during the project.

5.2.2.1 Measurement plan

1. Theatre start time delay in minutes on each weekly theatre list will be recorded on a run chart once interventions are being tested.
2. Process measures include:

a. Occurrence of the weekly review of the planned theatre lists by the clinical team,
b. Identification of a first patient on the theatre list,
c. Adherence to list order by the registration, nursing, and medical team.

3. The causes for further delays will be reviewed as part of the PDSA cycle.

5.2.3 Question 3. What changes can you make that will result in an improvement?

This question asks what changes will be tested in practice to reduce start time delay. It requires the input from frontline staff closest to the problem including representation from all services and or departments who contribute to the patient process.

5.2.3.1 Team formation

To achieve the aim and the objectives of the improvement project, an improvement team which originally consisted of the consultant surgeon, anaesthetist and nurse manager expanded to include day ward nursing, admissions, registration staff and a theatre secretary. The team attended a brainstorming session where they reviewed the quantitative data on the causes for delay, which combined with their knowledge and experience of delayed start times led to identifying the following changes that they believed would lead to improved start times:

5.2.3.2 Change ideas

1. Clinical theatre team (surgeon, anaesthetist and nurse) to review patient healthcare record prior to surgery to gain knowledge on:

- Clinical status,

- Surgical procedure,

- Co-morbidities,

- Potential risks,

- Specific requirements on the morning of surgery, i.e., medication, treatment.

2. Scheduling of an appropriate first patient who is anaesthetically reviewed, ready for surgery and is identified to all staff involved in patient preparation.

3. Focus on escorting patients to theatre at 08:10 am on the morning of surgery.

5.3 Testing changes in practice

At this stage, the team had identified the changes that they predicted will result in improvement. The next phase in the quality improvement cycle involves testing out interventions in practice to determine if they result in an improvement. The PDSA (Plan, Do, Study, Act) cycle is a framework to test the change ideas. The PDSA process is described in detail in chapter four. The following are the PDSA cycles for this case study.

5.3.1 PDSA cycle 1

PDSA Improvement Cycle1	
Aim: To improve communication and pre-operative planning by the clinical teams in theatre and in the services involved in patient preparation.	
Prediction: The team predicted that having an identified first patient that was 'ready for theatre' would result in a smooth flow on the morning of surgery which would help with improving start times. Concerns regarding bed availability were raised as this would impact on patients being able to go to theatre on time.	
Plan	1. A clinical team consisting of surgeon, anaesthetist and theatre nursing manager to identify an appropriate first patient on the following week's theatre list based on the type of surgery, pre-operative preparation required and patient's clinical status. 2. Medical team to confirm the planned theatre list for the following week with the admission staff to ensure the patient had appropriate notification and a referral to anaesthetic pre-operative assessment organised. 3. Day services nurse manager to adhere to the identified first patient when preparing patients for surgery on the morning of their operation. 4. Admission staff to inform the patient of the time for admission on the morning of surgery to ensure they arrived on time. 5. Registration staff on the day ward to register the 1st patient on the theatre list first instead of on a first-come-first served basis. 6. Medical team to start admitting the patient at 07:30 on the morning of surgery. 7. Ward staff to walk/transfer the patient to theatre at 08:10 on the morning of surgery. 8. Theatre staff to transfer the patient into the anaesthetic room at 08:30. 9. Theatre Start time and issues that arise will be discussed with the team following each list with a plan for formal review after 4 weeks.
Do	Commencing on the 5th of October 2016, The actions above were carried out by the relevant team member
Study	**Data review** Theatre start time delay of 0,5,10 and 40 minutes on the first 4 theatre lists of the trial. Overall, this

	was a median delay of 7.5 minutes, an improvement from 16 minutes. **Team feedback/ Process change reviews.** 1. The schedule for the following week was discussed by the clinical team and patient requirements pre-operatively were agreed. 2. An appropriate 1st patient was identified on each list. 3. It was not always feasible for the 1st patient scheduled to be a straight-forward day case as the breast surgery patients had to attend the radiology department for pre-op intervention. 4. The surgical team were finding it difficult to have the healthcare records available for review a week ahead of surgery. 5. Once the patients were ready for surgery they were escorted to theatre on time. 6. The reason for the long delay on week 4 was due to the patient arriving late to the hospital. 7. Start times were not impacted by bed delays. 8. The team were motivated to continue to work on addressing the issues and improve theatre start time.
Act	1. To address the problem of some day-case patients being unsuitable to be scheduled 1st on the theatre list, explore if in-patients admitted on the morning of surgery to the (DoSA) unit could be scheduled first on the theatre list. 2. Explore if the surgical directorate could assist with a solution for having healthcare records available each week for clinical team review. 3. Reiterate to the patients the importance of arriving on time. 4. Make data on start time performance visible in theatre. 5. Explore how access to planned dates could be used to trigger a pre-operative assessment appointment.

5.3.2 PDSA Cycle 2

PDSA Improvement Cycle 2	
Aim: Expand the project to include DoSA patients as potential first cases on a theatre list depending on the type of procedure being performed. To find a solution for the clinical team to access healthcare records a week ahead of surgery.	
Prediction: As there were frequent delays in patient readiness on the DoSA unit, the theatre team were concerned that DoSA patients scheduled first would not be ready.	
Plan	1. Invite the DoSA nurse manager to the project team meeting with the purpose of planning to schedule a patient from this service 1st on the theatre list if a day case patient is not suitable. 2. Meet with the surgical directorate to explore options for healthcare records to be delivered to theatre for clinical review. 3. Meet with admissions staff to discuss the information that is given to patients regarding their admission time and to reiterate to patients the time they should arrive at. 4. The medical team to demonstrate and give access to the electronic planning system they use to allocate surgery dates to admission staff. This information will initiate a pre-operative assessment referral.
Do	1. The DoSA nurse was invited to the subsequent team meeting. 2. A graph of start time performance was displayed on the wall in the theatre scrub room. 3. The team continued to work on scheduling the first patient that they wanted to operate on first. 4. The medical team continued to work on arriving to the surgical day ward at 07:30 to admit the

	patient. 5. DoSA nurse identified the following requirements to support patient preparation: • Access to the theatre scheduling system to identify which patient was planned first for surgery. • Healthcare records to be delivered to the unit by 12md on the day prior to surgery. • Patients to be pre-registered on the hospital system on the day prior to surgery.
Study	**Data Review.** During November and December 2016, 4 consecutive theatre lists started on time, no delays were experienced until week 5 when there was a 23-minute delay and the reason for this was not recorded. Overall, from the start of the project this was a median delay of 0 minutes, an average delay of 8.7 minutes and 80% on-time starts. **Team feedback/ Process change reviews.** 1. The medical team were arriving earlier to the DoSA unit. 2. Patients were ready on time except for those that were not anaesthetically pre-assessed. 3. Displaying the start time performance was motivating to the team. 4. The changes being made to the processes in both the day ward and DoSA were impacting on start times in other general lists in the same theatre. On-time starts for all lists 5 days a week in the specific theatre increased from 28% to 60%, with a median delay in start time reducing from 10 minutes overall for the theatre to 0 minutes. 5. To date issues regarding bed availability were not experienced for first patients listed which was a concern at the start of the project.
Act	1. Work with the DoSA staff to streamline processes pre-theatre for all patients. 2. The impact of improvements experienced in other theatre lists was very positive, and potentially created an opportunity to spread improvements. Discussions with the relevant stakeholders on progressing with a project to spread the improvements was required.

5.3.3 PDSA Cycle 3

PDSA Improvement Cycle 3	
Aim: To address challenges regarding the availability of healthcare records for weekly clinical team review and work with DoSA nurse manager to streamline the process for preparing patients for this theatre list.	
Prediction: The team believed that other options for accessing healthcare record existed and with the positive engagement with the DoSA service that improvements experienced could be spread across other theatre lists.	
Plan	1. Discuss with the theatre secretary the possibility of ordering healthcare records to be delivered to theatre for clinical team review. 2. The theatre secretary to have access to the medical team's electronic theatre planning system which indicates which patients records to request for review. 3. Organise a review of the process from the time the patient arrives in DoSA until they go to theatre to identify opportunities for streamlining the process.
Do	1. The theatre secretary started to request healthcare records for review. 2. The DoSA process from the time the patient arrives until they go to theatre was reviewed for a sample of patients.
Study	**Data Review.** Throughout January, February, and early March 2017 three of nine theatre lists started on-time (33% on-time starts) with a median start time delay increasing to 15 minutes.

	Team feedback /Process changes review 1. The system for chart review was embedded. 2. Greater attention was being given to scheduling an appropriate 1st patient. 3. Medical team were admitting patient's on-time on the morning of surgery. 4. Displaying data created regular discussion about start time performance. 5. There was insufficient capacity in anaesthetic pre-operative assessment for all DoSA patients to be reviewed. 6. By February 2017, due to increasing unscheduled care activity there were hospital-wide restrictions on the number of scheduled patients being admitted. This led to: - Cancellations on the morning of surgery due to lack of bed availability which disrupted patient flow, - Late confirmation to proceed with the first case. This issue was predicted as a problem at the start of the project.
Act	To improve planning of elective activity the team invited a representative from the patient flow department to help with identifying an appropriate first patient for each general theatre list. This patient would be a confirmed admission and would have an allocated bed post-surgery. The problems experienced were not limited to this service, it impacted across all theatres whose patients were admitted on the morning of surgery. A solution will require a system-wide approach for similar theatre lists with the aim that it will enhance performance for this improvement initiative. Concurrently the team planned to embed the positive changes that had improved start time performance.

5.3.4 PDSA Cycle 4

PDSA Improvement Cycle 4	
Aim: Continue to embed changes that led to improved performance. From a system-wide perspective involve the patient flow department in planning of 1st patients scheduled on the theatre list prior to the day of surgery.	
Prediction: The team believed that the local changes they had made could be sustained but were concerned about the ongoing impact of bed availability.	
Plan	1. Continue to embed and review practice changes. 2. As part of a larger initiative engage with the patient flow team on planning theatre list order ahead of morning of surgery.
Do	A meeting was scheduled with the patient flow manager, day surgery service manager, DoSA and theatre nurse managers.
Study	Data Review. Between March and end of July 2017, 63% of lists (n=16) started on-time with 81% starting within 5 minutes. Team feedback /Process changes review 1. Practices were well established. 2. The team were very positive about the improvements in practice. 3. Bed availability was not an issue during this time, but the team did recognise that this would likely change in the winter months, however they were willing to continue with practice changes.
Act	Continue to embed the changes that led to improved start time performance and spread the learning to other services.

5.4 Implementation

Implementation of the following practice changes were agreed in July 2017.

1. Weekly review by the consultant anaesthetist, surgeon, and nurse manager of upcoming patients' healthcare records to identify potential clinical risk, pre-operative requirements and appropriate first patient.
2. The theatre secretary to request healthcare records in advance of weekly clinical review.
3. The secretary and admissions staff access the electronic schedule to plan pre-operative assessment.
4. The DoSA and Day ward nurse manager review the theatre schedule to identify the first patient to be prepared on the morning of surgery.
5. Patient registration details updated on the hospital admission system and relevant paperwork delivered to the wards the day prior to surgery.
6. Weekly start time performance will be reviewed locally in theatre.
7. Monthly updates/ huddles will provide an opportunity for review of issues as they arise.
8. Data on start time performance will be updated monthly and displayed in theatre.
9. Education of the practice changes to ensure new medical staff are informed will take place in July (following medical staff change-over).

5.5 Spread of Improvement learning

Learnings from the initial stages of this study highlighted the need to review the processes for both day case procedures and for elective inpatients admitted on the morning of their surgery to the DoSA unit. The processes in both services were reviewed specific to this general/breast surgery theatre list. However, they impacted on patient readiness and on- time start on other theatre lists. There was a natural spreading of improvements. Staff in theatre reported improvements in the timing of patient readiness across all theatres which created momentum to start looking at process improvement projects in both the day ward and DOSA. The day

case project and DoSA project are presented in subsequent case studies. In summary, the changes that were spread across other specialties included:

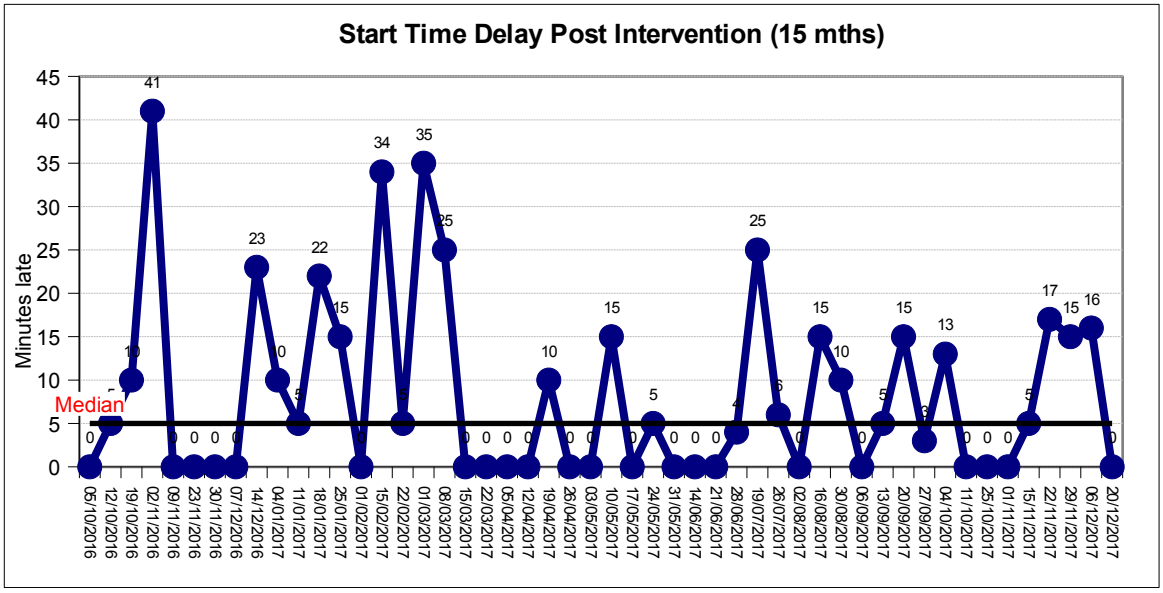
1. Circulation of the planned theatre list a day ahead of surgery,
2. Patient's healthcare records delivered to DoSA by 12md for the following day's theatre list,
3. Patient registration paperwork completed the day prior to surgery and delivered to DoSA,
4. A focus on the patient being walked to theatre at 08:10 from DoSA and Day ward.

5.6 Sustaining Improvements

Fourteen months post project commencement (December 2017), a review of start time performance demonstrated that, overall, throughout the duration of this improvement project from October 2016 to December 2017 (15 months) start time delay reduced from a median of 16 minutes to 5 minutes. Figure 2, demonstrates the start time performance on each theatre list over the 15-month period, showing:

- Median start time delay of 5 minutes, down from 16 minutes pre-intervention.
- 42% on-time starts.
- 60% theatre start within 5 minutes.
- An improvement in September and October led to a reduction in start time delay to a median of 3 minutes with 71% of cases starting within 5 minutes.
- Throughout November and December 2017, start time delay increased to a median of 10 minutes due to an increase in unscheduled care activity impacting on bed confirmation and cancellations on the morning of surgery.

Figure 2: Case study1. Theatre Start time delay post intervention.

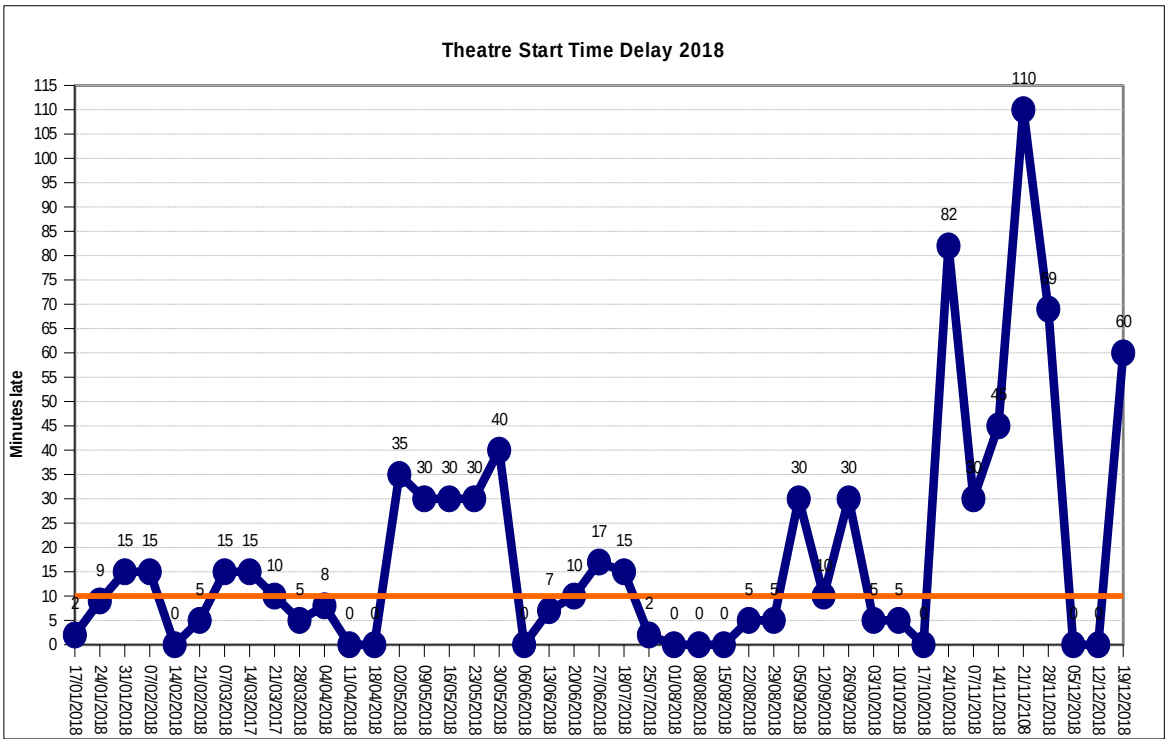


5.7 Sustaining Improvements long-term

At the end of 2018, two years post commencement of the improvement initiative and 12 months post project completion, the consultant surgeon reported that start time delays had increased. It was noted that there were delays with healthcare record availability on the morning of surgery. At this stage, the project had ended, however the weekly review of patient's healthcare records by the clinical theatre team to plan upcoming cases continued. This led to identifying an appropriate first case. All patients (day case and inpatients) were admitted to DOSA on the morning of surgery, the process for preparing patients was well embedded and the drive to escort patients to theatre on -time continued.

Figure 3 below demonstrates the start time delay throughout 2018. This shows an increase in delay from 5 to 10 minutes and a reduction in on-time starts within 5 minutes which was the goal of the project from 60% to 40%. It was still an improvement from the pre-intervention phase when median start time was 16 minutes and start time within 5 minutes was 29%.

Figure 3: Case study 1. Theatre start time delay 12 months post project end.



5.8 Evidence of Continuous Quality Improvement

Referring to chapter four (section 4.8) sustaining improvement, one of the recommendations to achieve sustained improvement is to continue to monitor performance and variation, have communication systems in place to identify issues/slippage in performance and proactively adapt to changing circumstances. This learning led, in early 2019, to the multidisciplinary team revisiting start time performance and reviewing the issues causing delays.

A review in January 2019 of patient readiness in DoSA showed that 37% of delays were bed related, the remainder were due to patient preparation. The improvement team regrouped and mapped the patient process over 4 weeks (4 theatre lists) in February 2019. The median start time delay between February and March on 7 theatre lists had increased to 40 minutes. The findings showed the main causes of delay were:

1. Patients' healthcare records were unavailable in DoSA on the morning of theatre.
2. Late medical admission.
3. Change of list order.

4. Inappropriate patient scheduled 1st on the theatre list.

1 of the 4 theatre lists started on-time. The findings were fed back to the team. It was noted that bed delays were not an issue on any of the lists over the four weeks. Discussion regarding healthcare record availability highlighted the problem that although healthcare record review by the clinical team continued, the chart was not delivered to DoSA on the afternoon prior to surgery and therefore not available on the morning of surgery. This led to the next improvement cycle.

5.8.1 PDSA cycle 5

PDSA Improvement Cycle 5	
Aim: Address the issue of healthcare records not being delivered to DoSA before the morning of surgery. An appropriate first patient to be scheduled first and list order to be adhered to by the medical team	
Prediction: The team predicted that the issue with healthcare records could be addressed and with strong consultant leadership that timely admission of patients and adherence to list order could be achieved	
Plan	1. A Physician Associate (PA) for the surgical team to confirm theatre list order with the consultant surgeon and anaesthetist 3 days ahead of the theatre date. 2. Theatre secretary asked to deliver healthcare records to DoSA post team review on the day prior to surgery. 3. Consultant surgeon to speak to their team about timely admission of patients, agreeing that the team should be available at 07:30 to do this.
Do	By April 3rd, 2019, the tasks above were in place, data on theatre start times was collected and reviewed by the team.
Study	**Data review,** The delays in starting between week 1 and week 4 were: 0, 26, 20, and 27 which was a median of 23 minutes, a reduction from 40 minutes. **Team feedback; Reasons for delay:** a) Week 1, no delays, b) Week 2, delay was due to the team having to attend to an emergency on the morning, and therefore arrived late to DoSA, the patient required consent to be signed, drug prescription to be charted and medical admission to be completed, c) Week 3, late medical admission, d) Week 4, 1st patient cancelled due to bed unavailability; 2nd patient scheduled required full work up on morning of surgery. 2. Patient's medical notes arrived on-time to DoSA each week. 3. Findings were discussed with the team members who expressed that there are constant issues having patients ready for theatre on time and felt that a pre-admission pathway for patients may help. This means that an agreed and appropriate 1st patient presents to the hospital within a few days of their surgery to have their admission completed. 4.The team discussed the challenges in achieving and sustaining improvement due to the variety of delay factors arising.
Act	1. Discuss the possibility of trialling a pre-admission pathway with the consultant surgeon. 2. Display performance data in theatre and record causes for delay and solutions that are being tested. 3. Identify issues as they arise on the day, by holding a 'huddle" to review how the day went.

	Following this, new interventions or tweaks to the process can be tested. This links with rapid cycle testing which is a principle of the improvement methodology. 4. Plan for sustainment of improvements.

5.8.2 PDSA cycle 6

PDSA Improvement Cycle 6	
Aim: Explore the possibility of introducing a pre-admission pathway for the first patient on each list with the consultant surgeon.	
Prediction: Pre-admission requires the patient to make an additional visit to the hospital pre-theatre to have a complete medical and nursing admission completed, the team felt that this may be unfair on the patient especially if they had to travel a long distance.	
Plan	1. Discuss the concept of a pre-admission pathway for the first patient scheduled with the consultant surgeon. 2. Hold a huddle to review start time and discuss issues affecting start times on each surgery day. 3. Record start time and delay reasons on graphs displayed in theatre.
Do	1. In May 2019, the PA discussed the suggestion about trialling a pre-admission pathway for the first patient with the consultant surgeon. 2. An issue chart along with a graph showing start time performance was being developed. 3. A weekly review of 'how the day went' started to happen. 4. The IHI Sustainability Framework was reviewed to guide the sustainability of the improvements.
Study	**Data Review,** Minutes late starting between week 5 and week 11 were: 0,16,10,15,5,15,8 which was a median delay of 10 minutes and an overall reduction from 40 minutes. a) Week 5, no delay. b) Week 6, the patient was late arriving to the hospital. c) Week 7, there was a delay sending for the patient. d) Week 8, the patient was unwell and needed treatment. e) Week 9, no delay. f) Week 11, the patient was late arriving to the hospital. **Staff Feedback/Process change reviews.** 1. There were no issues with the patient's medical chart being available or delays with the team arriving on time to admit the patient. 2. The delays were patient related and due to medical reasons. 3. The consultant felt that the team should continue to work towards streamlining the admission process on the morning instead of starting a pre-admission pathway which would require the patient attending the hospital for an additional appointment. 4. Scheduling of the most appropriate 1st patient was agreed 3 working days ahead of the theatre list between the consultant and the PA. This information was communicated with the medical team and a plan to ensure that a member of the medical team was available to admit the 1st patient on time.
Act	July 2019 1. The PA to organise a medical team huddle on the afternoon prior to surgery to discuss list order, patient requirements pre-op and agree the medical staff member that would be allocated to admit the patient at 07:30 on the following morning.

	2. The PA agreed to take on a co-ordination role for the improvement project and would be supported by an improvement facilitator in the QI process.

5.8.3 PDSA cycle 7

PDSA Improvement Cycle 7	
Aim: Assign medical team members to cover both DoSA and inpatient wards and issue the theatre schedule with the identified appropriate 1st patient to all team members three days prior to surgery date.	
Prediction: The team predicted that attending the huddle would provide the opportunity to plan the patient's admission on the following morning was feasible and would reduce pressure on the morning when inpatients needed to be reviewed.	
Plan	1. PA to co-ordinate a team huddle on the afternoon prior to surgery, where medical team members will be assigned various roles for the following morning: for example, which doctor would admit the patient in DoSA and who would look after the inpatients on the wards. 2. PA to set up a group email to update all team members of the plan for surgery, specifically the list order, identifying the right 1st patient 3 working days prior to the operation date. The timing of this was beneficial as a new medical team had started to work in the service. Providing this level of education about the theatre schedules would be important for sustaining the improvement work so far.
Do	On July 17th the 1st team huddle was held, and the PA sent a group message to the team informing them of the list order.
Study	**Team feedback; Reasons for delay:** a) Week 14 delay was due to patient clinical issues, b) Week 15 No delays, c) Week 16 No delays, d) Week 17 Patient needed an ECG, e) Week 18 Anaesthetist was covering 2 theatres
Act	1. Update the weekly start time on the run chart in theatre and record delay reasons. 2. Hold a monthly huddle to review progress.

5.8.4 PDSA cycle 8

PDSA Improvement Cycle 8	
Aim: Examine variation in start time and get an accurate understanding of factors causing delay i.e., prior to or after arrival in theatre reception as this will guide the next area for improvement.	
Plan	1. Measure and record the causes for delay over the next 9 theatre lists (September and October). 2. Discuss the delays weekly with the theatre manager. 3. Review the findings in early November.
Do	Delay reasons were recorded and were grouped into common themes.
Study	**Data review,** Over the 8 weeks the median start time delay increased to 13 minutes. Of these 8 weeks, 3 major delays occurred which were outside the control of the team. The delays were due to bed issues and an IT issue. When the data was analysed and the areas within the team's control was measured the median delay was 10 minutes. **Team Review** The team were finding it difficult to reduce the delay below 10 minutes. They decided to revisit the

	concept of pre-admission pathway which was working well in the Plastic surgery service.
Act	Commencing December 2019, the team agreed to step out the process required to support pre-admission of the 1st patient on each theatre list.

Figure 4 below shows the data on start time delays from February to December 2019. Overall start time delay reduced from a median of 40 minutes to 13.5 minutes. Figure 5 provides a breakdown of the reasons for delay between April and December 2019. The team analysed this data and could see that some of the delay factors were outside of their control and felt that it was difficult within this context to achieve on-time starts continuously. At the end of 2019, the team agreed to re-explore establishing a pre-admission pathway to address patient readiness, pre-operative investigations, and anaesthetic assessment prior to the day of surgery. The learning from case study 6 (plastic surgery service) was applied in this service.

Figure 4: Case study 1. Theatre start time delay Sustainment phase.

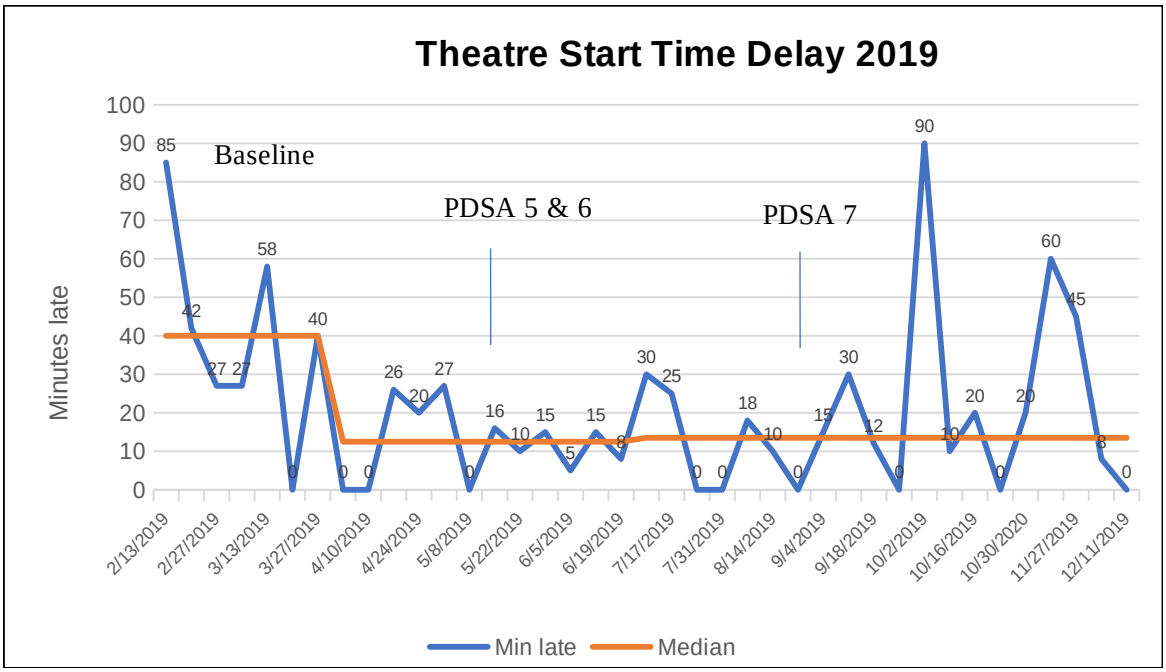
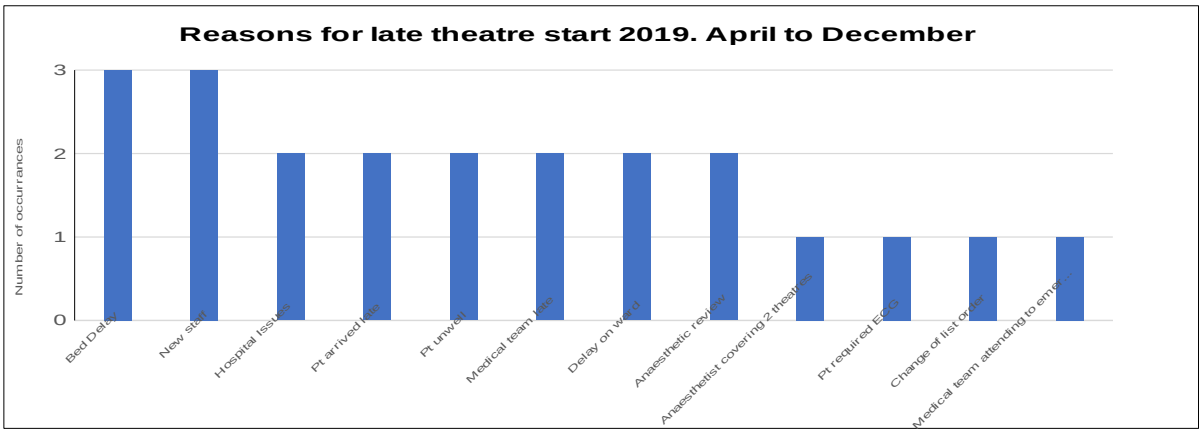


Figure 5: Case study 1. Reasons for late theatre start in sustainment phase.



5.8.5 Continuation of improvement

The team led by the PA continued to work on improving start time performance. In January 2020, the medical team revisited the concept of developing a pre-admission pathway whereby an appropriate patient who had a planned appointment in the hospital for example: x-ray or radiology intervention, and review in OPD on the days prior to their surgery attends the DoSA unit to have their pre-operative preparation completed. It is co-ordinated by the PA. Two patients were planned on the pathway which worked well. As this was getting underway, planned surgeries were cancelled due to Covid-19. It demonstrates the willingness and commitment to continuous improvement, and the ability to explore new ways of working to determine if they lead to further improvements in start time efficiency.

5.9 Learning from this study

This section will evaluate the case study under the following headings which relate to the research question which is:

Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

Firstly, the results of the study will be summarised. This will be followed by a tabled outline of the factors that contributed to improved performance, compared with those identified in the literature reviewed. In addition, the contribution of using an improvement framework will be presented, outlining how the process and steps in the model were followed. Finally, a review of how well the improvements were

sustained in practice will be discussed through a comparison with recommendations from the literature described in chapter four.

5.9.1 Results

A key learning in this study was the changes in practice did lead to improved start times. Between October 2016 and December 2017 start time delay reduced from a median of 16 to 5 minutes. There was variation in performance, some which could be addressed through the numerous change cycles. At the end of 2018, one-year post project completion, start time delay increased to a median of 10 minutes which was still an improvement on the pre-intervention performance, however variation increased for the last quarter of 2018. This led to a period of increased delays in 2019 following which renewed efforts reduced start time performance to 13 minutes by the end of 2019.

5.9.2 Interventions that led to improved performance

Outlined in table 5 are the interventions that led to improved performance. These can be summarised under the headings of: (i) ensuring an appropriate first patient scheduled on a theatre list, (ii) patient readiness, (iii) multidisciplinary planning to schedule an appropriate first patient.

Table 5: Case study 1. Factors that contribute to improved start times.

Concept	Factors that contribute to this/Evidence in practice	Evidence in literature
Identifying an appropriate 1st patient to be scheduled on a theatre list	1. Patient medically ready for surgery i.e pre-op needs identified from both an anaesthetic and surgery perspective within a sufficient timeframe to optimise the patient medically. 2. Pre-operative investigations on the morning of surgery i.e pts for specific breast surgery attend radiology on the morning of their operation making them unsuitable to be scheduled 1st on the theatre list. 3. Patient complexity; medically unwell patients may need treatment/interventions on the morning.	1. Javed (2013)-Golden patient
Patient readiness	1. Prior to the day of surgery the following is required: - Patient registration completed - Healthcare record available, -Healthcare record review by nurse on ward with potential problems identified and escalated to relevant staff, - Patient notified of timing of admission, - Patient scheduled on the electronic theatre system,	1. Overdyk (1998) 2. Panni (2013).

	- Review of the theatre schedule by ward nurse. 2. On the morning of surgery: - Patient registered 1st - Patient admitted by nursing staff 1st - Medical team admission within enough time for the patient to be ready for theatre on-time - Patient escorted to theatre on -time	
Multidisciplinary planning of theatre schedule	Discussion between the consultant surgeon, anaesthetist, and theatre nurse on the schedule of cases for the following week. The theatre manager, ward manager and medical team aware of the planned first patient This information was communicated on the day prior to theatre.	New finding

5.9.3 Application of the model for improvement in practice

The application of the improvement methodology will be reviewed and compared with the theoretical framework of the MFI which was described in chapter four. This will be described in table 6. It creates an opportunity to further advance the learning on the practical application of improvement methodologies and determine how they can contribute to successful quality improvement implementation and sustainment.

Table 6: Case study 1. Application of a QI methodology in practice.

Theory	**Evidence in practice**
Model for Improvement Three Fundamental Questions	**Question 1. What are you trying to accomplish?**
	The aim of the improvement initiative was clear and SMART. **S**pecific: Reduce theatre start time delays for patients on the general/breast surgery theatre list, **M**easurable: Theatre start time, **A**chievable: the team felt the changes in practice could be achieved and would lead to a reduction in overruns, **R**ealistic: the principles were in line with evidence in the practice changes required to make improvement in perioperative efficiency, **T**imely: Timeframes within which the change would be tested, and outcomes measured were clear in the aim statement.
	Question 2. How will you know the change is an improvement
	The impact of changes was continuously recorded to determine if changes made led to improvement. The MFI and Green et.al (2019) recommend process and balancing measures to be collected. Feedback was sought and acted upon, they were not measured quantitatively or displayed graphically. These measures are helpful to identify

	which changes are leading to improvement and the unintended consequences of the changes. For example, in each PDSA described there are several tasks in each cycle. It was not possible to identify which of the changes in practice is leading to improvement and which are negatively impacting on success. Recording balancing measures in this case the impact of practice changes in DoSA on other theatre lists was reviewed. This helped present the broader positive aspects of the change initiative, demonstrating the natural spread of improvement in practice.
	Question 3. What changes will you make that will result in improvement?
	Engaging with 'expert subject matter knowledge' across the episode of care for patients and examining the processes and interrelationships in the pathway of care helped articulate the problem and provided opportunity to come up with change ideas. The team, once established, had great strengths in this area and just needed to be brought together and focused on the aim of the project and the changes that could potentially lead to achieving this aim.
PDSA Cycle	There were eight PDSA cycles in this improvement initiative. - A clear aim of the specific cycle and the predicted outcome of the change were included. - There were several tasks involved in each PDSA and good evidence within the study phase of reviewing what happened both qualitatively and quantitatively. - When improvement in start time declined in 2018, further PDSA's were required to adapt to the slippage in performance, this demonstrates the need for continuous improvement as part of sustaining the outcome of the change. - The cycles of change initially were rapid, each week (after each theatre list) performance and feedback were reviewed.
Implementation	Formal implementation was not evident post project completion. The study seamlessly moved from testing to implementation. Many of the changes were well embedded, this happened naturally due to good understanding of the problem and well organised multidisciplinary planning of the changes. However, an implementation plan whereby new processes should be documented, including responsibility for adhering to the changes in practice, identifying and escalating issues affecting start times, monitoring performance and variation. When performance deteriorated, a system had not been established to monitor the impact and to escalate or solve problems affecting the service.
Spread	Learning from this study led to the improvements being naturally applied on all theatre lists for patients being prepared in the DoSA area. It resulted in improvement in start times on other theatre lists and created momentum to identify opportunities for improving efficiencies in the DoSA and theatre service.

5.9.4 Sustaining improvements

An evaluation of the study against the theoretical recommendations for sustaining improvement, outlined in chapter 4, section 4.8, is presented in Table 7 below. There was evidence of strong team commitment during the project. Measurement of performance and variation was not continued long-term which made it difficult to understand the root causes of delays in 2018. Standardisation of some of the new practices that led to improvement were well embedded, this needed to be formalised in the implementation plan. Awareness of the complexity of the system and the ability to adjust and adapt to changing circumstances needed to be incorporated into planning and testing of changes. It was dealt with at a system-wide level and is described in detail in case study 3 and 4. The team's reengagement and refocusing of their efforts in 2019, demonstrates their ability to continuously seek improvements. A process was required to monitor performance and variation, and to support, guide and facilitate continuous improvement. It highlights the importance of developing and managing a clear implementation and sustainment plan to support staff involved in the change process.

Table 7: Case study 1. Comparison of factors contributing to sustainment of improvements in practice with theoretical recommendations.

Theory	Evidence in practice (Case study 1)
Supporting the Human side of change	
1. Connect with individuals' hearts as well as minds so that team members internalise the "rightness" of the change, (Green et. al, 2019) 2. Remind people why work is needed" requires engagement to connect with people's emotional, cognitive, and behavioural styles. (The NHS Scotland. NHSS) 3. Celebrate to reinforce successful behaviour with recognition and have a marker to remind people that the new way is better than before (Green et. al, 2019) 4. To continue the work after the initial enthusiasm has dissipated	The improvement team were very engaged, motivated, and willing to improve theatre start times. It was a problem which they found very frustrating and believed in the importance of the change (rightness of the change). Strong connections were formed between the theatre team, DoSA and day ward service. The relationships formed led to spreading learnings gained. People began to understand the problem from a systems perspective (engagement and connection) When the project ended, a detailed implementation and sustainment plan was required. As this was not in place it was difficult when the team were faced with performance challenges (supporting staff through for example improvement huddles). In 2019 when efforts were refocused on re-establishing the team and problems affecting start times, the team were willing and committed to working on improving performance (winning hearts

the use of improvement huddles create an opportunity to support the continuity of the interventions in practice, to anticipate problems and review current performance. (Silver et al, 2016)	and minds, continuation of the work, reviewing performance)
Implement Standard work	
1. People need to be informed about the change, trained and supported in the new way of working so that everyone in the system knows what to do and why, how, and when to do it, and how to adjust when necessary (Scoville and Little 2016) 2. Standard work should include a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities. (Silver et al 2016) 3. Make measurement systems permanent. 4. Develop Standard Operating Procedures (SOP's)to reflect the changes in practice, 5. Teach new approaches when inducting newly appointed staff, (Green et. al, 2019)	One of the practice changes- weekly clinical review of healthcare records for upcoming patients planned for surgery continued a year post completion of the project. The implementation plan did not include a formal approach to standardise procedures for example: clear lines of responsibility for ongoing monitoring of performance, escalation of issues, applying a problem-solving approach and training of new staff on the process of preparing patients for surgery was not clearly defined. In 2019, when the improvement team was re-established, one of the team members (PA) agreed to take on this responsibility. There were changes to medical staff in mid-2017 and new staff were educated on the project and responsibilities each person had.
Continue to Measure	
1. Continue to measure, it provides objective information to determine if improvement is being sustained. (Green et.al, 2019) 2. Apply quality control which involves monitoring the system for stability, detecting emerging process problems, and taking steps to address them - special causes	There was continuous measurement of performance in the first year (2017) of the project. A system to measure performance in the sustainment phase was not developed. In 2019, when causes for delay were reviewed, it was found that the majority of delay factors could be addressed by the team.

(Scoville and Little 2016). 3. Apply a continuous cycle from PDSA to SDMA throughout the improvement journey. The cycle of improvement moves to: Standard work, Doing, Monitoring and Adapting (Scoville and Little 2016). 4. Measurements should focus both on numbers and on experiences which ties into the need of keeping communication lines open throughout the cycle of improvement. (The NHS Scotland)	
Develop robust systems	
1. Build contingencies for known exceptions, there are usually some exceptional conditions under which the change may not perform optimally or of which there is no previous experience. (Green et.al, 2019). 2. Adapt as part of the SDMA cycle for sustainability. It requires constant monitoring to pre-empt problems and subsequently testing changes through PDSA cycles to stabilise the improvement (Scoville and Little 2016).	When the project started one of the issues raised by the team was the problem with patients either being cancelled or delayed on the morning of surgery due to post-operative bed availability. This was experienced during the project. Changes needed to be tested under these conditions to see what actions were required. This became a system-wide issue which will be described in greater detail subsequent studies. In 2019 the team re-grouped and continued to undertake PDSA's to regain the outcomes originally achieved. It was difficult to reduce delays to 5 minutes which drove the team to commence a pre-admission pathway whereby patients attend pre-admission clinic prior to surgery to have a complete medical and nursing admission performed prior to the day of surgery.
Plan to continually improve	
1. Acknowledge and accept that the healthcare environment is complex and is constantly changing whereby new processes can quickly become old processes that do not support the levels of performance experienced (Green et. al, 2019). 2. Continue to apply techniques of setting goals, identify change ideas and measurement in response to patients' needs, known best practices and policy changes	For the duration of the project there was continuous effort to make and embed changes to practice that led to improvements. There was a great sense of achievement for the improvements made. Dixon -Woods in describing the challenges to sustaining improvement refers to the issue of 'projectness'. This is evident in this project. It had a start and an end. Once it ended, efforts were redirected to other initiatives in the theatre department described in subsequent studies. In 2019, when the team was re-established, they were reenergised, taking on responsibility to measure performance and variation, tested changes through PDSA's (4-8) and continued to look for new ways to improve their performance for preparing patients for surgery. This is the level of continuous and unceasing effort that is necessary, requiring support systems to be

(Green et. al, 2019). 3. Create a culture that supports continuous improvement, the continuous search for opportunities for all processes to get better. (Green et. al, 2019) 4. Understand the system and processes that require improvement, identifying problems leading to poor quality, making improvements, adapting to constant changes inherent in complex systems whilst acknowledging that this effort and mind-set is required to create a culture for quality improvement (Mondoux 2017).	established to drive and continue to create this culture.

5.10 Conclusion

This study led to improved start time performance, reducing delays from 16 minutes to 5 minutes between October 2016 and December 2017. This was achieved through an initiative whereby: a) the consultant surgeon, consultant anaesthetist and theatre nurse manager planned an appropriate first patient to be scheduled on each theatre list, considering each patients' clinical requirements, anaesthetic risk, and specific needs on the morning of surgery and b) co-ordination of patient readiness in both DoSA and day ward on the morning of surgery in-line with the theatre schedule. This multidisciplinary approach to planning the theatre schedule was a new intervention for this study.

Applying a systematic approach which in this study is the Model For Improvement (MFI) provided a framework to plan, test and implement the changes in practice that led to improvements in start time. Planning and testing stages of the study were followed with practice changes in multidisciplinary planning of the theatre schedule being well embedded throughout the project.

Long-term sustainment of the improvements gained was evaluated against the IHI sustainment cycle which includes standardising new practices, continuing to

monitor performance, and adjusting/adapting to process changes that affect performance. The evaluation identified the lack of a formal implementation and sustainment plan. With this learning, the team was re-established and were willing and eager to work on the current issues affecting start time to regain the initial outcomes achieved. The sustainment cycle was applied along with communication and feedback systems to discuss progress and delay factors which led to additional interventions being tested in practice. Improvements in start times were achieved during this phase demonstrating the teams focus on continuous quality improvement.

CHAPTER 6- CASE STUDY 2

6.1 Introduction

The establishment of a quality improvement initiative aimed at improving efficiency in the operating theatre led to six practice-based improvement initiatives being conducted in the theatre department. In conjunction with case study number one previously described, the improvement initiative presented in this case study was undertaken during the same time in the upper Gastro-Intestinal (GI) service between October 2016 and November 2017.

A complex procedure called Oesophagectomy which is removal of the oesophagus, usually because of cancer is scheduled regularly on a consultant's weekly theatre list. Frequency of the procedure is unpredictable as it is part of a treatment pathway for oesophageal cancer but on average 12 to 15 of these procedures are performed by one of the GI consultants annually. This type of procedure is referred to locally as a long complex procedure and inevitably leads to an over-run past 16:30 which is the staffed theatre finish time. The procedure duration ranges from 7 hours to 14.5 hours, on average it takes 10:20 hours.

Prior to the surgery date, patients will have been on a specific pathway involving a diagnostic surgical procedure and radiotherapy/chemotherapy treatment. Best practice for the initial post –operative care and management recommends care in the High Dependency Unit (HDU). Patients are admitted on the morning of surgery to the Day of Surgery Admission unit (DoSA). Due to the urgent need for surgery, these patients are not cancelled unless there are unforeseen medical reasons or a HDU bed is unavailable. This is very rare, and all efforts are made to proceed with surgery. In the past, the provision of an HDU bed was difficult at times but this has become less of an issue due to the opening of an HDU unit in the hospital.

The impetus for change is driven by the impact of theatre overruns and the inefficiency of late start times. The main causes for overruns were - firstly, the duration of the procedure, secondly; overbooking of the theatre list, frequently an additional patient was scheduled which increased the overrun further and thirdly; patients were not always ready for surgery on time on the morning of surgery. This

coupled with insufficient notice of the planned dates for surgery to the theatre department preventing the required staffing levels being planned.

A consultant surgeon, consultant anaesthetist and theatre nurse manager working in this service were interested in starting theatre at an earlier time of 07:30 so that theatre overruns could be reduced. The team reviewed data on theatre start time performance, the average duration of the various stages of the procedure i.e., anaesthetic time, positioning time and surgical time and overruns. A review of procedure times over nine theatre lists showed a median start time delay of 48 minutes. They proposed to trial changes to the current pre-operative process to improve theatre start times when an oesophagectomy procedure was scheduled. The following four interventions were tested: -

- Scheduling one long procedure only on the theatre list, preventing over-booking and therefore longer over-runs.
- Trialling an earlier start time of 07:30 to assess its impact on finish time,
- Pre-planning patient preparation, involving anaesthetic pre-operative assessment, gaining consent, and taking up-to-date bloods at OPD pre-operatively.
- Medical team notified theatre of planned oesophagectomy cases one week in advance to allow sufficient time to plan for staff to come on duty earlier to facilitate the early start and to support the planned overrun.

6.2 Methodology

An improvement methodology: The Model for Improvement by the Institute of Healthcare Improvement (IHI) was applied in practice to plan, test, analyse and implement the improvement interventions. The model for improvement (MFI) incorporates three questions and the PDSA cycle described in chapter 4.

6.2.1 Question 1. What are you trying to accomplish?

The aim of the project was to achieve an earlier theatre start-time for Oesophagectomy procedures at 07:30 to reduce procedure overrun to less than 3 hours between October 2016 and May 2017.

6.2.2: Question 2. How will you know a change is an improvement?

Data on late theatre start time and overruns was retrospectively collected on nine oesophagectomy cases between February and July 2016. It showed:

- a median start time delay for oesophagectomy procedures of 48 minutes/ average delay of 60 minutes
- a median finish time of 19:30, 3 hours of an over-run.

Figure 6 shows the median start time delay in minutes being 48 minutes. Figure 7 demonstrates theatre overrun at a median of 180 minutes or 3 hours. The two excessive overruns of 400 and 445 minutes were patient related and would not be the normal procedure time that would be seen on a consistent basis.

Figure 6: Case study 2. Theatre start time delay baseline data

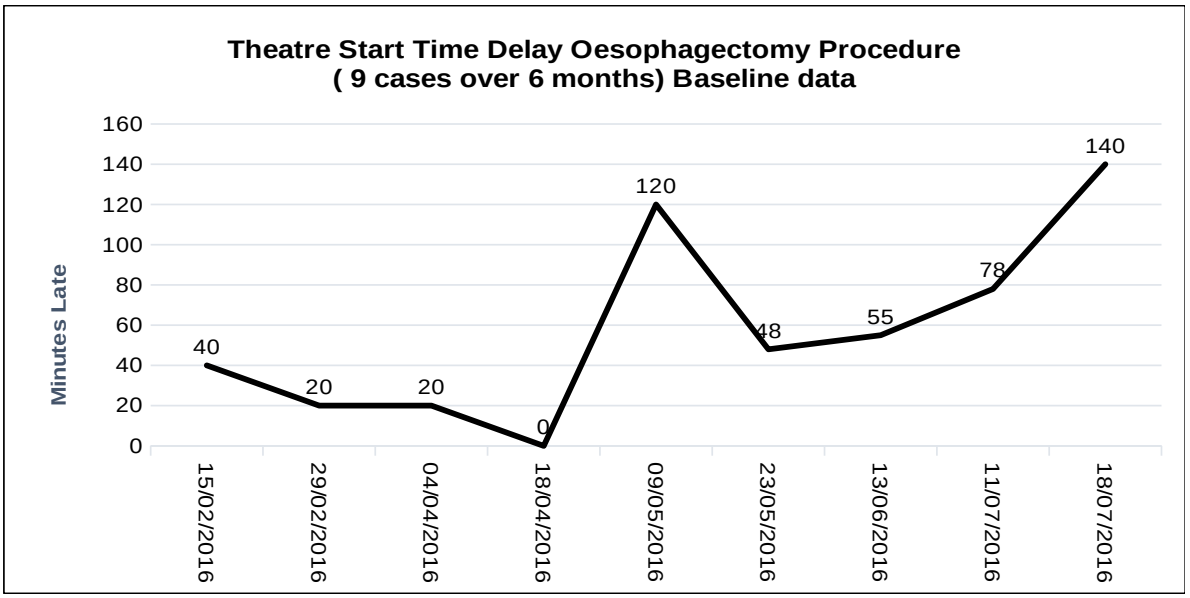
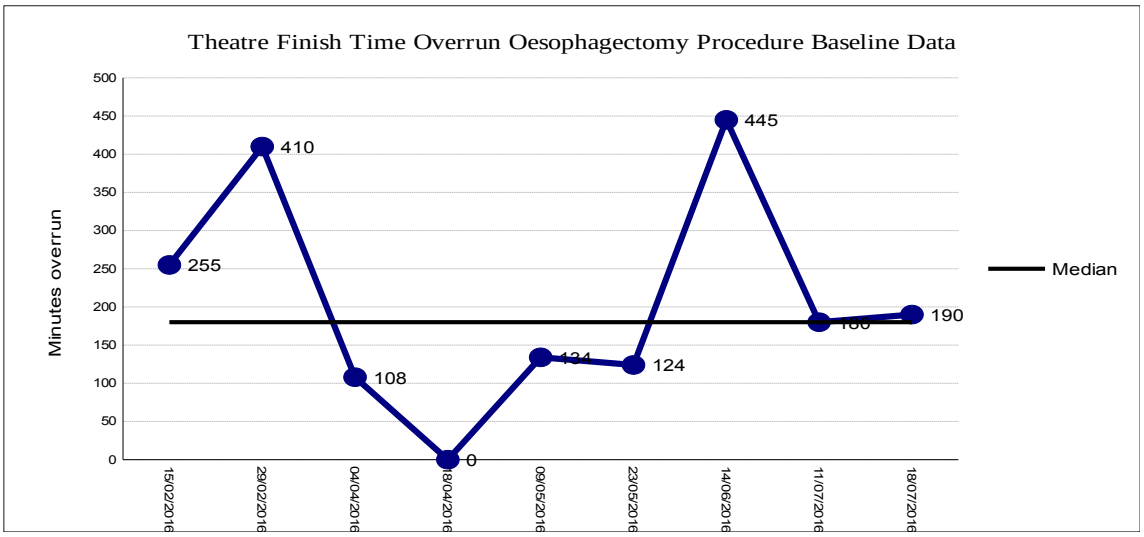


Figure 7: Case study 2. Theatre overrun baseline data.



6.2.2.1 Measurement plan

The following data was collected and reviewed throughout the duration of the study.

1. Theatre starts time delay in minutes on each theatre list whereby an oesophagectomy procedure is scheduled will be recorded on a run chart once interventions are being tested.
2. Theatre overruns past 16:30 will be recorded on a run chart.
3. Process measures include:
    a. Notification to the theatre department of planned procedure dates
    b. Scheduling of one procedure only to avoid overbooking of theatre list.
    c. Patient ready on the morning of surgery to walk to theatre by 07:20
4. The causes for further delays will be recorded as the testing cycles progress.

6.2.3 Question 3. What changes can you make that will result in an improvement?

6.2.3.1 Establishment of the project team

To achieve the aim and the objectives of the improvement project, the project team which originally consisted of the consultant surgeon, consultant anaesthetist and theatre nurse manager expanded to include, anaesthetic nurse manager in theatre, DoSA nurse manager, pre-operative assessment nurse, upper GI nurse specialist, admissions, and registration staff. The changes identified for the first test were:

6.2.3.2 Change ideas

1. Notification of surgery dates a minimum of one week ahead of surgery.
2. Appropriate nursing levels for early start and extended working day.
3. Patients to attend pre-operative assessment on the day of OPD visit when surgery plans are being finalised.
4. Perform pe-operative tests in OPD.
5. Patient documentation to be commenced on the day prior to surgery.
6. Patient ready to walk to theatre at 07:20.

6.3 Testing changes in practice

At this stage, the team have identified the changes that they predict will result in improvement. The next phase in the quality improvement cycle involves testing out interventions in practice to determine if they result in an improvement. The PDSA (Plan, Do, Study, Act) cycle is a framework to test the change ideas. The PDSA process is described in detail in chapter four. The following are the PDSA cycles for this case study.

6.3.1 PDSA cycle 1

PDSA Improvement Cycle1	
Aim: Early notification and pre-operative planning of patients to facilitate an earlier theatre start time of 07:30 instead of 08:30 (normal start time) to determine if an overrun of 3 hours could be reduced	
Prediction: The team felt that an earlier start time could lead to a reduced overrun but had concerns that the patient may not be ready on time on the morning of surgery.	
Plan	The improvement team planned the following actions to be completed in advance of the first trial of an early theatre start. 1. Medical team to communicate planned dates for oesophagectomy cases with the theatre manager and the consultant anaesthetist a week in advance of surgery. 2. Nurse specialist to refer the patient for anaesthetic pre-operative assessment on the day of their OPD visit. 3. Pre-op bloods & consent to be completed prior to the morning of surgery in OPD. 4. Admissions staff to request the patient's healthcare records to be delivered to DoSA by 12 md on day prior to theatre. 5. Admissions staff to inform the patient to arrive at the DoSA unit at 7am on the morning of surgery. 6. Theatre nurse manager and anaesthetic nurse manager to roster staff on duty at 7am. 7. DoSA nurse to prepare the patient at 07:00 on the morning and escort the patient to theatre at 07:20 on the morning of surgery. 8. Consultant and medical team member to admit the patient in DoSA at 7am on the morning of

	surgery. 9. Consultant anaesthetist to commence anaesthetic administration at 07:30. 10. Review of outcome and process measures following each case with the theatre team. 11. Formal review with the improvement team planned.
Do	Commencing November 2016, the 1st patient for an oesophagectomy procedure was scheduled.
Study	**Data Review** Over the following 8 oesophagectomy procedures between November 2016 and February 2017, 1. 75% of the lists started on or before 07:30 with an average delay of 2 minutes (median 0 minutes). 2. The median finish time reduced from 19:30 to 16:55, a 2.5-hour earlier finish. **Staff Feedback/ Process outcomes** After each case, the team reviewed how the day had run. A formal review identified: 1. Feedback from staff was very positive and earlier finish time was good for staff morale. 2. A good system of notification of planned dates was in place, 3. Patients were arriving well prepared to the DoSA unit on the morning of surgery and were transferred to theatre by 07:15. 4. Medical and nursing staff were performing their individual roles in the process. a) Medical team arriving to DoSA at 07:00, b) DoSA nurse prepared the patient on-time, c) Theatre nursing had the theatre prepared/set-up and were ready to greet the patient when they arrived in the theatre department. 5. The theatre list was scheduled appropriately i.e., only one case per theatre list. 6. Changes to practices in patient preparation were automatically being applied across all specialties in DoSA, i.e., healthcare record arrival, patient registration, theatre schedule review and a focus on patient readiness.
Act	1. Embed and sustain the practices that had been put in place. 2. The theatre team agreed to review the impact of the earlier start time on staff rosters in 2018. 3.Continue to review performance on each list. 4.Organise a team meeting for March 2017.

Figure 8. Demonstrates the reduction in start time performance from a median of 48 minutes to 0 minutes on 8 theatre lists over four months. Figure 9 shows the reduction in overruns from a median of 3 hours to a median of 26 minutes.

Figure 8: Case study 2. Theatre start time post intervention.

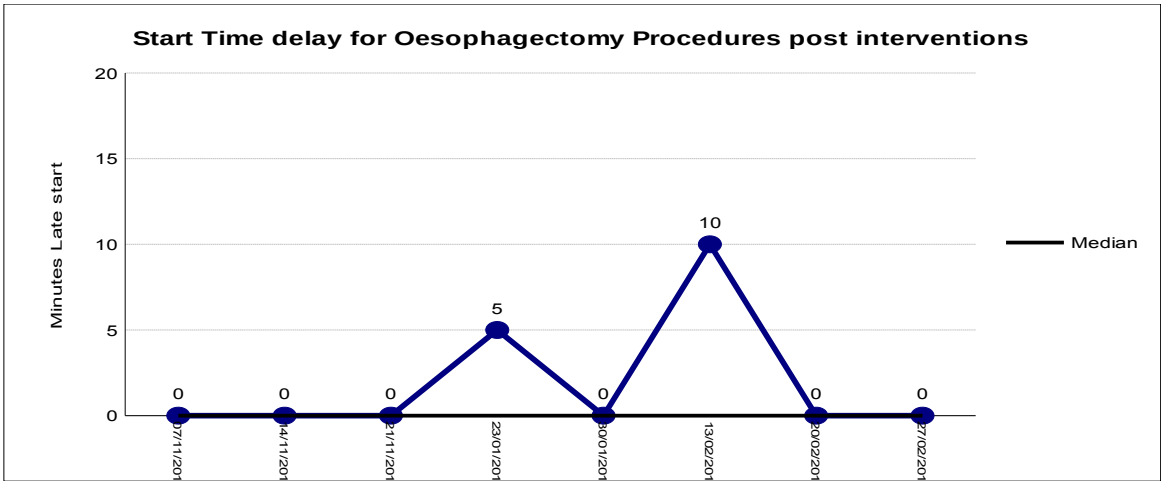
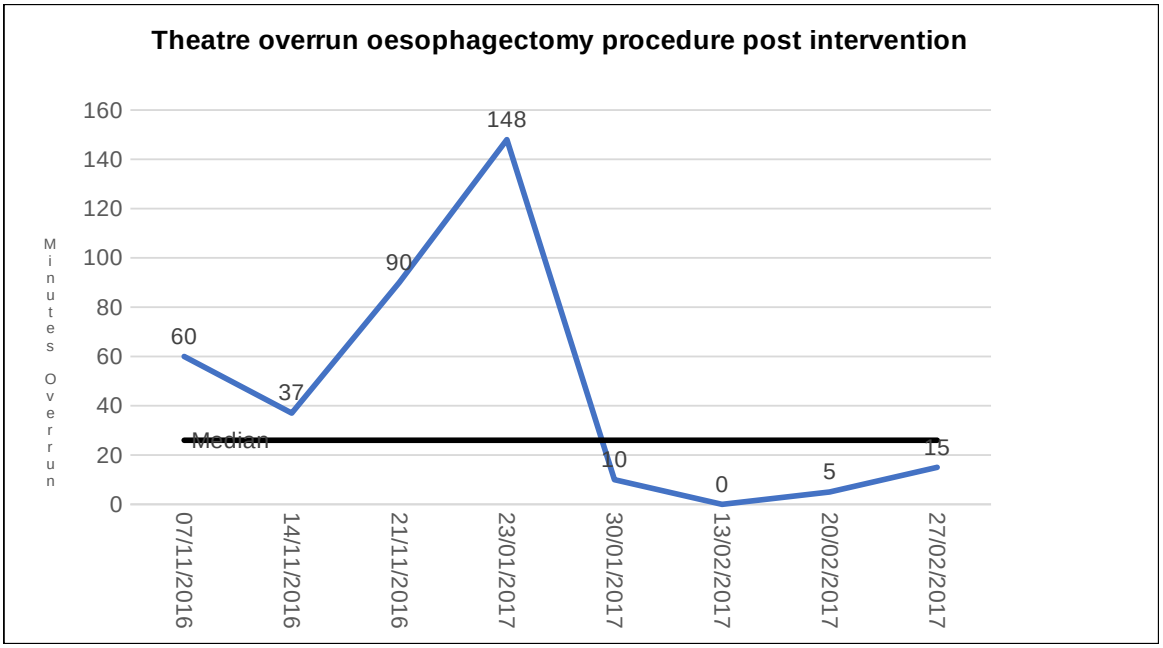


Figure 9: Case study 2. Theatre overrun post intervention.



6.4 Implementation.

In March 2017, the improvement team reviewed the process and practice changes. This was a well-planned initiative with strong clinical leadership. The initial changes made were well embedded in practice. Standard operating procedures detailing the process, each person's role and responsibility and a plan to monitor performance was not developed.

6.5 Spread of Improvement

This study ran concurrently with case study number 1. Learnings from this study reinforced the requirement to streamline the patient journey pre-theatre. Specific to this study was the drive to have the patient admitted and ready on the morning of surgery by 07:20. It reinforced the need for:

1 Healthcare records for all scheduled patients to be delivered to DoSA on the day prior to surgery.
2 Arrival times on the morning of surgery to be reiterated to patients,
3 DoSA staff to have access to the theatre scheduling system, allowing visibility on surgical procedures and list order,
4 Changes to the pre-registration process which streamlined practice on the morning of surgery,
5 Focus on early transfer of patients to theatre,
6 Relationships between DoSA and theatre staff developed which led to improved communication and awareness of each department's role in contributing to theatre efficiency,
7 The drive and enthusiasm by both theatre staff and DoSA nursing staff involved in this initiative and the previous case study led to the start of a subsequent improvement initiatives for all DoSA patients.

This supported the concepts of good communication, planning, and a system-wide multidisciplinary team approach to drive improvements in theatre start time efficiency that were evident in case study one.

6.6 Sustaining Improvements

Overall, throughout the duration of this improvement project on 17 theatre lists on which oesophagectomy cases were scheduled between November 2016 to November 2017 (12 months).

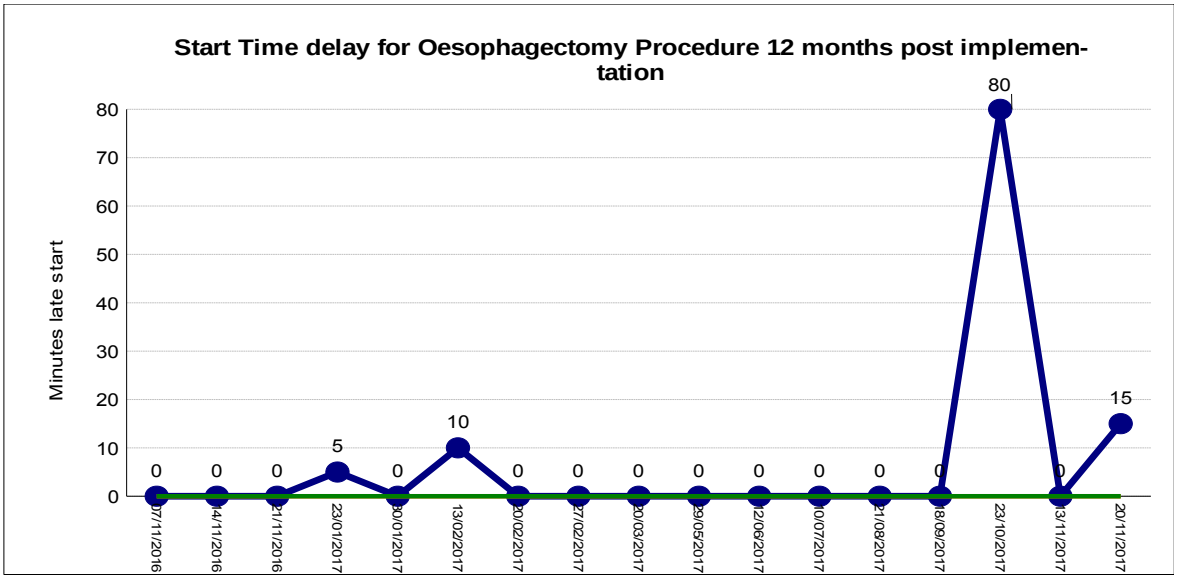
- Start time delay reduced from a median of 48 minutes to a median of 0 minutes,
- On-time starts increased from 11% to 76.5%,
- Overrun reduced from 3 hours to 26 minutes.

A review of practice changes in December 2017 confirmed that changes that led to improvements were embedded. These include:

- Patients were being referred to pre-operative assessment; a direct access process from OPD to pre-operative assessment was established.
- Consent and blood tests were completed in the OPD prior to surgery.
- The medical team notified theatre a week in advance of the scheduled date.
- Staff were rostered to support the earlier start time.
- Good organisation and planning in the DoSA unit were improving patient readiness and transfer to theatre.
- Commitment to scheduling one long procedure was adhered to.
- Sustaining the 07:30 start time was challenging due to inconsistent staff availability for an earlier start time.
- The theatre team decided in 2018 to change the start time from 07:30 to 08:00, 30 minutes earlier than normal start time.

Figure 10 demonstrates the start time performance on each theatre list over the 12-month period, it shows: the improvement in on-start times from 48 to 0 minutes (median).

Figure 10: Case study 2. Theatre start time delay 12 months post project end



6.7 Sustaining improvements long-term

The project ended in December 2017. Throughout 2018, the improvement team met to discuss changes to start time from 07:30 to 08:00. A formal process was not put in place to monitor the impact of this change. A review of start times carried out in early 2019 showed:

- A median start time delay of 5 minutes.
- 10% of theatre lists started on time.
- 60 % of theatre lists started within 5 minutes. The two main causes of delay expressed by staff were:
    - When the patient arrived in theatre reception at 07:50, a nurse was not available to complete patient check-in. One anaesthetic nurse was rostered on duty at 07:30, they were preparing the theatre/ setting up for the patient until 08:00.
    - A porter was not always available at the earlier start time to transfer the patient into the anaesthetic room.
    -

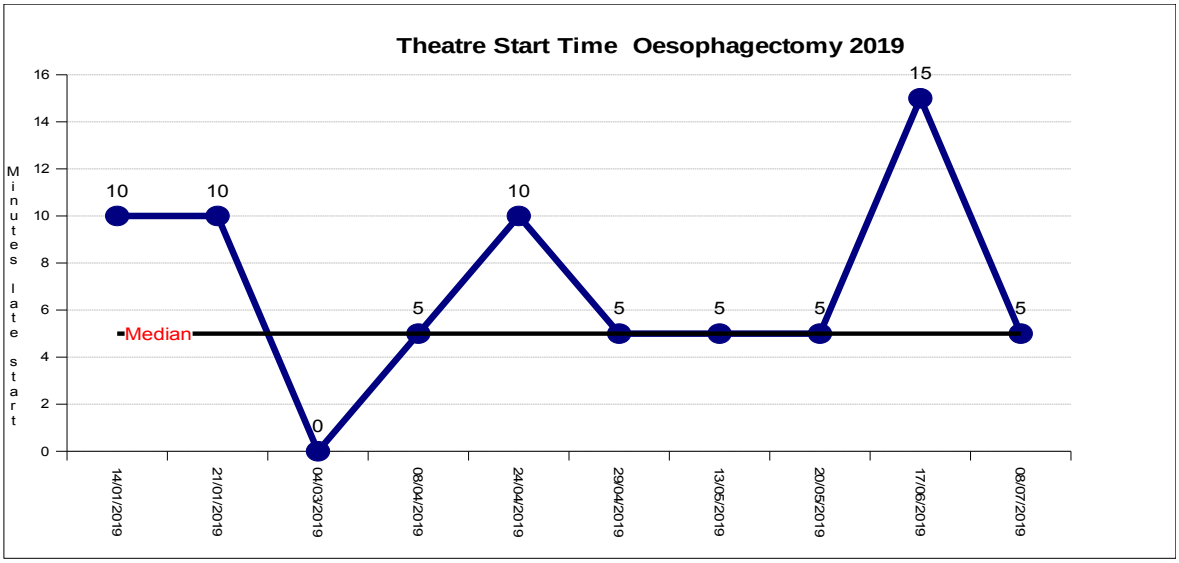
Practice changes implemented in 2016/17 continued as follows:

- Notification to theatre of planned surgeries continued.
- Patients were scheduled on the theatre booking system ahead of time.
- One patient was scheduled on each list.
- Patients attended pre-operative assessment.
- DoSA unit staff were informed of planned surgery dates.

Performance in start and finish times was not formally measured or monitored in 2018. A change in start times moving from 07:30 to 08:00 had occurred as the required team of nursing staff were not able to consistently start work at 07:00. The impact of this on start times and overruns was not measured. The multidisciplinary team reconvened and planned to work on two main issues that were impacting on start times.

Figure 11, shows the start time performance increasing from 0 to 5 minutes median delay on 10 theatre lists from January to July 2019.

Figure 11: Case study 2. Theatre start time sustainment phase.



6.8 Evidence of Continuous Quality Improvement

A review of long-term sustainment of practice changes that led to improvements was undertaken at the start of 2019. Learning from case study one along with a review of the literature and guidance on sustaining improvements (chapter 4) in practice led to the implementation of a sustainment plan. This involved a weekly review in the theatre department of improvement interventions with theatre nurse managers. The purpose of this engagement was to review performance, in this case start times and overruns and discuss how practice changes were being implemented and of issues arising. The improvement team re-convened and the findings from the review of performance were discussed. The team were willing to address these issues. As a result, additional PDSA cycles were carried out, as follows:

6.8.1 PDSA cycle 2

PDSA Improvement Cycle2	
Aim: Adjust the nurse roster to facilitate the earlier start time to receive the patient in theatre reception and encourage the patient to walk into theatre if able to avoid waiting for porters to arrive on duty.	
Plan	1. A theatre nurse was rostered on duty at 07:45 to accept the patient in theatre reception at 07:50. 2. If a porter were not available to transfer the patient into theatre, then the patient would walk from the reception area into the anaesthetic room. 3. Outcome and process measures would be reviewed following each case.
Do	This was planned for patients having an oesophagectomy on the next theatre list in October 2019.

Study	**Data review.** Start Time. 14th Oct: delay 15 minutes 21st Oct: delay 15 minutes 16th December: 20 minutes **Staff feedback/Process review** 1. A change in the registration process on the morning of surgery delayed patients arriving in DoSA. Previously, patients went directly to the DoSA unit whilst a family member registered the patient at the registration department. A change in practice led to all patients attending the registration department in person to sign admission paperwork prior to arriving at the DoSA unit. All patients queued at registration and were called on a first come-first-serve basis.
Act	1. Review the registration process and explore how the patient could be registered prior to 7am.

In January 2020, further initiatives involving the registration and admissions department commenced to address delays on the morning of surgery. Furthermore, the clinical team planned a trial of the pre-admission process that was underway in case study 6 for the next patient being admitted. Due to Covid-19, this work could not continue at the time.

6.9 Learning from the study

This section will evaluate the case study under the following headings which relate to the research question which is:

Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

Firstly, the results of the study will be summarised. This will be followed by a tabled outline of the factors that contributed to improved performance, compared with those identified in the literature reviewed. In addition, the impact of using an improvement framework will be presented, outlining how the process and steps in the model were followed. Finally, a review of how well the improvements were sustained in practice will be discussed through a comparison with recommendations from the literature described in chapter four.

6.9.1 Results

Over the duration of the project 76.5% of theatre lists started on time and a median delay of 0 minutes was achieved. Overruns reduced significantly, from 3 hours to 25 minutes.

6.9.2 Interventions that led to improved performance.

Outlined in table 8 are the interventions that led to improved performance. These can be summarised under the headings of patient readiness and communication across the patient pathway.

Table 8: Case study 2. Factors contributing to improvement in start times.

Concept	Factors that contribute to this/Evidence in practice	Evidence in literature
MDT Communication	1. A week prior to a scheduled case, the medical team to inform the theatre nurse manager of the planned case. 2. Medical team to inform the consultant anaesthetist of scheduled case. 3. Medical team to inform the DoSA nurse of the planned case on the day prior to surgery, this can be done verbally or scheduled on the electronic theatre booking system. 4. Theatre nurse manager to inform anaesthetic nurse of planned early start.	New finding
Patient Readiness	1. Nurse specialist refers the patient for anaesthetic pre-operative assessment. 2. Pre-op bloods & consent to be completed in OPD. 3. Healthcare records delivered to DoSA on the day prior to surgeryt. 4. Patient to arrive at the DoSA unit at 7am on the morning of surgery. 5. DoSA nurse to prepare the patient at 07:00 on the morning and escort the patient to theatre at 07:20. 6. Medical team to arrive in DoSA on-time to admit the patient prior to 07:20.	Overdyk et al (1998). Javed et al. (2013)
Earlier theatre start time	This was the first example in the theatre department whereby a theatre list started prior to 08:30. It demonstrated how approaching a problem from a different perspective led to such changes in the mindset in theatre and impacted positively on planning and preparation of patients for theatre.	New finding

6.9.3 Application of the model for improvement in practice

The process of planning, testing, and implementing interventions is described in the case study using the model for improvement. The application of an improvement methodology in practice will also be reviewed and compared with the theoretical

framework of the MFI to determine its impact on achieving improvement in practice. This will be described in table 9.

There was strong evidence of adherence to the principles of the science of improvement, for example people's experiences and knowledge of the problem and possible solutions were articulated. Involvement of staff across the episode of care brought a system-wide perspective to the team. It led to a creative approach to addressing the problem which was new to the theatre department. Measurement was evident throughout the project. Knowledge developed as the project progressed and was useful in spreading the changes to the DoSA service.

The three fundamental questions were incorporated and addressed, there was a clear and smart aim, good measurement, and positive brainstorming of creative ideas to improve. There was one PDSA cycle throughout the initial testing phase with additional cycles in the sustainment phases. Detailed planning led to a combination of changes which once implemented had immediate impact that lasted the duration of the project. The project was not affected by external factors outside the control of the improvement team. It moved seamlessly from testing to implementation. Once the changes that led to improvement were established a formal implementation plan was required, this was not given the same effort and structure as the planning and testing stages to ensure the change is embedded, monitored, and supported.

Table 9: Case study 2. Application of QI methodology in practice

Theory	**Evidence in practice**
Model for Improvement Three Fundamental Questions	**Question 1. What are you trying to accomplish?**
	The aim of the improvement initiative was clear and SMART. **S**pecific: Theatre start time for Oesophagectomy procedures to reduce overruns **M**easurable: Earlier start time 07:30 and a reduction in overruns under 3 hours **A**chievable: the team felt the changes in practice could be achieved and would lead to a reduction in overruns **R**ealistic: the principles were in line with evidence in the practice changes required to make improvement in perioperative efficiency **T**imely: Timeframes within which the change would be tested, and outcomes measured were clear in the aim statement.
	Question 2. How will you know the change is an improvement?
	Baseline measurement of start time and overruns were retrospectively collected.

	Impact of changes were continuously evaluated to determine if changes led to improvement. The MFI and Green.et.al (2019) recommend process and balancing measures to be collected. Although feedback was sought and acted upon, they were not measured continuously or displayed graphically. The importance of these measures is they help identify which changes are leading to improvement and the unintended consequences of the changes. For example, in the PDSA described there are several tasks involved in achieving the aim. The ability to interpret which of the changes in practice are leading to improvement and which are negatively impacting on success is difficult. Recording balancing measures would have enhanced the broader positive aspects of the change initiative, demonstrating the natural spread of improvement in practice.
	Question 3. What changes will you make that will result in improvement?
	Engaging with 'expert subject matter knowledge' across the episode of care for patients undergoing an oesophagectomy and examining the processes and interrelationships in the pathway of care helped articulate the problem and provided opportunity to identify change ideas. The team once established had great strengths in this area and just needed to be brought together once this happened, they had very creative ideas that had not been previously tried in theatre.
PDSA Cycle	There was one PDSA cycle in this improvement initiative and a further two cycles in the sustainment phase. A clear aim of the specific cycle and the predicted outcome of the change were included. There were several tasks involved in the PDSA and good evidence within the study phase of reviewing what happened both qualitatively and quantitatively. This initiative was successful once the initial changes were made and required an implementation and sustainment plan. When changes were made to the start time, moving to an 08:00 instead of 07:30 the impact of the change was not studied, demonstrating that the PDSA cycle was not completed. In the evaluation phase of the projects, further PDSA's were required to adapt to the slippage in performance, demonstrating the need for continuous improvement as part of sustaining the outcome of the change
Implementation	The study seamlessly moved from testing to implementation. Many of the changes were well embedded, this happened naturally due to good understanding of the problem and multidisciplinary planning of the changes that was well organised. A formal implementation plan which included a system to monitor performance, adapt to issues affecting start time was not established.
Spread	Changes to practice that led to improvements in this study reinforced the learning on the factors that contribute to efficient theatre start times. It created momentum to expand quality improvement initiatives in the DoSA and theatre service. More recently the concept of early start times for long complex procedures was tested in the Plastics service with very positive effects.

6.9.4 Sustaining improvements

In evaluating the study against the theoretical recommendations for sustaining improvement, outlined in table 10, the following learning has been gained. Firstly, in supporting the human side of change, there was evidence of strong team commitment to improve start time performance and reduce overruns. This is demonstrated in both willingness to make improvements and the interest in proposing change ideas. Once the project ended, a process to measure start and end times and variation was not continued long-term. Standardisation of some new practices that led to improvement were well embedded. A formal system or process was required to measure performance, variation and causes for variation support, guide and facilitate staff to adjust to unpredictable changes to the process. The team's reengagement and refocusing of their efforts in 2019, demonstrates their ability to continuously seek improvements.

Table *10*: Case study 2. Comparison of factors that contributed to sustaining improvement with theoretical recommendations.

Theory	Evidence in practice
Psychology of change 'The Human side of change'	
1. Connect with individuals' hearts as well as minds so that team members internalise the "rightness" of the change, (Green et. al, 2019) 2. Remind people why work is needed" requires engagement to connect with people's emotional, cognitive, and behavioural styles. (The NHS Scotland. NHSS) 3. Celebrate to reinforce successful behaviour with recognition and have a marker to remind people that the new way is better than before (Green et. al, 2019) 4. To continue the work after the initial enthusiasm has dissipated the use of improvement huddles create an opportunity to support the continuity of the interventions in practice, to anticipate problems and review current performance. (Silver et al, 2016)	Team participation, creating ideas and planning the steps in the change process demonstrates the rightness of the change. The team wanted to reduce overruns which impacted on their working hours and believed an earlier start time would help address this problem. There was evidence of constant engagement and feedback with the team at the planning stage and by discussing progress on daily theatre lists as the project progressed. This reinforced the purpose of the change.
Implement Standard work	
1. People need to be informed about the change, trained and supported in the new way of working so that everyone in the system knows what to do and why, how, and when to do it, and how to adjust when necessary (Scoville and Little 2016)	12 months post implementation, a review of practice changes confirmed that these were well embedded. The improvement team continued to perform their roles in the change. A formal implementation plan which would have included a process to, measure

2. Standard work should include a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities. (Silver et al 2016) 3. Make measurement systems permanent. 4. Develop Standard Operating Procedures (SOP's)to reflect the changes in practice, 5. Teach new approaches when inducting newly appointed staff, (Green et. al, 2019)	performance, monitor changes in practice and maintain the teams focus through regular performance review and problem solving as issues arose was required.
Continue to Measure	
1. Continue to measure, it provides objective information to determine if improvement is being sustained. (Green et.al, 2019) 2. Apply quality control which involves monitoring the system for stability, detecting emerging process problems, and taking steps to address them - special causes (Scoville and Little 2016). 3. Apply a continuous cycle from PDSA to SDMA throughout the improvement journey. The cycle of improvement moves to: Standard work, Doing, Monitoring and Adapting (Scoville and Little 2016). 4. Measurements should focus both on numbers and on experiences which ties into the need of keeping communication lines open throughout the cycle of improvement. (The NHS Scotland)	Measuring performance was evident for the duration of the project, following this continuous measurement was not maintained.
Develop robust systems	
1. Build contingencies for known exceptions, there are usually some exceptional conditions under which the change may not perform optimally or of which there is no previous experience. (Green et.al, 2019). 2. Adapt as part of the SDMA cycle for sustainability. It requires constant monitoring to pre-empt problems and subsequently testing changes through PDSA cycles to stabilise the improvement (Scoville and Little 2016).	Overtime processes needed to be modified, due to changes in start time. Pre-empting, the impact of these changes required further testing and studying in the new work conditions. Tweaks that were required to change the start time, needed to be stepped out and monitored to support the changes in practice. Changes to the registration process required further readjustments of the process on the morning of surgery, this had become a problem without the DoSA team proactively managing the impact on start times.
Plan to continually improve	
1. Acknowledge and accept that the healthcare environment is complex and is constantly changing whereby new processes can quickly become old processes that do not support the levels of	Although there was a deterioration in start time performance, albeit minimal, the multidisciplinary team reconvened and planned to work on two main issues that were impacting on start times. This

performance experienced (Green et. al, 2019). 2. Continue to apply techniques of setting goals, identify change ideas and measurement in response to patients' needs, known best practices and policy changes (Green et. al, 2019). 3. Create a culture that supports continuous improvement, the continuous search for opportunities for all processes to get better. (Green et. al, 2019) 4. Understand the system and processes that require improvement, identifying problems leading to poor quality, making improvements, adapting to constant changes inherent in complex systems whilst acknowledging that this effort and mind-set is required to create a culture for quality improvement (Mondoux 2017).	demonstrates the willingness and effort to improve, highlighting the need to apply constant effort and the continuous search for opportunities for all processes to get better. The team like in case study one just needed to be brought back together and supported with the changes required. Keeping initiatives live and constant lends to creating a mindset of a need to adapt and adjust as part of a complex system.

6.10 Conclusion

The case study presents the move to an earlier theatre start time from 08:30 to 07:30 for a long complex procedure called oesophagectomy with the aim of reducing theatre overruns of 3 hours between October 2016 and November 2017. To achieve the earlier start time, improvements in multidisciplinary communication and patient preparation were necessary. Testing and implementation of changes in practice by applying a model for improvement were stepped out.

Results of the study show the achievement of an earlier start time in 76% of cases over one year and a reduction in start time delay from 48 minutes to 0 minutes during the project. Theatre start and finish times performance data and staff feedback is used to demonstrate the impact of interventions made. There was a natural spread of interventions to the DoSA unit which enhanced the learning from case study 1. Changes to practice that led to improvement were well embedded with good results sustained 12 months post commencement. Longer-term sustainment showed a slight slippage in start time performance which was focused on in 2020.

CHAPTER 7- CASE STUDY 3

7.1 Introduction

This case study is set in the Day of Surgery Admission service (DoSA). Day of Surgery Admission is commonly referred to as DoSA. The service was established in the hospital in 2010 to facilitate the admission of inpatients for surgery on the morning of their operation. Previously inpatients were admitted on the day prior to their operation. The purpose of this change in practice was to reduce pre-procedure length of stay and therefore create bed capacity. The service has grown steadily over the years, to the point where 70% (average 12 patients per day) of surgical patients are admitted on the morning of surgery. Admissions to the unit come from a variety of specialties and vary in complexity, these include Urology, Plastic surgery, Breast surgery, Colorectal surgery, Upper Gastrointestinal surgery, Vascular surgery and Orthopaedic surgery.

In late 2016, learning from case study one and two led to spreading improvements for all DoSA admissions. DoSA nursing staff and management had been involved in ongoing improvement work with general and breast surgery service and the upper-gastrointestinal service. This had built relationships with the theatre department, creating opportunities to work together and apply learning from each of these initiatives to all patients admitted to the DoSA unit. At this time, the median operating theatre start time delay for all inpatients admitted to DoSA was 26.5 minutes when measured over two months in 2016 on forty-three theatre lists. Four main causes for delay were identified; (i) timely availability of healthcare records, (ii) nonadherence to theatre list order (1st patient scheduled first, done first) due to lack of awareness of theatre schedule, (iii) delays with patient registration, and patient readiness; for example: patient documented consent, medical admission, and (iv) timely transfer to theatre.

The aim of this study was to reduce start time delay for patients scheduled first on each theatre list who were admitted to the DoSA service from 26.5 minutes to 10 minutes between October 2016 and May 2017. Four interventions were tested:

- Healthcare records of each patient scheduled for surgery on the following days theatre list to be delivered to DoSA by 12md each day.
- Healthcare records to be reviewed by nursing staff to identify potential requirements/delays on the morning of surgery,
- Streamline the registration process by pre-registering patients prior to admission,
- Nursing staff to confirm list order on the theatre scheduling system and adhere to this when preparing patients on the morning of surgery.

7.2 Methodology

An improvement methodology: The Model for Improvement by the Institute of Healthcare Improvement (IHI) was applied in practice to plan, test, analyse and implement the improvement interventions. The model for improvement (MFI) incorporates three questions and the PDSA cycle. The combination of both is fundamental to making improvements.

7.2.1 Question 1. What are you trying to accomplish?

The aim of the project was to reduce start time delay for patients admitted to DoSA who were scheduled first on each theatre list from 26.5 minutes to 10 minutes between October 2016 and May 2017.

7.2.2 Question 2. How will you know a change is an improvement?

7.2.2.1 Baseline data

The median operating theatre start time delay for all inpatients admitted to DoSA scheduled first on a theatre list was measured retrospectively over two months in 2016. It showed:

- Theatre starts time delay of a median of 26.5 minutes.

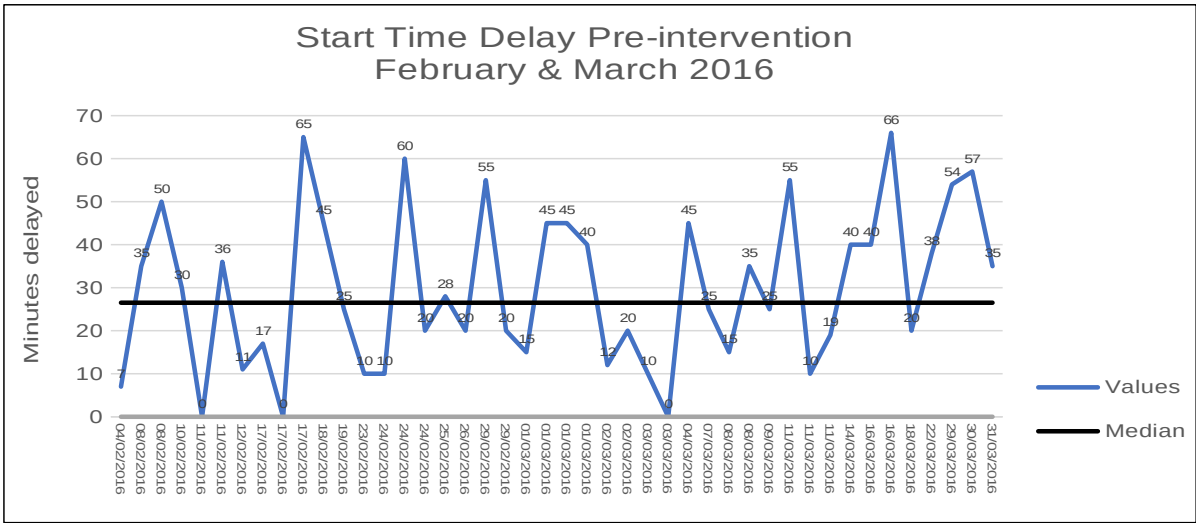
The causes for delays at this time included.

1. Timely availability of healthcare records,
2. Non-adherence to theatre list order (1st patient scheduled first, done first) due to lack of awareness of theatre schedule,
3. Delays with patient registration,

4. Delays with patient readiness, for example waiting for consent, medical admission.
5. Timely transfer to theatre.

Figure 12 shows the median start time delay in minutes being 26.5 minutes over 2 months for 43 cases scheduled 1st on the theatre list across a variety of specialties between February and March 2016.

Figure 12: Case study 3. Theatre start time delay baseline data.



7.2.2.2 Measurement plan

The following measures will be collected throughout the study.

1. Theatre start time delay in minutes on each theatre list whereby the 1st patient scheduled was admitted via the DoSA service
2. Process measures include:
    a. Patient ready on the morning of surgery to walk to theatre at 08:00
3. The causes for further delays will be recorded throughout the PDSA cycles.

7.2.3 Question 3. What changes can you make that will result in an improvement?

7.2.3.1 Establishment of the Project team

To achieve the aim of this initiative, the team expanded to include the surgical directorate nurse manager to support the initiative. Engagement and co-working between DoSA and theatre nursing staff had been established in the previous two studies. The admission, registration and healthcare records department staff were invited as required. The team scoped out change ideas for testing.

7.2.3.2 Change ideas

The changes identified included:

1. Timely patient readiness for theatre, to include:

    - Healthcare records available for review on the day prior to theatre.

    - Pre-registration on the eve of surgery.

2. Access to theatre scheduling system to determine first patients scheduled.

3. Review information regarding patient's clinical status and requirements on the morning of surgery.

4. Communication between theatre and DoSA on plans for first patients scheduled.

5. Escort patients to theatre at 08:00.

7.3 Testing changes in practice

At this stage, the team had identified the changes that they predicted would result in improvement. The next phase in the quality improvement cycle involved testing interventions in practice to determine if they result in an improvement. The PDSA (Plan, Do, Study, Act) cycle is a framework to test the change ideas. This process was described in chapter four, section 4.8. The following PDSA cycles for this study include.

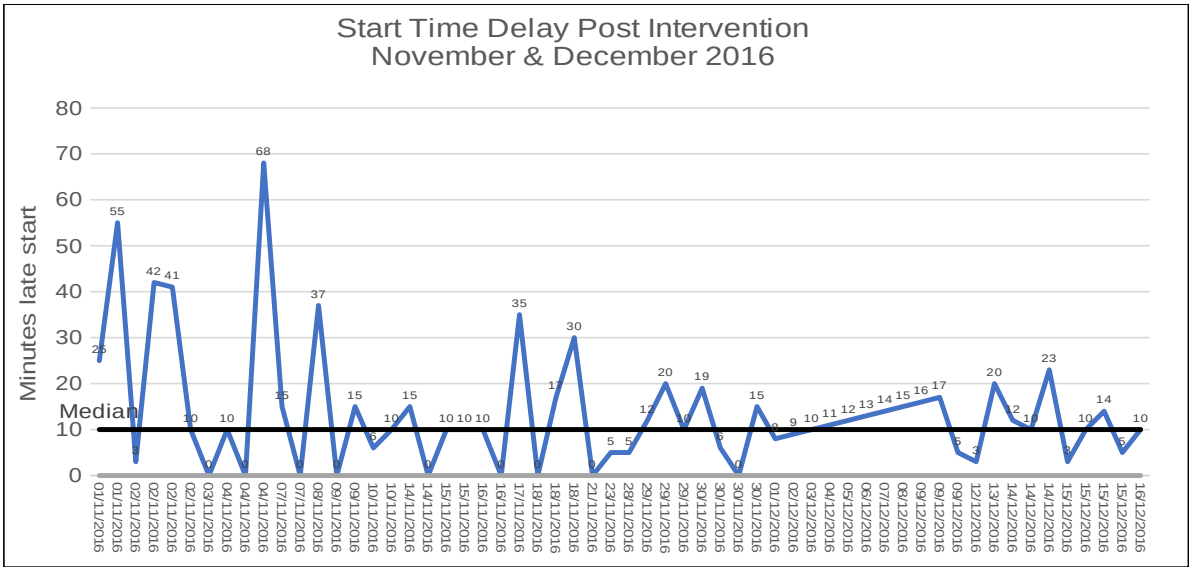
7.3.1 PDSA cycle 1

PDSA Improvement Cycle 1	
Aim: Streamline the pre-operative process in line with the theatre schedule to ensure all patients admitted via DoSA who are scheduled first on the theatre list are ready to transfer to theatre by 08:00.	
Prediction: There was a sense that improved organisation, planning, and communication would contribute to reducing delays in theatre start time.	
Plan	1. Admission staff to request all healthcare records to be delivered to DoSA by 12md for the following day's theatre list. 2. Healthcare records department to deliver all patients records to DoSA by 12md for the following day's theatre. 3. Registration staff to pre-register patients prior to admission and activate them as 'live' on the morning of surgery. 4. Admissions staff to inform patients of 7am admission time.

	5. For the following days theatre list, the DoSA nurse to: - Review each patient's medical notes to identify potential requirements/delay on the morning of surgery, - Commence pre-operative documentation for each patient, - Review theatre-scheduling system for the following day to confirm list order, - Adhere to list order when preparing patients for surgery, - Liaise with the theatre department regarding specific information regarding the patients scheduled first if required, for example: if the patient requires pre-operative x-ray, medication, anaesthetic review, - Escort all patients scheduled 1st on the theatre list to theatre by 08:10.
Do	In November 2016, the improvement team and relevant services started to carry out the actions outlined above.
Study	**Data Review.** Throughout November and December 2016 Start time delays reduced to 10 mins (Fig.3) **Staff Feedback/Process change reviews.** 1. Regular problem of healthcare record availability reduced. 2. Medical teams were informed in advance of potential issues for the following morning. 3. Oversight of the theatre list and confirmation of scheduled first patient between DoSA and theatre department occurred on the day prior to surgery. 4. Pre-registration of 1st patients scheduled avoided patients queuing. Learning from the impact of interventions centered on timely planning, visibility of theatre schedule, communication with teams and streamlining the registration process.
Act	Review causes for continued delays and sustain the improvement through embedding the practice changes established in DoSA and relevant services.

Figure 13 shows the reduction in start time delay from 26.5 minutes to 10 minutes in 2 months post intervention on 58 theatre lists.

Figure 13: Case study 3. Theatre start time delay post intervention.

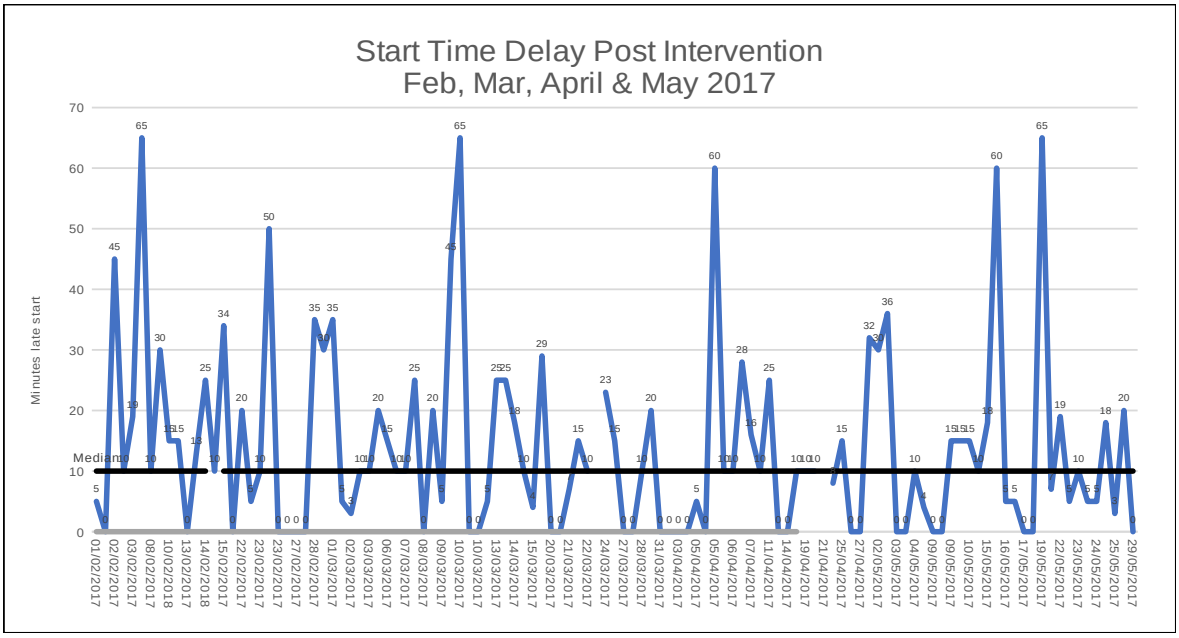


7.3.2 PDSA cycle 2

PDSA Improvement Cycle 2	
Aim: Sustain improvements within the DoSA service and the relevant departments and continue to monitor start time performance.	
Prediction: Practice changes will be embedded as DoSA nurse and supporting services committed and willing to continue with improvements.	
Plan	1. Formalise the practice changes with DoSA nurse and healthcare records, admissions, and registration staff. 2. Provide a feedback opportunity for issues to be raised and addressed between DoSA and theatre. 3. Monitor and report start time performance to Directorate management team.
Do	Between February and May, weekly (or more frequent if required) communication between DoSA nurse and theatre managers to discuss progress and solutions to issues as they arose.
Study	**Data Review** Sustained improvement throughout February, March, April and May 2017 with a median start time delay of 10 minutes. **Staff Feedback/Process change reviews.** 1. Practices were well embedded. 2. Theatre staff reported experiencing a very positive improvement in planning, co-ordination, and communication with the DoSA service. 3.Issues that were impacting on start time were discussed with the DoSA and theatre staff. This became a regular action and was helping to tweak local issues between both areas.
Act	Continue with formal feedback loop to identify issues as required.

Figure 14 demonstrates sustained improvement in median start time delay at 10 minutes between February and May 2017

Figure 14: Case study 3. Theatre start time delay post intervention



In October 2017, the admission process for day-case patients changed. Day case patients who did not have an allocated post-operative trolley were relocated to the DoSA unit on the morning of surgery. This increased the volume of patients attending the department and coupled with reduced post-operative bed capacity for scheduled patients led to the following issues:

- In adherence to list order as first patients scheduled could not go to theatre until a bed was confirmed,
- Late allocation of post-operative beds which prevented patients going to theatre on-time.
- Increase in theatre start time delay from 10 to 15 minutes.

7.3.3 PDSA cycle 3

PDSA Improvement Cycle 3	
Aim: To facilitate daily communication between DoSA, day-ward and theatre to discuss appropriate 1st patients and to ensure these patients are prepared first for surgery. These patients were most likely to have a post-operative bed and unlikely to be cancelled for surgery i.e., urgent patients.	
Plan	At 2.30 each afternoon, DoSA, day surgery and theatre nurse managers attend a planning meeting to identify the first patients on each theatre list on the following day and confirm bed allocation for these patients. This connects to case study number 4 which was underway at the same time on the

	day surgery ward.
Do	In October 2017, the daily meetings were held. Information regarding bed availability for the following day was not always available at this time.
Study	**Data Review** Start time delay increased from 10 mins to 15 mins. **Staff Feedback** 1. It was difficult to sustain the daily communication huddle as there was uncertainty about which patients would have a post-op bed identified on the morning of surgery. 2. One outcome achieved was that DoSA staff were informed the previous day of potential first patients for each theatre, bringing DoSA into the loop of planning for the 1st patient with the day ward. This was a new practice as day case patients are generally scheduled first on the theatre list. 3. The process for Day-case patients re-assigned to DoSA on the morning of surgery-involved patients presenting at the Day ward, registering, and waiting for a decision about the time they could go to theatre prior to being redirected to DoSA. On occasion patients scheduled 1st on the theatre list arrived to DoSA at 08:00.
Act	Day case patients scheduled 1st in theatre who were reassigned to DoSA to arrive at 07:30 in DoSA on the morning of surgery.

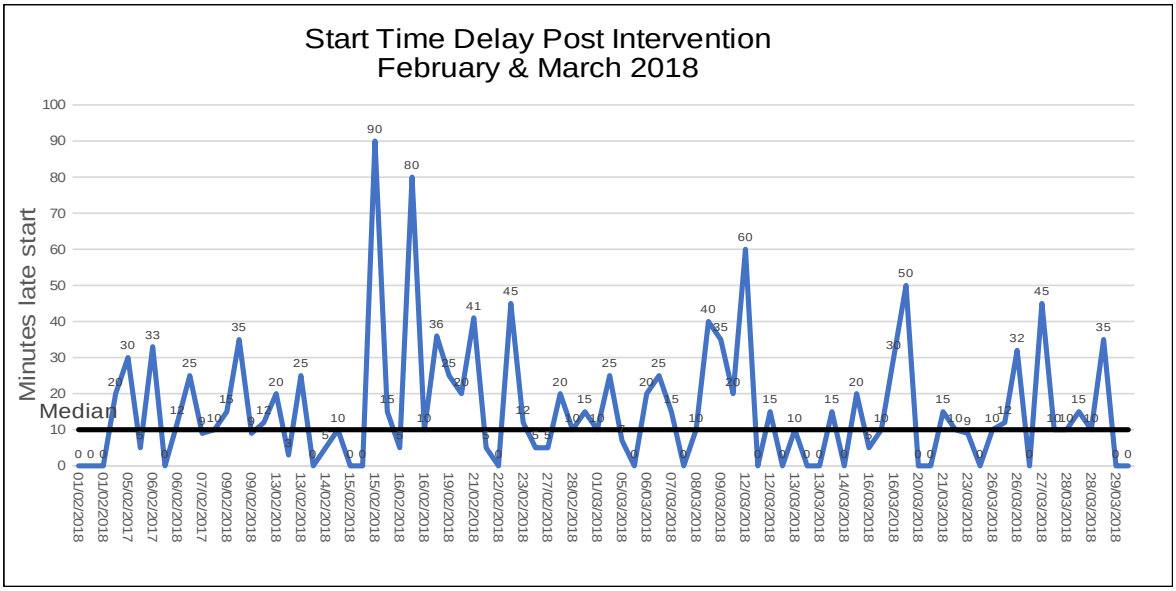
7.3.4 PDSA cycle 4

PDSA Improvement Cycle 4	
Aim: Once patients were registered on the day ward; they proceeded to DoSA to be prepared early for surgery.	
Plan	1. Predict trolley/bed capacity on the day ward for the following day. If it is expected that there may not be sufficient capacity for elective day cases on the following morning, patients to be contacted to go directly to DoSA so that they would be ready to go to theatre first.
Do	In January 2018, day case patients were informed to go directly to DoSA on the morning of their surgery to avoid queuing unnecessarily on the day ward and so that they could be prepared to go to theatre on time.
Study	**Data Review** Start time delay reduced from 15 minutes to 12 minutes in February and 10 minutes in March 2018. **Staff Feedback/Process change review.** 1. Day case patients arrived earlier in DoSA. 2. An increase in DoSA patients scheduled 1st as a post-operative bed was more likely to be available for urgent patients compared with day case patients of whom a proportion were less

	urgent. 3. Practices commenced whereby DoSA patients were allowed go to theatre irrespective of bed availability. 4. Nursing staff in theatre reception may not be available to take handover when the patient arrived from DoSA. This delayed the DoSA nurse getting back to the unit to prepare and transfer subsequent patients. 5. A further problem of trolleys in theatre reception not being ready in the morning when up to 11 patients would be arriving between 8am and 08:20. These patients needed to have their operation trolley set up in specific way for surgery and once ready needed to be transferred into the theatre. It was suggested that a porter assigned to the reception area between 8am & 9am would help with theatre trolley set up and patient transfer.
Act	Review the process for patient handover between DoSA and theatre reception and explore the possibility of a theatre porter being assigned to theatre reception each morning to improve the flow of patients.

Figure 15 demonstrates the reduction in delay from 15 to 10 minutes in February and March 2018.

Figure 15: Case study 3. Theatre start time delay Sustainment phase

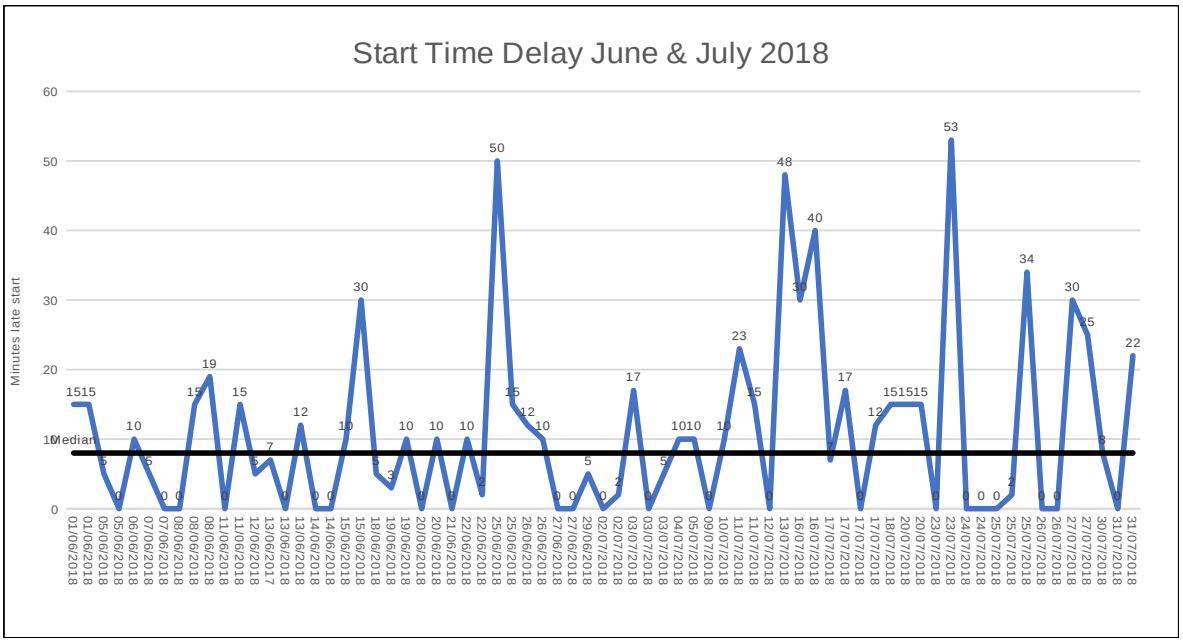


7.3.5 PDSA cycle 5

PDSA Improvement Cycle 5	
Aim: Reduce the wait-time for handover between DoSA nurse and the theatre reception nurse and address delays in preparation of theatre trollies in reception.	
Prediction: Theatre staff felt that a brief handover of the patient was sufficient if all the patient's details were correct especially as a detailed assessment by the anaesthetic nurse led to a 2nd assessment of the patient in reception.	
Plan	1. The DoSA nurse will inform the theatre reception nurse of the arrival of the patient and give a brief handover. 2. The reception nurse will do a detailed assessment of the patient as normal and handover to the anaesthetic nurse. 3. If any patient information is missing or incomplete it will be dealt with prior to the patient going into the theatre suite. 4. A trial allocating a theatre porter to the reception area each morning from 8am to 9am to speed up trolley preparation and patient transfer to be organised.
Do	This practice commenced in March 2018.
Study	**Data Review** By July 2018 Start time delay had reduced 8 minutes (median). **Staff Feedback** 1. The theatre staff reported that DoSA patients are always well prepared for theatre and did not require a long-detailed handover. 2. An additional nurse was appointed to the DoSA service. Patient readiness in DoSA was faster with more patients ready to be brought to theatre at 8am. 3. In April 2018 a porter was assigned to the reception area from 8am to 9am each morning. This practice resulted in the porter being on-site in reception, preparing theatre tables in advance. It also meant that nursing staff did not have to leave the theatre reception area to request porter staff support.
Act	Embed practice changes. Communicate to each theatre staff and to the porter service the changes to handover and allocation of a porter each morning in theatre.

Figure 16 demonstrates the reduction in delay to a median of 8 minutes in the months of June and July 2018.

Figure 16: Case study 3. Theatre start time delay Sustainment phase



7.4 Implementation

Practice changes that resulted in improvements were implemented as the project progressed. Testing and implementation were seamless and happened in conjunction with one another. The DoSA team consisted of two nursing staff and one healthcare assistant. All staff were very clear about the new practices and their roles.

7.5 Spread of Improvements

Practice changes identified above that led to improvement for all specialties admitting patients to DoSA were mainly in.

a. Improving communication between theatre, day ward nursing and medical teams,
b. Improving pre-operative planning to ensure patients were ready for surgery,
c. Focusing on timely transfer of patients to theatre.

There were numerous actions involved in achieving these improvements and learning outlined in the PDSA cycles above. The next phase of improvements in DoSA focused on specific specialties for example the plastic surgery service which will be described in case study six.

7.6 Sustaining Improvements

Overall, throughout the duration of this project, improvement was achieved from a delayed start time of 26.5 minutes in 2016 to 8 minutes by mid-2018.

During this time improvements in preparation of patients for theatre along with good communication practices between theatre and DoSA nursing staff regarding list order and patient needs were well embedded. A review of sustained improvements in mid-2018, twenty months' post commencement of the initiative showed that the following changes to practice were well embedded. Overall good organisation and planning practices were embedded in DoSA. For example.

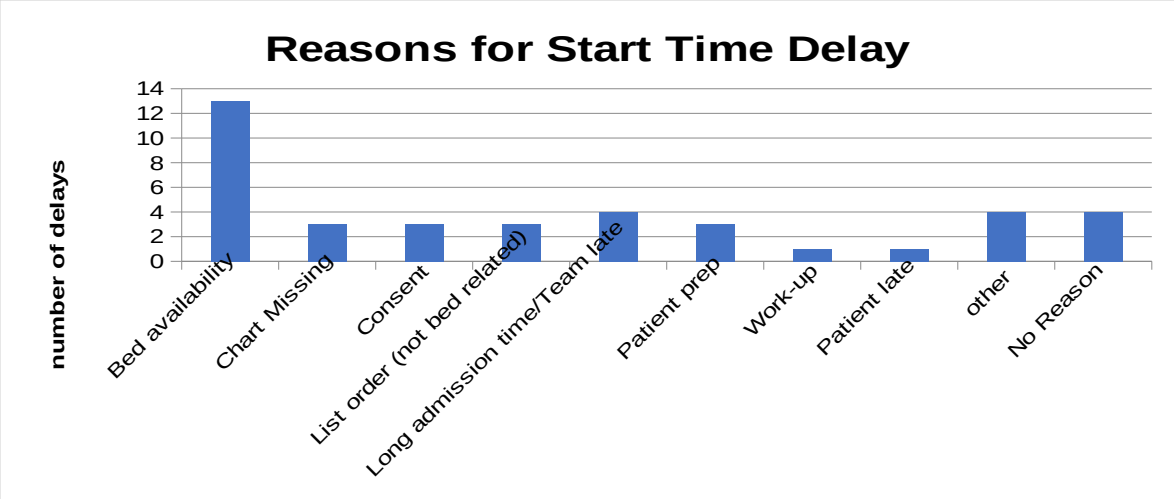
- Healthcare records of all patients scheduled for surgery on the following day were delivered to DoSA by 12md,
- Patient's records were reviewed by nursing staff to confirm patient readiness,
- Preparation of theatre paperwork commenced on the eve of surgery,
- Patients' pre-operative requirements that could potentially lead to delays were discussed with the medical team,
- Pre-registration of the patient on the hospital system saved the patient queuing in the registration department prior to walking to the DoSA unit,
- The theatre schedule was checked for planned first cases for the following day,
- There was a focus on transferring patients to theatre on time,
- Excellent communication between theatre and DoSA staff was in place,
- A feedback process on issues between DoSA and theatre staff was common practice,
- Handover process between DoSA and theatre reception was working well,

- A member of the portering team was assigned to theatre reception each morning between 8am and 9am continued which greatly helped set up patient trolleys and transporting patients into theatre.

7.7 Sustaining Improvements long-term

In January 2019, a review of theatre start times was completed. This came from concerns raised by the DoSA nursing team about delays getting the patients ready for surgery each morning. Bed availability was causing problems and it was noted that some teams were arriving late to DoSA. On review of start times, it showed that delays had increased to 23 minutes and although it was evident that lack of bed availability caused 37% of delays, other factors that could be addressed were focused on. Figure 17 shows the causes for delay throughout the month of January 2019, for 53 patients scheduled first on the theatre list.

Figure 17: Case study 3. Reasons for theatre start time delay



7.8 Evidence of Continuous Quality Improvement

A team consisting of DoSA nursing, theatre nursing and consultants in General Surgery, Plastics Surgery and Vascular Surgery reviewed the data. Reflecting on the previous improvements made, which were mainly in organisation, planning, and communication, it was felt that it would be appropriate to work on specific issues that the specialties were experiencing and to revisit the initiatives with the general and breast surgery service and upper gastrointestinal service. The Plastics Surgery

service agreed to work on improving start times for one case and proposed a trial of a pre-admission pathway for this procedure. This initiative will be presented in case study number six. Also, at this time the improvement team in general and breast surgery (case study number 1) and upper gastrointestinal surgery (case study number 2) was re-established to work on addressing problems that resulted in recent inefficiencies. This was presented in section 5.8 and 6.8.

7.9 Learning from the study

This section will evaluate the case study under the following headings, which relate to the research question, which is:

Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

Firstly, the results of the study will be summarised. This will be followed by a tabled outline of the factors that contributed to improved performance, compared with those identified in the literature reviewed. In addition, the contribution of using an improvement framework will be presented, outlining how the process and steps in the model were followed. Finally, a review of how well the improvements were sustained in practice will be discussed through a comparison with recommendations from the literature described in chapter four.

7.9.1 Results

Overall start time delay reduced from a median of 26.5 minutes to 10 minutes between October 2016 and July 2018, dipping to 8 minutes at the end of the project.

7.9.2 Interventions that led to improved performance

Outlined in table 11 are the interventions that led to improved performance. These can be summarised under the headings of; (i) ensuring an appropriate first patient scheduled on a theatre list, (ii) patient readiness, (iii) communication across the patient pathway, (iv) addressing external factors for example ensuring available bed capacity and (v) streamlining the process in theatre reception i.e., handover and porter support.

Table 11: Case study 3. Factors that contribute to improving theatre start time.

Concept	Factors that contribute to this/Evidence in practice	Evidence in literature
Identifying an appropriate 1st patient	1. Patients clinically ready for surgery, who will have an appropriate bed available post-operatively and do not require investigations or treatment on the morning of surgery.	Javed et al. (2013) describes the concept of the 'Golden patient'
Patient readiness	1. Prior to the day of surgery the following is required: - Patient registration completed, - Healthcare records delivered to DoSA by 12md for following days patients, - Healthcare record review by nurse on ward with potential problems identified and escalated to relevant staff, - Patient scheduled on the electronic theatre system, - Review of the theatre schedule by DoSA nurse - Commence patient documentation for theatre. 2. On the morning of surgery: - Patient admitted by nursing staff 1st. - Medical team admission within enough time for the patient to be ready for theatre on-time, - Patient escorted to theatre on –time.	Overdyk et al (1998) Panni (2013).
Interdepartmental communication	1. Daily communication between DoSA and theatre regarding the following day's theatre list and prioritised first patients across the theatres incorporating bed availability. 2. Changes to the handover process in theatre reception.	New Finding
External Factors	Bed capacity- a confirmed post-operative bed is required so that the patient can go to theatre. This information is necessary on the day prior to surgery especially if there is a risk that capacity may not be available early morning or at the time required to make decisions regarding theatre order.	New Finding

7.9.2.2 Application of the model for improvement in practice

The application of the model for improvement in practice is outlined in table 12. There was strong evidence of adherence to the principles of the science of improvement, for example people's experiences and knowledge of the problem and possible solutions were articulated and involvement of staff across the episode of care brought a system-wide approach to the fore. Measurement was evident throughout the project and addressing variation drove PDSA cycles. Knowledge developed as the project progressed and was useful in spreading the changes to the day surgery services in case study 4. The three fundamental questions were incorporated and addressed, there was a clear and smart aim, good measurement, and positive brainstorming of ideas to improve. The PDSA cycles were clear and the study of the impact of changes was deep which led to further cycles of

improvement. The project moved seamlessly from testing to implementation. Practice changes were sustained, and problems were dealt with as they arose. However, a formal implementation plan or SOP with clearly defined roles and responsibilities would support new staff when appointed and ensure monitoring of performance was continued.

Table 12: Case study 3. Application of QI methodology in practice.

Theory	Evidence in practice
	Question 1 What are you trying to accomplish?
Model for Improvement 3 Fundamental Questions	The aim of the improvement initiative was clear and SMART. **S**pecific: Theatre start time for all patients admitted to DoSA who are scheduled first on the theatre list **M**easurable: Achieve a theatre start time of 08:30 **A**chievable: following the success of the first two case studies, the team felt the changes in practice could be achieved **R**ealistic: the principles were in line with evidence in the practice changes required to make improvement in perioperative efficiency **T**imely: Timeframes within which the change would be tested, and outcomes measured were clear in the aim statement.
	Question 2. How will you know the change is an improvement?
	A baseline measurement of start time was retrospectively collected. Impact of changes were continuously recorded to evaluate if changes led to improvement. The MFI and Green et.al recommend process and balancing measures are collected, although feedback was sought and acted upon, they were not measured continuously or displayed graphically. The importance of these measures is that it is helpful to identify which changes are leading to improvement and the unintended consequences of the changes. For example, in each PDSA described there are several tasks in each cycle, the ability to interpret which of the changes in practice is leading to improvement and which are negatively impacting on success.
	Question 3. What changes will you make that will result in improvement?
	The changes being implemented were from the learning from the first two case studies which were being spread across all specialties in DoSA.
PDSA Cycle	There were five PDSA's in this improvement initiative. A clear aim of the specific cycle and the predicted outcome of the change were included. There were several tasks involved in each PDSA and good evidence within the study phase of reviewing what happened both qualitatively and quantitatively. In the evaluation phase of the projects, the study didn't progress past achieving a reduction in start time delay of less than ten minutes, there was a lot of variation in start time performance and although it eventually led to working with individual teams on

	specific delays to reduce variation earlier recognition of variation would have led to further PDSA's and data analysis which could support sustaining the aim of the initiative post project completion.
Implementation	The study moved seamlessly from testing to implementation. Many of the changes were well embedded, this happened naturally due to good understanding of the problem and multidisciplinary planning of the changes that was well organised. Strong leadership of the DoSA service ensured that practice changes were sustained, and problems were dealt with as they arose. The team was small which made it easier to embed practices. However, a formal implementation with clearly defined roles and responsibilities would support new staff when appointed and ensure monitoring of performance was continued.
Spread	Learning from the previous studies led to adoption of these interventions for all specialties in the DoSA unit. It reinforced the findings on the factors that led to improved theatre start times which were applied in the day surgery service which is described in case study four (next chapter). Longer-term it provided a deeper insight into the complexity of the context in which the changes were being made which is considered much earlier in case studies five and six.

7.9.3 Sustaining improvements

In evaluating the study against the theoretical recommendations for sustaining improvement, outlined in table 11 the following learning has been gained. Firstly, in supporting the human side of change, there was excellent commitment by DoSA and theatre nursing teams in achieving the intended goals. There was regular feedback on issues as they arose, this was evident when the changes to practice in day surgery impacted on DoSA volume and flow. However, although a very challenging time to try and sustain improvement, the team adapted and made some changes in communication with theatre to work on addressing the issues.

Measurement continued throughout the project improvement cycles up to July 2018.There was variation in performance and an increase in delays noted in January 2019. This led to continued efforts to address the factors causing late theatre start times. The improvements made related to the systems around planning, organisation, and communications within the DoSA service. Improvement work progressed to focusing on specific specialties at the start of 2019, demonstrating efforts to continuously improve. Like the previous case studies a standardised system for monitoring and adapting of practice was not a standard practice once the initiative moved into sustainment stages.

Table 13: Case Study 3. Comparison of factors that contributed to sustaining improvement with theoretical recommendations.

Theory	Evidence in practice
Psychology of change 'The Human side of change'	
1. Connect with individuals' hearts as well as minds so that team members internalise the "rightness" of the change, (Green et. al, 2019) 2. Remind people why work is needed" requires engagement to connect with people's emotional, cognitive, and behavioural styles. (The NHS Scotland. NHSS) 3. Celebrate to reinforce successful behaviour with recognition and have a marker to remind people that the new way is better than before (Green et. al, 2019) 4. To continue the work after the initial enthusiasm has dissipated the use of improvement huddles create an opportunity to support the continuity of the interventions in practice, to anticipate problems and review current performance. (Silver et al, 2016)	The DoSA team consisted of a small number of people and was led by the nurse manager working in the area. There was consistent evidence of engagement and feedback on both the positive impact of changes and issues as they arose. Problems were dealt with as they occurred and efforts were made to streamline some of the issues that were in their control to address. This approach has been maintained over the years reflecting the drive to continuously improve.
Implement Standard work	
1. People need to be informed about the change, trained and supported in the new way of working so that everyone in the system knows what to do and why, how, and when to do it, and how to adjust when necessary (Scoville and Little 2016) 2. Standard work should include a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities. (Silver et al 2016) 3. Make measurement systems permanent. 4. Develop Standard Operating Procedures (SOP's)to reflect the changes in practice, 5. Teach new approaches when inducting newly appointed staff, (Green et. al, 2019)	18 months post implementation, a review of the changes to practice confirmed that they were well embedded. These were not documented in the form of standard work or SOP's. It did not impact on sustaining the changes which could possibly be due to the small team running the service (only two people worked in DoSA)..
Continue to Measure	

1. Continue to measure, it provides objective information to determine if improvement is being sustained. (Green et.al, 2019) 2. Apply quality control which involves monitoring the system for stability, detecting emerging process problems, and taking steps to address them - special causes (Scoville and Little 2016). 3. Apply a continuous cycle from PDSA to SDMA throughout the improvement journey. The cycle of improvement moves to: Standard work, Doing, Monitoring and Adapting (Scoville and Little 2016). 4. Measurements should focus both on numbers and on experiences which ties into the need of keeping communication lines open throughout the cycle of improvement. (The NHS Scotland)	Once the improvement was achieved measurement continued post initial testing and data was collected and reviewed periodically depending on feedback re problems and when additional changes were being tested. Continuous measurement post completion was not maintained, A review in 2019 of causes for delayed start times led to improvements focused with specific teams for example the Plastic surgery service, this work will be presented in case study number 6. It also led to the re-establishing the improvement teams in case study one and two.
Develop robust systems	
1. Build contingencies for known exceptions, there are usually some exceptional conditions under which the change may not perform optimally or of which there is no previous experience. (Green et.al, 2019). 2. Adapt as part of the SDMA cycle for sustainability. It requires constant monitoring to pre-empt problems and subsequently testing changes through PDSA cycles to stabilise the improvement (Scoville and Little 2016).	Overtime, practice changes external to DoSA impacted on the service i.e change in admission pathway for day case patients were diverted to the unit. Initially the changes were unpredictable and were put in place in response to unscheduled care demand. It was unclear at the time if this change in practice would continue, therefore it took some time to understand the impact of the changes and the parts of the problem that could be addressed locally. The team did adapt and worked on addressing the following problems, all of which resulted in a reduction in delays: 1. Day- case patients arriving late. 2. Handover in theatre reception. 3. Porter assignment to theatre reception.
Plan to continually improve	
1. Acknowledge and accept that the healthcare environment is complex and is constantly changing whereby new processes can quickly become old processes that do not support the levels of performance	There were consistent efforts to highlight and address issues as they arose. The first phase of this improvement was to address the easier 'low hanging fruit', this was achieved, and the impact was spread across the service. When the complexities of the system became a factor to sustaining improvements, efforts were continued to

experienced (Green et. al, 2019). 2. Continue to apply techniques of setting goals, identify change ideas and measurement in response to patients' needs, known best practices and policy changes (Green et. al, 2019). 3. Create a culture that supports continuous improvement, the continuous search for opportunities for all processes to get better. (Green et. al, 2019) 4. Understand the system and processes that require improvement, identifying problems leading to poor quality, making improvements, adapting to constant changes inherent in complex systems whilst acknowledging that this effort and mind-set is required to create a culture for quality improvement (Mondoux 2017).	address problems. Formal and regular monitoring and review was not maintained, which at the end of 2018 led to an increase in start time delay which was addressed in early 2019. This demonstrates the need to for a formal sustainment plan, to ensure a robust and adaptive approach necessary in a complex healthcare system.

7.10 Conclusion

The case study presents the implementation of changes to practice to the DoSA service which proved successful in studies presented in case study one and two on improving theatre start times. This initiative focused on streamlining processes to plan for the pre-theatre phase of the patient's surgical pathway and to develop good communication practices between DoSA and theatre staff. The study describes the application in practice of the Model For Improvement, under the headings of planning, PDSA cycles, sustainability and spread of the learning to other areas.

Improvements in theatre start time for DoSA patients was achieved over 20 months with delays reducing from 26.5 to 10 minutes. This came from implementing efficient practices for all patients admitted via the DoSA unit. Over the duration of the study, practices were well embedded. Sustaining improvements was challenged due to changes to the day case pathway for admission. This required a refocus on interventions to adapt to the recent changes. Once energies were re focused, improvements in start time performance were regained. This is a real example of implementing change in complex systems. The need to monitor and

adapt and reach out to other services who are key to finding solutions. Throughout the study there was strong commitment from the manager and nurse in the service to drive and implement improvements in practice. This continued with the focused work with the Plastic surgery service that will be described in chapter six.

CHAPTER 8- CASE STUDY 4

8.1 Introduction

The following study was undertaken in the day surgery service between April and October 2017. Applying learning from studies described earlier; similar interventions were tested for all day- case procedures. The aim of the study was to improve start times in theatre for patients scheduled for day case procedures.

Day case procedures are performed by various surgical specialties for example: Urology, Orthopaedics, General Surgery, Breast Surgery, Colorectal and upper Gastrointestinal Surgery. A day surgery procedure means that patients have their procedure early in the day, recover and are discharged home on the same evening. There are protocols in place for the types of procedures that can be performed as a day case with the patients' medical status also considered. A theatre list for most specialties in this hospital consists of a combination of both day cases and inpatient procedures and are performed at the start of the day which ensures patients have recovered sufficiently for discharge on the same day. Day cases tend to have short procedure times (maximum up to 2 hours). Longer complex procedures are scheduled for the remainder of the theatre list.

The Day ward unit consists of 22-trolleys for patients to recover in post anaesthetic and an additional 10 'chair' area for patients having minor procedures who do not require a general anaesthetic. Over recent years, the capacity on the day ward has been increasingly used to admit unscheduled patients from the Emergency Department (ED). This practice is used to help manage the high volumes of patients in ED to ensure safe care to patients. The number of emergency patients admitted to the day ward varies each day. Attempts to have a consistent number of scheduled and unscheduled patients have been tried, however in practice, this is difficult which makes planning for elective day case admissions more complicated.

In February 2017, nursing staff in theatre suggested applying the learning from the three improvement initiatives described previously to the day surgery service. The successes achieved for example: a team focus on starting on time, efficient and timely pre-operative planning, anaesthetic pre-operative assessment, and good

communication regarding list order were appropriate in the day surgery context. The nursing team felt that the spread of successful changes to all day cases would positively impact daily on a number of theatre lists as the majority of specialties had day case patients scheduled on each list.

The median theatre start time delay for day-case patients was 20 minutes in February 2017 when measured on twenty-two theatre lists where a day case procedure was scheduled first. An analysis of causes for delay over eight days in March 2017 identified the following reasons: post-op trolley availability, adherence to theatre list order (1st patient scheduled first, done first), patient readiness, for example consent, medical admission, healthcare record availability and timely transfer to theatre. Five interventions were tested:

- Communication each morning on a dedicated phone between theatre and day ward nurse manager to discuss each patient's readiness for theatre and to confirm that the patient could be escorted to theatre.
- Patients scheduled 1st on the list were phoned the day prior to surgery and requested to arrive at the earlier time of 07:15 on the morning of surgery.
- Streamline registration of patients: patients scheduled first to be registered first.
- Patients having local anaesthesia were prepared in an alternate location.
- A daily afternoon meeting involving the day ward, theatre & patient flow managers was held during which the theatre schedule for the following day was reviewed, the 1st patient on each theatre list was confirmed and a post-op trolley was organised.

8.2 Methodology

An improvement methodology: The Model for Improvement by the Institute of Healthcare Improvement (IHI) was applied in practice to plan, test, analyse and implement the improvement interventions. The model for improvement (MFI) incorporates three questions and the PDSA cycle.

8.2.1 Question 1. What are you trying to accomplish?

The aim of this change project was to reduce theatre start time delay of 20 minutes to 5 minutes for day-case patients undergoing a surgical procedure who were scheduled first on the theatre list between April 2017 and June 2017.

8.2.2 Question 2. How will you know a change is an improvement?

The median start time delay for all inpatients admitted to the day ward who were scheduled first on a theatre list was retrospectively measured over one month on twenty-two theatre lists in February 2017. It showed:

- A late theatre start time of a median of 20 minutes.

The causes for delays reviewed over an eight-day period included:

1. Post-op trolley availability,
2. Nonadherence to theatre list order (1st patient scheduled first, done first) due to lack of awareness of theatre schedule,
3. Delays with patient readiness, for example consent and medical admission,
4. Availability of healthcare records,
5. Timely transfer to theatre.

Figure 18 shows the median start time delay in minutes being 20 minutes and figure 19, shows the causes for delay:

Figure 18: Case study 4. Theatre start time delay baseline data.

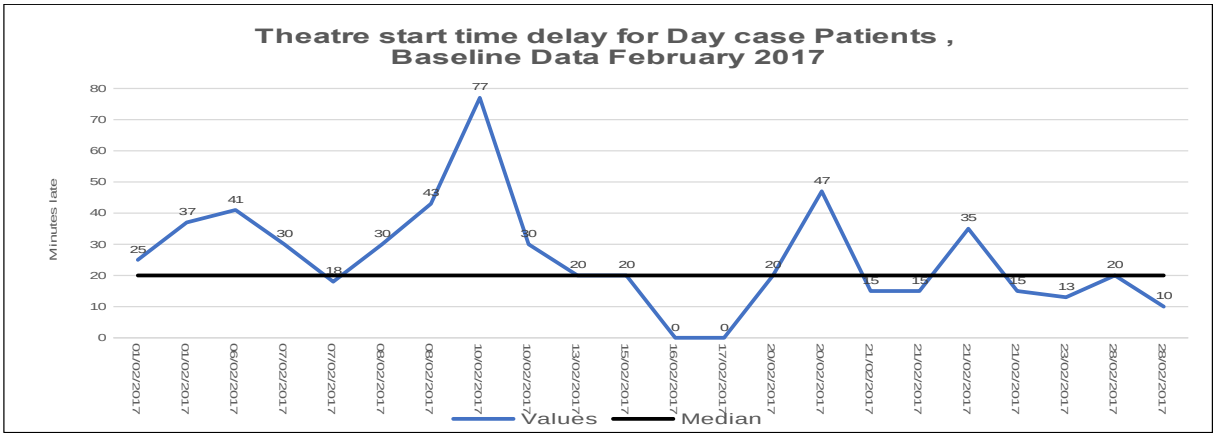
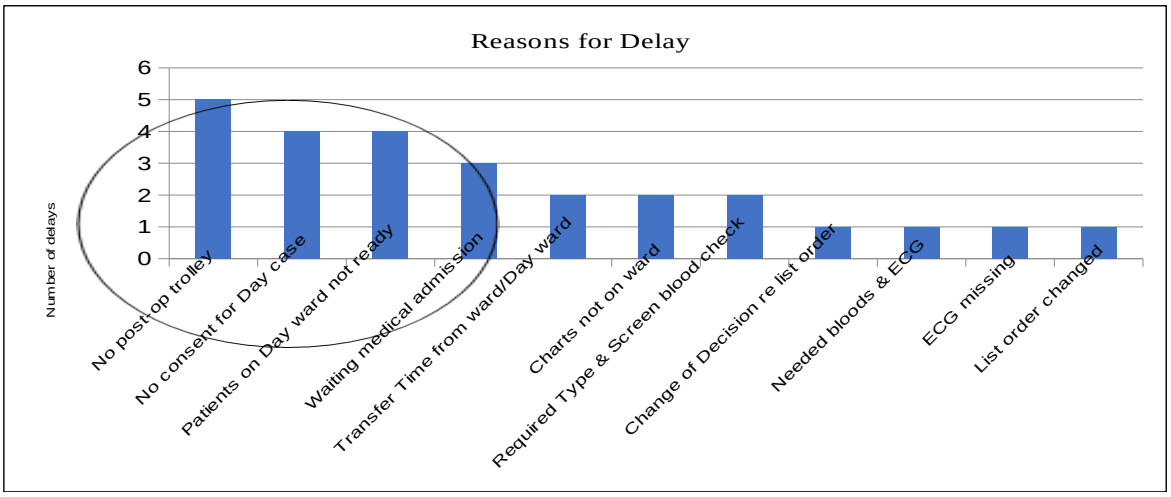


Figure 19: Case study 4. Reasons for delay in start time



8.2.2.1 Measurement plan

The following measures will be collected and analysed throughout the project.

1. Theatre start time delay in minutes on each theatre list when the 1st patient scheduled was undergoing a day case procedure.

2. Process measures include:

- Daily phone call between theatre and day ward to determine patient's readiness,
- Patient ready on the morning of surgery to walk to theatre at 08:10,

3. The causes for further delays will be recorded throughout the PDSA cycle.

8.2.3 Question 3. What changes can you make that will result in an improvement?

8.2.3.1 Formation of the Project team

An improvement team was formed consisting of day ward and theatre nursing staff. Initial discussions involved reviewing baseline data and the delay factors that contributed to the problem. The experience of the staff on the day ward was that there were four main causes of delay that were interlinked, for example if the patient did not have an allocated post –operative trolley then time was spent trying to organise this instead of preparing the patient for surgery, this subsequently delayed the medical team admitting and consenting the patient for surgery.

During team meetings, it became clear that staff in theatre were unaware of issues with patient readiness until they called for the patient to come to theatre after 8am each morning. Theatre start time is 08:30, defined as the time the patient enters the anaesthetic room. Staff on the day ward commented that they may receive numerous phone calls within a 10- minute period from each individual theatre with queries over patient's readiness for theatre; this was at a time that they were busy getting patients ready for theatre.

8.2.3.2 Change ideas

The team suggested one phone call from the theatre department directly to the nurse preparing the day cases at a specific time during which all the 1st day cases on the theatre list were discussed to confirm their readiness. This was the first intervention that would be implemented.

8.3 Testing changes in practice

At this stage, the team have identified the changes that they predict will result in improvement. The next phase in the quality improvement cycle involves testing out interventions in practice to determine if they result in an improvement. The PDSA (Plan, Do, Study, Act) cycle is a framework to test the change ideas. The PDSA process is described in detail in chapter four. The following are the PDSA cycles for this case study,

8.3.1 PDSA cycle 1

PDSA Improvement Cycle1	
Aim: Establish a communication process each morning to confirm patient's readiness for theatre by 8.10am**.**	
Prediction: It is expected that one phone call between the day ward and theatre will reduce the number of interruptions due to the frequent calls from each theatre. It is also predicted that the theatre department will be informed earlier in the morning of 1st patient's readiness and can subsequently plan for their arrival.	
Plan	1. Commencing March 27th, 2017, each morning the theatre manager to contact the day ward nurse at 07:45 on a dedicated phone held by the day ward nurse preparing elective day cases. 2. Both staff will discuss all patients scheduled first on each list to determine the patient's readiness for theatre and to confirm that the patient could be escorted to theatre. 3. The test will run over 10 days.

	4. The data collected will include start time for day cases scheduled first and if the phone –call took place.
Do	On March 27th, 2017, theatre and day ward staff started a daily communication asking the questions outlined below.
Study	**Data Review** **Outcome Measure.** The median start time delay over the following 14 days reduced from 20 minutes to 10 minutes (see figure 20 below). **Staff feedback/Process change review.** 1. One planned morning phone call which replaced the numerous calls avoided the delay that the theatre staff experienced when they had to wait to talk to the relevant staff member who was looking after the day cases for up-to-date information. 2. Theatre managers were becoming comfortable with their colleague contacting the day ward regarding their patient readiness and feeding back information to each theatre. 3. Staff on the day ward reported that by 07:45 they may not have assessed all patients and therefore may not have up to date information on delay issues. 4. In most cases the theatre staff were aware earlier in the morning of potential delays and could progress onto the next patient on the theatre list if problems were suspected. 5. Some patient delays were still experienced. 6. Improvements were achieved whilst unscheduled care patients continued to be admitted to the day ward.
Act	Continue to measure start time performance and causes for delay for 1st patients scheduled.

Questions to be asked at 07:45 daily call to the Day Ward.

Questions to be asked at 07:45 daily call to the Day Ward.

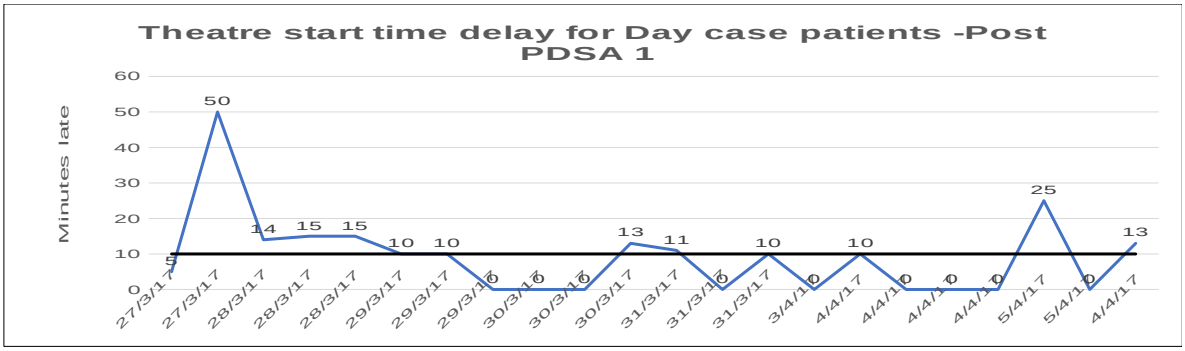
Aim: To plan for the on-time arrival of day cases in theatre reception area at 08:10,

Call 7348

1. Are the following patients admitted (List all day cases on the theatre lists)?
2. Will the 1st patient on each list be ready to come to theatre for 08:10?
3. Can the following patients walk to theatre?
4. Record on the theatre lists if the patient is cancelled or delayed.

Figure 20. Shows a further reduction in start time throughout April 2017 for all day case procedures scheduled 1st in theatre.

Figure 20: Case study 4. Theatre start time delay post PDSA 1

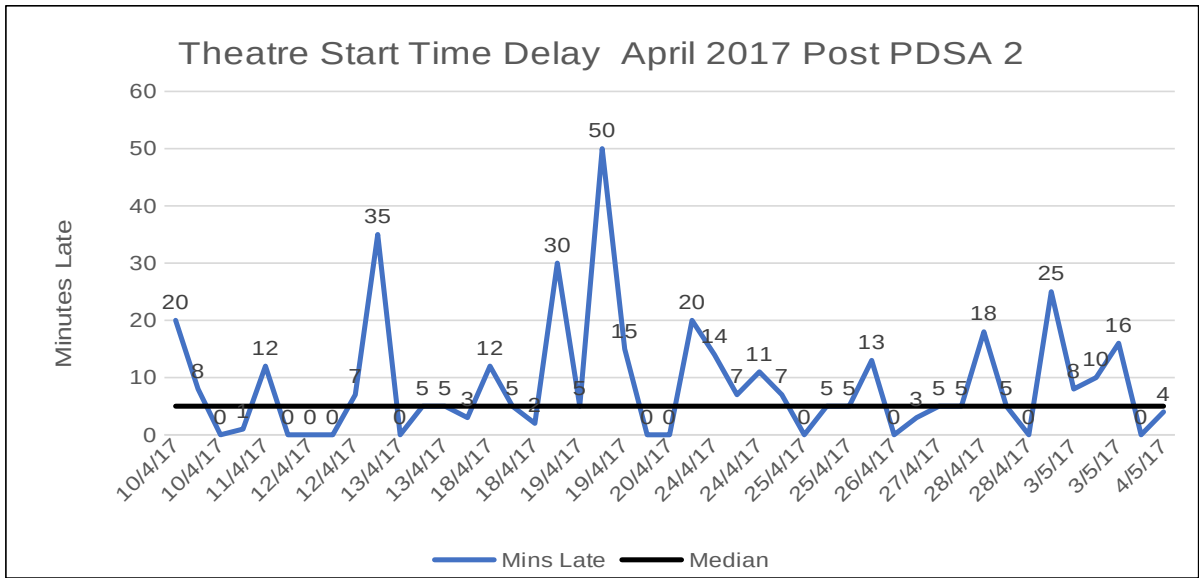


Note: there is more than one start time recorded for each date, this represents more than one day case patient scheduled 1st in a number of theatres on the same day.

8.3.2 PDSA cycle 2

PDSA Improvement Cycle 2	
Aim: Continue to measure start time performance and reasons for variation in start time.	
Prediction: The team felt there were other causes for delays that the phone call could not address.	
Plan	Commence a feedback approach between the day ward and theatre to understand the causes of delay as they arise.
Do	In April 2017, follow up each day on delay issues and collate the reasons for delays.
Study	**Outcome/Data Review** Start time delays reduced to a median of 5 minutes (figure 21). **Staff Feedback/Process change reviews.** 1. Nurses on the day ward were waiting for patients to be registered at 07:30 before they could start to assess/admit the patient. 2. Patients were arriving late to the day ward. 3. Patients attending theatre for procedures under Local Anaesthesia had to wait to get ready in the same area as nurses were taking hand-over from the night duty staff.
Act	Map out the patient pathway from 07:30am when the patient arrives on the day ward until they go to theatre at 08:10.

Figure 21: Case study 4. Theatre start time delay post PDSA 2



8.3.2.1 Process Mapping of pathway for patients from arrival on the ward until they go to theatre.

Analysis of the mapping exercise with staff on the day ward identified the following:

1. Patient's queue for registration on a first come /first served basis, irrespective of position on theatre list.

2. Registration staff did not have knowledge of theatre list order.

3. Nursing staff prepared patients once they were registered irrespective of whether they were first on the theatre list.

4. If patients arrive at 07:30, by the time they are registered, admitted by the nurse and doctor, it is difficult for them to be ready by 8am.

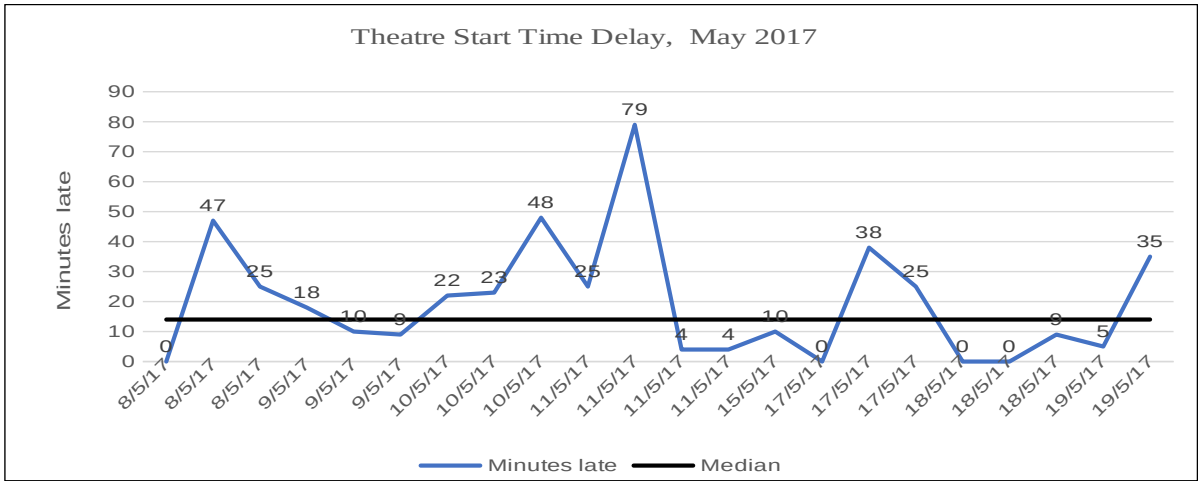
8.3.3 PDSA 3

PDSA Improvement Cycle 3	
Aim: Streamline the registration process on the morning of surgery.	
Prediction: Registration staff were concerned that they may not be aware of which patient is 1st on the list.	
Plan	1. Admissions staff to ask all patients scheduled 1st on the list on the afternoon prior to surgery to arrive on the day ward at 07:15. 2. Ward manager to inform the registration staff of patients scheduled 1st on the theatre list so that they know who to register 1st. 3. Registration staff to ask patients to present for registration according to list order.

	4. Ward manager to inform nursing staff of which patients to get ready 1st.
Do	In May 2017, the admission /registration and nursing staff worked on improving the early morning process.
Study	**Data Review** Delays in start time increased to a median of 14 minutes (figure 6). **Staff Feedback/Process change reviews.** 1. Staff worked on implementing the above. 2. It was difficult to confirm the 1st patients for theatre as patients although scheduled first did not routinely have a confirmed post –op trolley and therefore could not proceed to theatre. 3. Bed availability was an issue, where possible if a definite bed was available the process was carried out. 4. A new location on the ward was found for patients having local anaesthetic to get ready for theatre. 5. Feedback from staff was that changes implemented were making an impact and although the initial improvement in start time was not sustained it was better than the baseline level. <u>Feedback on the causes of increased late starts identified the following:</u> An increase in unscheduled care demand led to scheduled day cases being having to wait for a post-op trolley to be identified prior to going to theatre. Increasing number of patients were redirected to the DoSA unit to wait for a confirmed bed.
Act	To deal with the issue of redirecting patients on the morning of surgery to DoSA, Patient flow department representative (the dept., with responsibility for capacity allocation in the hospital) to be invited to look at a way for planning for expected over capacity demands on the day prior to surgery.

Figure 22 shows an increase in start time delay from 5 minutes to 14 minutes in May 2017.

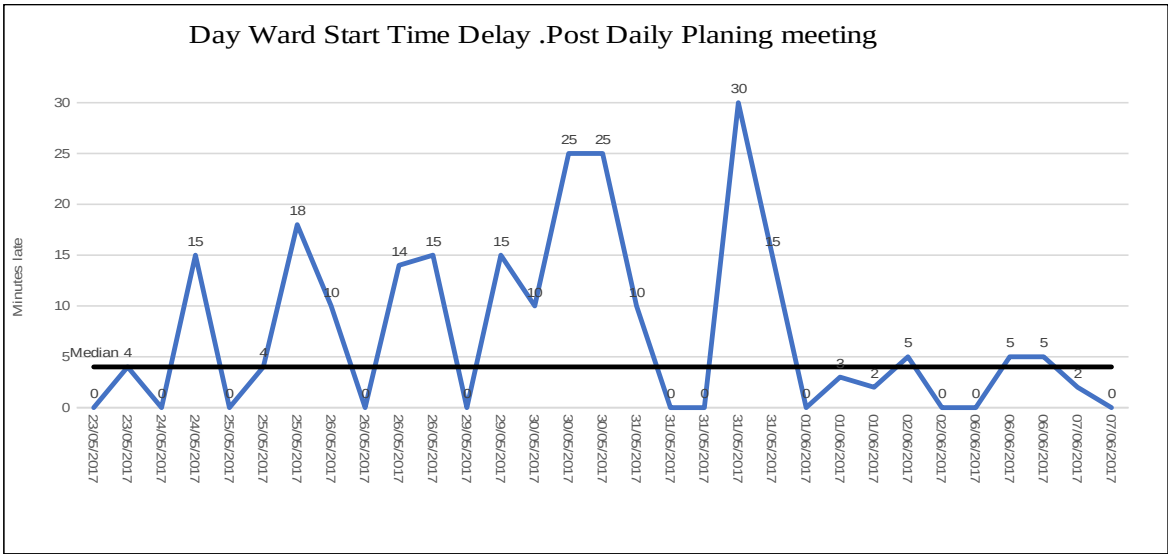
Figure 22: Case study 4. Theatre start time during PDSA 3.



8.3.4 PDSA 4

PDSA Improvement Cycle 4	
Aim: Implement a timely decision-making process for confirming the 1st patients on each theatre list with an allocated post-operative bed/trolley.	
Prediction: The team felt this was essential as patient flow department were integral to addressing this issue.	
Plan	Invite the patient flow manager onto the improvement team to assist with decisions regarding appropriate first patients on the following day's theatre list and to use this information to plan trolley allocation post –operatively.
Do	From 23rd May 2017, a short daily meeting involving patient flow, theatre and day ward nursing was held, each theatre list was reviewed and an appropriate 1st patient with a confirmed post-op trolley was agreed at this time for the following day list.
Study	**Data Review** Delays in start time reduced to a median of 4 minutes over the following 2 weeks (figure 23). **Staff Feedback/process change reviews.** During the test phase, meetings were held daily, although a definite post-op trolley could not be confirmed all the time, there was improvement in the appropriate first patient confirmed for theatre who had a trolley available. Over the month of August, the impact of unscheduled care on the day ward lessened therefore elective patients had access to trolleys each morning; the daily meetings were not required to continue. However, it was expected that demand for unscheduled allocation of trolleys would increase in the coming winter months and that it was timely to plan to sustain the improvements achieved.
Act	Plan to sustain the changes made that led to improvement.

Figure 23: Case study 4. Theatre start time delay post PDSA 4



8.4 Implementation

In September 2017, the improvement team regrouped to plan how the interventions could be standardised to sustain the improvements in day-case start times. An implementation plan was developed which incorporated the changes that were implemented, and which were required to ensure an on-time start time in theatre.

Implementation Plan for Day Ward Staff

The process to be followed by day ward staff planning and preparing patient for surgery.

Day Prior to Theatre

Theatre Lists printed off at 2pm

First patient listed identified on list, the following people are informed:

- ✓ Registration staff informed of the 1st patients for surgery, these patients will be registered 1st.
- ✓ Admissions staff to contact the 1st patients listed to ask them to arrive at 07:15 the following morning.

Charts of 1st patients listed are reviewed by nursing staff to check that patients have no outstanding requirements on the morning of surgery.

Post 2:30pm the theatre department is contacted on 8121 to discuss with the nurse in charge the plan for the 1st patients listed for the following morning.

Following this conversation, patient flow coordinator is contacted to inform of the 1st patients planned for surgery so that they will be allocated a post-operative trolley and are not diverted to DoSA.

Note: If the 1st patient isn't ready but the 2nd patient is, this should be discussed at the morning phone call as this patient may be suitable to go to theatre 1s

t

Morning of Surgery

07:45 Theatre Co-coordinator contacts nurse looking after day cases on 7348 to discuss the following:

- ✓ Will all day cases be ready for theatre by 08:10?
- ✓ Can the patients walk to theatre?
- ✓ If there are no delays predicted with the patients, they can then be walked to theatre after 8am (A follow-up phone call is not required)

8.5 Spread of Improvements

Improvement initiatives achieved in the day surgery service can be summarised as; (i) interdepartmental communication between theatre, day ward nursing and patient flow department and (ii) pre-operative planning to ensure patients readiness for

surgery. It required efforts in streamlining registration and adherence to list order when preparing patients. There were a number of tasks involved in achieving this as outlined in the PDSA cycles above. The changes are similar to those carried out in the previous case studies. They contribute to the growing body of knowledge on the factors that contribute to start time improvement within the context and culture of the research setting.

8.6 Sustaining Improvements

Compliance with the action plan was reviewed 2 weeks post implementation, the following issues were highlighted.

1. The majority of patients scheduled 1st on the theatre list were contacted to arrive earlier on the day of surgery.
2. During registration staff annual leave, staff covering the service needed to be informed to refer to the order on the theatre schedule when registering patients.

Other issues not previously experienced were impacting on day case efficiency. These included:

1. As the review was taking place it coincided with the ED wait-time target being reduced which increased the number of unscheduled patients being admitted to the day ward.
2. The timeframe to achieve the 15-month scheduled care target by the end of October was fast approaching. This resulted in increased elective admissions on the day ward with more patients being diverted to DoSA on the morning of their surgery.

8.7 Long-term sustainment

In October 2017, to balance scheduled and unscheduled activity, the day ward was used predominantly for admission of patients from ED. All scheduled day cases were admitted to the DOSA unit on the morning of surgery. Therefore, the study could not be reviewed for long-term sustainment of improvements in the context of day surgery services.

8.8 Learning from the study

This section will evaluate the case study under the following headings which relate to the research question which is:

Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

Firstly, the results of the study will be summarised. This will be followed by a tabled outline of the factors that contributed to improved performance, compared with those identified in the literature reviewed. In addition, the impact of using an improvement framework will be presented, outlining how the process and steps in the model were followed. Finally, a review of how well the improvements were sustained in practice will be discussed through a comparison with recommendations from the literature described in chapter four.

8.8.1 Results

Over the duration of the project start time delay in theatre for all day case patients scheduled first on a theatre list reduced from 20 minutes to 10 minutes with periods during which delays reduced to a median of 5 minutes.

8.8.2 Interventions that led to improved performance

Outlined in table 14 are the interventions that led to improved performance. Similar to previous case studies, interventions can be summarised under the headings of patient readiness, communication and post-operative trolley/bed identified.

Table 14: Case study 4. Factors that contributed to start time improvement

Concept	Factors that contribute to this/Evidence in practice	Evidence in literature
Communication/ Cross-departmental planning	1. Daily phone call at a set time between day ward and theatre manager to discuss patient readiness. 2. Daily huddle between patient flow department, theatre, and day ward to plan for the appropriate 1st patient. 3. Contact with the patient regarding arrival time. 4. Communication between nursing and registration staff regarding list order 5. Daily/regular feedback between day ward and theatre as issues arose led to problems being addressed as they arose.	New Finding
Patient Readiness	1. Streamline of the registration process to avoid queuing. 2. Adherence to theatre list order when preparing	Overdyk et al (1998). Panni et.al (2013)

	patients. 3. Medical records available for review prior to surgery	
Bed availability	Appropriate bed identified for the patient to return to post surgery.	New Finding

8.8.3 Application of the model for improvement in practice

The application of the improvement methodology in practice will also be reviewed and compared with the theoretical framework of the MFI to determine if it contributed to improving theatre start times. This will be described in table 15.

There was strong evidence of adherence to the principles of the science of improvement, for example staff working in both the day ward and theatre were able to express their experience and knowledge of the problem and possible solutions. This brought a system-wide approach and view of the existing processes. Measurement was evident throughout the project with baseline data, causes of variation and continued measurement as the improvement cycles progressed. Knowledge developed mainly supported the findings from previous studies on patient readiness, communication and appropriate first patient. Learning on change in complex systems for example the impact of interconnected processes like bed capacity was coming to the fore.

The three fundamental questions were incorporated and addressed, there was a clear and smart aim, good measurement, and positive brainstorming of creative ideas to improve. There were four PDSA cycles throughout the testing phase and the impact of each PDSA was measured both quantitatively and qualitatively. New to this case study was a detailed implementation plan, which outlined the steps in the process and a structured new way of working. This study did not have the benefit of a long sustainment phase as the day ward was used predominantly as an inpatient unscheduled care ward. Consequently, the process admitting day case patients was incorporated into the DoSA service.

Table 15: Case study 4. Application of QI in practice

Theory	Evidence in practice
Model for Improvement three Fundamental Questions	**Question 1. What are you trying to accomplish?**
	The aim of the improvement initiative was clear and SMART. **S**pecific: Theatre start time for all day case patients scheduled first on the theatre list. **M**easurable: Achieve a theatre start time of 08:30. **A**chievable: following the success of the first three case studies, the team felt the changes in practice could be achieved. **R**ealistic: the principles were in line with evidence in the practice changes required to make improvement in perioperative efficiency. **T**imely: Timeframes within which the change would be tested, and outcomes measured were clear in the aim statement.
	Question 2. How will you know the change is an improvement?
	A baseline measurement of start time and, the reasons for delay were collected in the planning phases of the study. The outcome of changes was recorded so continuous evaluation was feasible. The MFI and Green et.al recommend process and balancing measures to be collected, although feedback was sought and acted upon, they were not measured continuously or displayed graphically. The importance of these measures is that it is helpful to identify which changes are leading to improvement and the unintended consequences of the changes.
	Question 3 What changes will you make that will result in improvement?
	The team worked closely discussing the issues that needed to be addressed to achieve the aim of improving start time performance. The project started with implementing the learning from the previous case studies, one of the changes tested in this study relates to bed availability which impacted on case studies 1 and 2.
PDSA Cycle	There were four PDSA's in this improvement initiative. A clear aim of the specific cycle and the predicted outcome of the change were included. There were tasks involved in each PDSA and good evidence within the study phase of reviewing what happened both qualitatively and quantitatively. PDSA's were executed in quick succession which is recommend determining which changes led to improvement and also helped maintain motivation of the team.
Implementation	A structured approach to implementation was included in the study. A protocol for standardising the actions that had led to improvement was established, communicated, and reviewed.
Spread	Findings from this study built on the learning from the previous studies relating to improvements in pre-operative organisation and planning and the importance of communication between all contributors to the patient pathway. The interdepartmental planning meetings with patient flow, theatre, day and DoSA staff were replicated in case study 3.

8.9 Conclusion

This case study presents an improvement intervention in the day surgery service aiming to reduce start time delay from 20 minutes to 5 minutes for all patients admitted to the service scheduled first on the theatre list between April and October 2017. The background to the study incorporates the learning from the previous studies which motivated staff in both theatre and the day ward to improve efficiencies for day-case patients. The framework for improvement, called the MFI steps out the improvement process through the stages of planning, testing, implementing, spreading, and sustaining improvements. The PDSA cycles describe the interventions that were tested to improve start times, these were similar to those previously tested, for example, communication, patient readiness and adapting to unpredictable bed capacity, however the context changed whereby an increase in unscheduled demand prevented improvements being embedded and sustained.

Learning from the study highlighted the need to factor in complexity and context into planning and testing changes. It reinforced the need to test changes under various conditions to learn if the changes being implemented will be sustained as systems react to variation in practice. It also demonstrates that although the work did not continue, learning on the factors that contribute to improving start times was gained.

CHAPTER 9 - CASE STUDY 5

9.1 Introduction

The following study was undertaken in the Neurosurgery service between January 2018 and December 2018. Beaumont hospital is the national centre for neurosurgery in Ireland, providing a service for patients with acute neurological problems transferred from hospitals throughout the country and patients referred for planned treatment. On average, 2,300 neurosurgical operations are performed annually in Beaumont hospital: consisting of a mix of scheduled, urgent, and emergency procedures. Allocated theatre capacity consists of three designated theatres providing fourteen scheduled eight-hour theatre lists per week with access to the emergency theatre as required. The majority of procedures are complex and long, requiring highly skilled professionals and highly technical equipment. Bed capacity to support the service is managed within the neurosurgical service.

Waiting times for scheduled patients although has reduced exceeds the national target of 15 months. Due to lengthy procedure times, an average of 2 to 3 patients are scheduled on each theatre list which is low compared with specialties who perform a mix of shorter/day case surgery whereby four to five procedures may be performed within a similar timeframe, therefore meeting demand at the required pace is challenging.

Theatre utilisation within core time runs at a median of 90%, which is very high. Case type and duration of procedures generally contributes to high utilisation rates. There is some variation within this causing dips and peaks on the daily utilisation rates. Low rates of utilisation when examined are caused by cancellations primarily due to unavailable bed capacity and patients presenting medically unfit. Theatre overruns are frequent and on average, one of the neurosurgical theatre's (one third) overruns per day. This is caused by both the duration of procedure and process delays, mainly late start times.

Start time delays in neurosurgical theatres are a longstanding problem. Over 15 months from late 2016 to the end of 2017, there was a median delay of 10 minutes per neurosurgical theatre list. The main cause for delay on the morning of surgery

were: - patients were not ready for theatre as they required bloods and ECG's, pre-operative anaesthetic assessment, x-ray imaging and consent signing. There were also delays escorting patients to theatre.

The directorate management team for neurosurgery on reviewing the findings of the causes of inefficiencies and late starts in theatres proposed the establishment of a pre-operative assessment (POA) service and agreed to support this with providing the nursing resource to deliver the service. POA involves a clinical assessment of a patient's level of health and fitness for anaesthesia. The National Clinical Programme for Anaesthesia defines the aim of anaesthetic pre-operative assessment is to:

- Assess the patients' health status,
- Identify anaesthetic risk factors,
- Optimise the patient's medical co-morbidities pre-operatively,
- Organise access to health promotion programmes' (The National Clinical Programme for Anaesthesia, p. 12-13).

The establishment of the POA would address some of the issues but not all, as evident from the data, waiting for patient's arrival in theatre was the most frequent cause of delay due to transportation issues. In mid-2017 an improvement initiative commenced for patients to walk to theatre to deal with this issue which is common practice for all other specialties. This project ran alongside the development work for establishing the POA.

9.2 Methodology

The Model for Improvement by the Institute of Healthcare Improvement (IHI) was applied in practice to plan, test, analyse and implement the improvement interventions. The model for improvement (MFI) incorporates three questions and the PDSA cycle.

9.2.1 Question 1. What are you trying to accomplish?

The aim of this initiative was to establish a pre-operative assessment service for elective neurosurgical patients between March and June 2018.

9.2.2 Question 2. How will you know a change is an improvement?

Start time performance data was collected across three neurosurgical theatres between September 2016 and December 2017. It showed a median delay of 10 minutes. Figure 24 below demonstrates this. A review of causes of delay was undertaken between June and September, demonstrating that the reasons were multi-factorial. Figure 25 demonstrates the causes for delay.

Figure 24: Case study 5. Theatre start time delay baseline data.

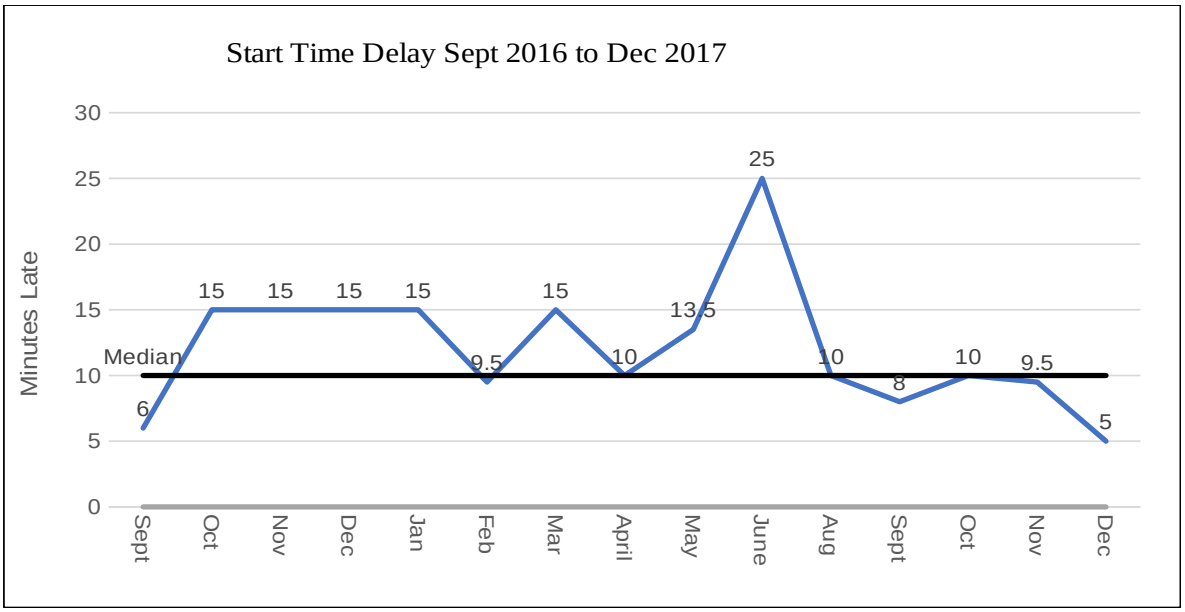
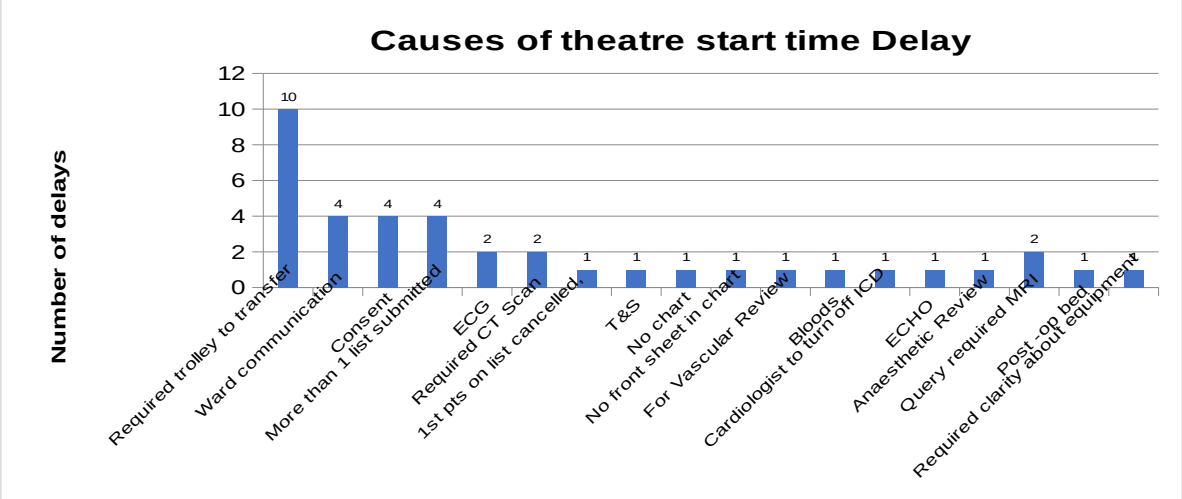


Figure 25: Case study 5. Causes of theatre start time delay.



9.2.2.1 Measurement plan

1. Number of patients pre-operatively assessed.

2. Number of cancellations due to medical reasons

9.2.3 Question 3. What changes can you make that will result in an improvement?

9.2.3.1 Formation of the Project team

A multidisciplinary improvement team consisting of theatre nursing staff, neurosurgical directorate nurse and business manager, administrative staff in the neurosurgery service, consultant neurosurgeon and consultant anaesthetist was established. Initial discussions involved reviewing baseline data, delay factors that contributed to the problem and the steps required to establish a POA service.

A process mapping exercise by the team stepped out the patient pathway from: allocation of a date for surgery to the POA appointment. Timeframes for each step was included in the process map. Additional retrospective data on demand for the service and timeframes from allocation of procedure date to theatre date was reviewed.

The improvement team agreed the initial steps to establish the referral process to POA and the location of the service.

9.2.3.2 Change ideas

The change idea was to establish a nurse delivered; consultant led anaesthetic pre-operative assessment service for elective neurosurgical patients.

9.3 Testing changes in practice.

At this stage, the team have identified the changes that they predict will result in improvement. The next phase in the quality improvement cycle involves testing out interventions in practice to determine if they result in an improvement. The PDSA (Plan, Do, Study, Act) cycle is a framework to test the change ideas.

9.3.1 PDSA cycle 1

PDSA Improvement Cycle 1	
Aim: To determine the demand for the service and plan how appointments will be scheduled for the POA service within the appropriate timeframe.	
Plan	1. Determine the demand for the pre-operative assessment service. 2. Analyse the time between the patient being allocated a date for surgery and the surgery date as this is relevant to allow for the scheduling and follow-up from the anaesthetic assessment. 3. Clarify and agree each person's role in process.
Do	1. In March 2018, data was extrapolated from the hospital administration system on planned surgery dates; this information was used to schedule a pre-assessment appointment within an appropriate timeframe. 2. Existing staff agreed to prepare the pre-assessment clinic, notify patients of their appointment, and undertake the administrative work involved supporting the clinic.
Study	**Data Review** A review of data by the improvement team on the demand for the service showed that: - A median of 35 patients has neurosurgical procedures per week, - Of this number, 20 patients are scheduled for surgery, - The remainder of the patients are transferred from other hospitals or admitted through the emergency department, - Initially the team need to schedule a minimum of 20 patients in the pre-operative assessment clinic per week. This excludes allowing for contingency in case of cancellations whereby additional patients require assessment and to plan for annual leave etc. - Mapping of the pre-assessment process with the current staff levels supporting the service showed a timeframe of 3 weeks was required to schedule and pre-assess a patient. **Staff Feedback** 1. A review of scheduled dates for surgery showed that 1 of 11 consultant's allocated dates on the hospital admissions system greater than 3 weeks ahead of surgery date. 2. Patients who had a short turnaround time between the date of scheduling and the actual surgery date made planning the service more challenging. 3. The scheduling process needed to be flexible to facilitate urgent referrals for patients who although were planned as opposed to an emergency admission were of a more urgent nature. These are generally patients who were reviewed in an out-patient clinic and admitted within a week for their surgery. 4. This was a new service being established without additional administrative supports. Administration staff started to prepare for the pre-assessment clinic, which involved: notifying the patients of their appointment, ordering healthcare records, and updating the IT scheduling system.

	5. Mapping the pathway from identification for surgery to completion of pre-operative assessment made understanding the importance of each person's role and the timeframes in which specific activities must be performed easier.
Act	Increase the number of referrals to the service through promotion of POA to consultant neurosurgeons and their medical teams.

Table 16 presents the source of admission for neurosurgical patients who had surgery over a 12-week period between February and June 2018. It showed that a median of 20 patients per week are planned electively. It also demonstrated that elective activity makes up 57% of the actual neurosurgical service.

Table 16: Case study 5. Sources of admission.

Source of admission				
Date	A&E	Elective	Transfers	Totals
29/01/2018	3	20	7	30
05/02/2018	7	14	14	35
19/02/2017	4	22	9	35
02/04/2018	4	14	16	34
09/04/2018	6	22	25	53
16/04/2018	5	20	15	40
23/04/2018	3	13	13	29
07/05/2018	2	19	6	27
14/05/2018	6	20	18	44
21/05/2018	3	21	18	42
28/05/2018	3	22	20	45
04/06/2018	0	17	7	24
Median	**3.5**	**20**	**14.5**	**35**
Total				438

9.3.2 PDSA cycle 2

PDSA Improvement Cycle 2
Aim: To promote the use of the POA service and ensure timely referral of patients to PAO by medical teams.
Prediction: Referral to the service by the medical teams will be slow. There is a need to factor access to bed

capacity for patients as it influences timing of patient preparation.	
Plan	Promote the service through engagement with consultants and their medical teams by. a) The business manager informing and updating consultants at monthly meetings, b) The POA nurse to meet with medical teams at OPD to discuss the referral of urgent patients, c) The POA nurse and administrative team member to map out the referral process for teams to follow.
Do	Between mid-March to April 2018, each person on the team agreed to promote the service through: - The business manager presented the referral process to consultant neurosurgeons at their monthly meeting, - The POA nurse and a member of the administrative support staff prepared and distributed written documentation of the process for referral to the neurosurgical teams during their outpatient clinics. The intention was to encourage the referral for urgent planned admissions whom following their OPD appointment would be scheduled for surgery within a couple of days, - The admissions staff member trialled communicating with one consultant and their team each week to discuss their planned patient's surgery dates, - Consultant anesthetists in theatre encouraged the neurosurgical teams to prepare their patients for theatre by referring to the service.
Study	**Data Review:** By the end of April the median number of patients having anaesthetic pre-assessment was 13 per week. **Staff Feedback** 1. Feedback from consultants was that they were supportive of the pre-assessment service. A concern raised was that access for neurosurgical patients for surgery was constrained due to the lack of bed capacity and insufficient theatre space. These challenges prevented planning of elective admissions 3 weeks in advance as high levels of cancellations disrupt scheduling of patients. Cancelled patients need to be rebooked into the following week's theatre session. 2. Pathways for referral including contact numbers for appointments were developed. Medical teams were spoken to in OPD and the pathway for both planned and urgent patients was explained. 4 teams were captured in this trial. 3. The admissions officer talked to 2 consultants about allocating surgery dates for the coming

	weeks. This information would be used to trigger POA appointments. 4. At the morning team briefing in theatre, medical teams were asked to refer patients for pre-assessment; this was a good opportunity to promote the benefits of pre-assessment especially when on two recent occasions patients were cancelled on the morning of their surgery as they were medically unfit. Anaesthetic pre-assessment would have prevented this. 5. One additional consultant discussed how they plan their patients for theatre a month in advance. They asked if the pre-assessment nurse could have access to this information system which could be developed as a referral system for their team. At this point two consultants were on board with a good system for referring patients to the service. The learning so far included the need for - a flexible approach to working with the medical teams, - to use the system that teams were already working within to plan their surgeries, - medical teams to identify patients that they intended on admitting for surgery in the following 3 months.
Act	Discuss with the various medical teams the processes they use to organise and plan their theatre lists in advance and if the POA nurse could be linked in with this system.

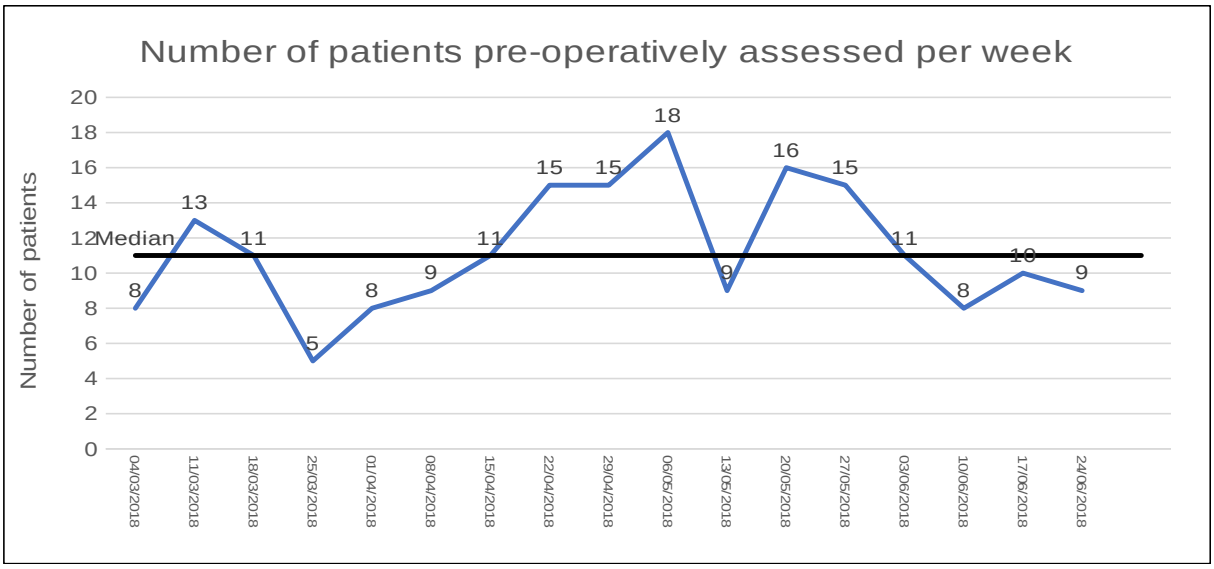
9.3.3 PDSA cycle 3

PDSA Improvement Cycle 3	
Aim: The POA nurse to connect with existing theatre planning systems and explore possibility of day of surgery admissions for elective neurosurgical patients.	
Plan	1. Ask consultants to describe their planning process for elective patients to determine if the POA nurse could link in with this process. 2. Use feedback from consultants on the lack of bed availability to explore how additional bed capacity could be created. The concept of day of surgery admissions was discussed. This was a practice already in place for other specialties, the neurosurgical service could link into the existing process.
Do	1. The POA nurse reviewed a soft copy of the waiting list booking card to check for specific detail regarding a plan for the patient which would not be included in the hard copy report. 2. An admissions staff member started to ask one consultant a week to prioritise a group of patients from their waiting list that require surgery within the next 3 months and use this information to schedule POA appointments.

	3. Discussions with the DoSA unit manager regarding neurosurgical patients being admitted on the morning of their operation, planning required to support this and the timeframe for these tasks. The Consultant staff and ward nursing staff were spoken to and emailed about trialling day of surgery admissions. The POA nurse and the bed manager for neurosurgery worked with the medical teams to identify appropriate patients for this initiative.
Study	**Data Review** By the end of May, a median of 15.5 patients were pre-operatively assessed per week, a slight increase since April. In June, the referral rate reduced to a median of 9.5 patients per week. 3 consultants out of 11 had a system to refer to the service. **Staff Feedback** 1. A 3rd consultant was consistently using the service; a communication process was put in place between the consultant, their team and the POA nurse where a plan for surgery dates for patients was discussed. 2. On reviewing the soft copy of the waiting list card, the POA nurse picked up information regarding the patient's requirements pre surgery and expected admission timeframe. 3. More consultants were referring patients on an ad hoc basis. 4. The improvement team felt they needed to continue promoting this service and start to collect and analyse some additional data about the impact of the POA on theatre and bed use. 5. Excellent feedback from the referring consultants using the service, this positive feedback needed to be used to encourage their colleagues to increase referrals. 6. Planning for morning of surgery admissions was going well with the intention of starting in June.
Act	1. Continue to engage with consultants and their teams through email, attendance at monthly consultant meetings and medical team's education sessions to promote the service. 2. Commence Morning of surgery admissions. 3. Explore the possibility of reviewing waiting list cards weekly to capture information regarding the plan for the patient. 4. Start to measure the value of the service, for example, the rate of cancellations due to patients being medically unfit, the number of patients having their surgery deferred due to problems being identified during pre-op assessment, the percentage of patients having surgery being pre-assessed and the impact on theatre start times if patients pre-operatively assessed were scheduled 1st.

Figure 26 demonstrates the number of patients pre-operatively assessed per week between March and the end of June 2018. A median of 11 patients were pre-assessed per week.

Figure 25: Case study 5. Patients attending pre-operative assessment



9.3.4 PDSA cycle 4

PDSA Improvement Cycle 4	
Aim: Continue to promote the service and present the value and benefits of POA to the neurosurgical consultants and their medical teams.	
Plan	1. Collect data on the value of the pre-operative assessment service. 2. Discuss with medical team's potential admission timeframes i.e. (within 0-3 months, 3-6 months etc.) for patients when submitting patient names for addition to the waiting list system.
Do	1. An admission staff member took responsibility to ask the medical team when requesting for the patient to be added to the waiting list: within what timeframe do you intend for this patient to have surgery? If the timeframe is within three months, the patient is referred for pre-assessment. The intention is to plan patients POA appointment in advance, improve communication and promote the pre-assessment service.
Study	**Data Review** By September 2018, there was an increase in referrals to the service to a median of 20 patients pre-assessed per week, this was sustained over 5 weeks. Over 6 months between March and September: - 351 patients were pre-operatively assessed from March to Sept, a median overall of 11 per week, however this number did increase to 15 per week between April and the end of May, - 31 patients had their surgery date deferred following POA as they required further treatment/tests, this resulted in more efficient use of theatre and bed capacity as other patients were scheduled instead for surgery, - An increase from 7% up to 54 % of elective patients were pre- operatively assessed, - 40% reduction in cancellations for Medical Reasons, - 32 patients admitted on Day of surgery, reducing pre-procedure Length of Stay,

	- Theatre start time delay reduced to a median 5 minutes for patients pre-assessed who were scheduled 1st, on the theatre list. This compares to all neurosurgical lists on which the overall delay was 10 minutes. **Staff Feedback** 1. At this stage there were more people driving the service. Simultaneously the business manager and pre-assessment nurse attended the medical teams teaching sessions to promote the service and provide feedback on progress. 2. Data was collected on the value of pre-operative assessment which was used in promoting the service. 3. The business manager attended regular consultant meetings to update on the service. 4. There was a positive outcome from the discussions with the medical teams. 5. Admissions on the morning of surgery commenced an average of 3 patients per week were attending the Day of Surgery Unit (DoSA).
Act	The next phase involved encouraging all consultants to consistently refer patients to the service, presenting data on the impact of the service to date and work specifically with medical teams to increase referrals to the POA service.

9.4 Implementation

At the end of September 2018, the POA service was well established. There was an increase in referral to a median of 20 patients per week throughout the month of September. However, variation in the number of referrals continued. For example, the number of referrals in October reduced to a median of 11 per week but increased again at the start of November. The implementation plan needed to incorporate efforts to continue to promote the service and monitor progress on referral rates. In summary the implementation plan involved:

1. Standardise the processes that create referrals to the POA service.
2. Continue to monitor progress on referral rates- The team planned fortnightly meetings to review POA performance measures, expansion of the service and to address issues arising.
3. Appoint a secretary to the service. This will reduce the level of administration work required by the POA nurse, therefore freeing up their time to assess patients and communicate with the medical teams.

4. The Busines Manager for the neurosurgical directorate took a leadership role for sustaining and continuing to develop the service.

9.5 Spread of Improvement Learning

The positive impact to date of pre-operative assessment on the readiness of elective patients has driven the project team with support from consultant anaesthetists to explore the possibility of anaesthetic screening of transfers in referring hospitals. As mentioned earlier around 30% of all admissions are transferred to Beaumont hospital for treatment. Some transfers are emergencies and come immediately to Beaumont, however, there are a cohort of patients who wait in the referring hospital between 2 to 5 days prior to transfer to Beaumont hospital. There was an opportunity for a system whereby the referring medical team completes a screening tool which includes a detailed medical history of the patient which is reviewed by an anaesthetist in Beaumont hospital. If additional investigations are required, this will be communicated back to the referring hospital so that the preparation for surgery can start before the patient arrives in Beaumont. This service was established in October 2019 and led to 72% of neurosurgical patients with a diagnosis of a brain tumour transferred to Beaumont hospital having pre-assessment screening.

9.6 Sustaining Improvements

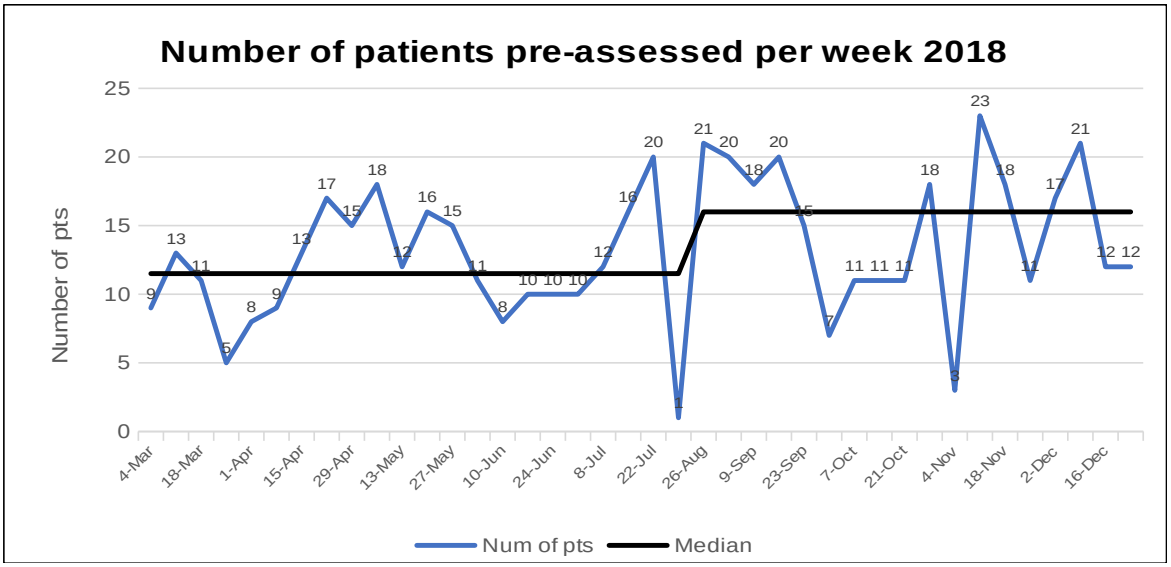
Attendances increased at the elective POA service to a median of 16 patients per week from July to December 2018. Variation in the rate of referrals continued. Feedback from the improvement team cited two reasons for this; (i) one person delivers this service, during their annual leave the service is paused and (ii) inconsistent referral patterns. The improvement team continued to:

1. Attend fortnightly team meetings where they reviewed data on number of referrals, process measures for example theatre cancellations, percentage of patients having surgery being pre-assessed and start times in neurosurgery theatre were reviewed intermittently.
2. Presentation on performance was reviewed at each meeting which provided the necessary information.

3. Address issues pertinent to each person on the team and escalate to the directorate management team if unable to do so.

Figure 27 demonstrates the number of patients attending pre-operative assessment weekly up to December 2018. A median of 11.5 patients attended pre-operative assessment per week from March to July. Attendances increased to a median of 16 patients per week from July to December 2018.

Figure 26: Case study 5. Attendance at pre-operative assessment 2018.

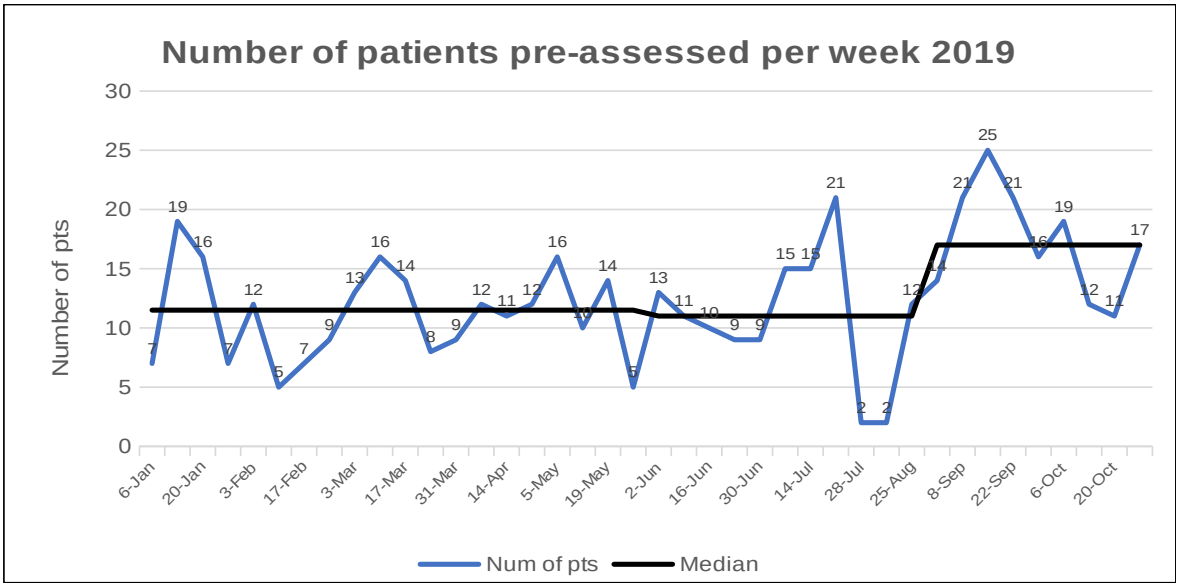


9.7 Sustaining improvements long-term

Between January and August 2019, the median number of patients attending the POA service dropped to 11.5 patients per week. The improvement team continued to explore ways to increase referrals. In September 2019, a new pathway for low complex straight-forward back surgery was commenced. Surgery for these patients was planned in a local elective surgery hospital which is part of Beaumont Hospital. At this time, patients with this diagnosis waited over 2 years for their operation. They experienced frequent cancellations as more urgent patients were prioritised for surgery. For patients to have surgery in the outlying elective hospital, anaesthetic pre-operative assessment was a pre-requisite to ensure that the patients' medical status fits the clinical criteria for this location. This initiative led to an increase in the numbers of patients attending pre-operative assessment each week and helped to engage the medical teams to refer patients to the service for patients attending Beaumont hospital. Through September and October 2019, the numbers of patients attending POA increased to 17 per week. Figure 28

demonstrates the numbers of patients attending the service per week, showing an increase in the median rate from 11.5 to 17 at the end of the year.

Figure 28: Case study 5. Attendance at pre-operative assessment sustainment phase



9.8 Evidence of Continuous Quality Improvement

As discussed in the implementation and sustainment sections above, the improvement team continued to develop the POA service. The neurosurgical service is a national specialty and is constantly challenged to meet emergency, urgent and elective demands. The approach taken by the team is an attempt to put order on a process that optimises patients' medical status for surgery. This pathway on its own is predictable and can be stabilised, however in a complex system like neurosurgery linear and non-linear process become entwined. It took unceasing efforts by the team who were constantly challenged with variation in rates of referral to keep focused on the efficient and effective use of the POA service. The service was established 18 months when they could see attendance numbers nearing the target of 18 patients per week. The commencement of a new pathway for low complex neurosurgical patients helped this and was a patient centred initiative to reduce waiting times which were over 2 years. The POA service was key to supporting this initiative.

Alongside the POA service for elective patients, a similar service started for transfer patients which has been very successful. Furthermore, patients were admitted on the day of surgery which reduced pre-op length of stay. The neuro service was

starting to weed out processes that can be streamlined and made more efficient. With this continued effort, inefficiencies in the service for example theatre cancellations, unnecessary pre-op length of stay and delays in theatre start time were addressed.

This study reflects how hard it can be to improve the healthcare system. It takes time and it is not simple. However, the team made great inroads to making changes that led to improvements which continued to grow throughout the project.

9.9 Learning from the study

This section will evaluate the case study under the following headings, which relate to the research question, which is:

Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

Firstly, the results of the study will be summarised. This will be followed by a tabled outline of the factors that contributed to improved performance, compared with those identified in the literature reviewed. In addition, the contribution of using an improvement framework will be presented, outlining how the process and steps in the model were followed. Finally, a review of how well the improvements were sustained in practice will be discussed through a comparison with recommendations from the literature described in chapter four.

9.9.1 Results

Between March and December 2018, the number of elective neurosurgical patients having an anaesthetic pre-operative assessment increased from zero to a median of 16 patients per week, increasing to 17 at the end of 2019. A target of 18 patients was set for the following year.

9.9.2 Interventions that led to improved performance

Outlined in table 17 are the interventions that led to improved performance. These can be summarised under the headings of; (i) early notification of planned surgery

dates (ii) developing a pre-assessment pathway for neurosurgical patients (iii) communication (iv) team willingness and leadership.

Table 17: Case study 5. Factors that contributed to establishing pre-operative assessment.

Concept	Factors that contribute to this/Evidence in practice	Evidence in literature
Notification of Planned surgery date	The neurosurgical medical teams started to provide dates for surgery of patients ensuring sufficient time for the patient to attend the POA service. A variety of methods were used, for example, IT system, individual teams planning meeting and identifying potential timeframes within which the patients would have surgery.	New Finding
Communication	Constant communication with consultants and medical teams regarding the POA pathway, referral system and outcomes of the service. This was a key feature of this improvement initiative.	New finding

9.9.3. Application of the model for improvement in practice

The application of the model for improvement in practice is outlined in table 9.9.3.1. There was strong evidence of adherence to the principles of the science of improvement. Staff in the neurosurgical directorate were clear about what was required to establish a POA service and identified the current challenges that needed to be addressed to deliver the service. The team worked together and were supported by leadership in the directorate to develop the service and address issues affecting the service. Measurement was evident from understanding demand for the service and feedback on the impact in theatre on the lack of a POA service. Three fundamental questions were incorporated and addressed, there was a clear and smart aim, good measurement, and positive brainstorming of ideas to improve. PDSA cycles were clear and the study of the impact of changes was deep which led to further cycles of improvement. Once the changes that led to improvement were established a formal implementation plan was developed with clear roles and responsibilities defined. Knowledge developed as the project progressed and was later applied for patients awaiting transfer for treatment of a brain tumour.

Table 18: Case study 5. Application of QI methodology.

Theory	Evidence in practice
Model for Improvement three Fundamental Questions	**Question 1. What are you trying to accomplish**
	The aim of the improvement initiative was clear and SMART. **S**pecific: Establish an anaesthetic pre-operative assessment service for neurosurgical patients. **M**easurable: Achieve assessment of 20 patients being pre-operatively assessed per week. **A**chievable: POA has been successfully implemented in other specialties, learnings can be applied in establishing this service for neurosurgical patients. **R**ealistic: POA is a key contributor to a safe and efficient pre-operative pathway for elective patients. **T**imely: Timeframes within which the change would be tested, and outcomes measured were clear in the aim statement.
	Question 2. How will you know the change is an improvement
	Baseline measurements of start time was retrospectively collected, the reasons for delay were subsequently collected in the planning phases of the study. Outcome measures were recorded so continuous evaluation was feasible, 1. Number of patients pre-assessed per week, 2. Percentage of patients having surgery pre-assessed, 3. Theatre start time, 4. Theatre cancellations.
	Question 3 What changes will you make that will result in improvement?
	Combining in depth knowledge from staff in the neurosurgical directorate, the anaesthetist providing POA service and involved in theatre along with knowledge of the existing POA service in the hospital, service demand and process steps to establish the service led to identifying the changes that would result in improved start time in theatre.
PDSA Cycle	There were 4 PDSA's in this improvement initiative. A clear aim of the specific cycle and the predicted outcome of the change were included. There were tasks involved in each PDSA and good evidence within the study phase of reviewing what happened both qualitatively and quantitatively. Clear actions from each cycle of change were featured in subsequent PDSA's.
Implementation	A structured approach to implementation was included in the study. The implementation plan demonstrates a continuous quality improvement approach in which the good practices that led to the establishment of the service were continued whilst efforts continued to grow and develop the service. Focused reviews of progress and performance were undertaken in the forthnightly review team meetings.
Spread	The learning from this study built on the learning from the previous studies relating to improvements in pre-operative organisation and planning and the importance of a multidisciplinary approach to system-wide improvement. Later, in 2019, a further initiative to pre-assess all patients with brain tumors who were being referred to Beaumont hospital was undertaken. Learning from this project has been applied but more importantly, the motivation and willingness to continuously

	improve the service for all neurosurgical patients both elective and urgent referrals was evident.

9.9.4 Sustaining improvements

In evaluating the study against the theoretical recommendations for sustaining improvement, outlined in table 9.9.4.1 below, the following learning has been gained. Firstly, in supporting the human side of change, there was excellent engagement, willingness, and commitment by all team members. Regular feedback on issues as they arose was evident which supported staff with problem solving and understanding the complexities of making improvements. A clear process for implementing standard work was defined and continued after the improvement were embedded. Measurement continued throughout the project improvement cycles, variation in performance was analysed and efforts to address this were taken on by the consultant team. A key feature of this project is the consistent application of the guidance on sustainability for improvement. This study did not end, the team continued to drive and develop the service using measurement and feedback to support their approach. They acknowledged the complexity of the service and worked within it to streamline the service.

Table 19: Case study 5. Comparison of factors that contributed to sustainment of improvements with theoretical recommendations.

Theory	Evidence in practice
Psychology of change 'The Human side of change'	
1. Connect with individuals' hearts as well as minds so that team members internalise the "rightness" of the change, (Green et. al, 2019) 2. Remind people why work is needed" requires engagement to connect with people's emotional, cognitive, and behavioural styles. (The NHS Scotland. NHSS) 3. Celebrate to reinforce successful behaviour with recognition and have a marker to remind people that the new way is better than before (Green et. al, 2019) 4. To continue the work after the initial enthusiasm has dissipated the use of improvement huddles create an opportunity to support the continuity of the interventions in practice, to anticipate problems and review	The improvement team were very motivated and believed in the rightness of the changes. Changes in the patient's admission pathway needed to be carried out by staff in the neurosurgical service, the request for the establishment of the POA service came from the theatre department, which was where the problem of the lack of the service was felt. This shows the connectedness and the recognition of the rightness of the change that the neurosurgical service felt, they were making changes for the betterment of patients. The team did celebrate their successes at the end of the project and presented at local quality conference for which they received a reward. Throughout the following year, the team met fortnightly and reviewed POA performance measures, expansion of the service and addressed issues that had arisen.

current performance. (Silver et al, 2016)	
Implement Standard work	
1. People need to be informed about the change, trained and supported in the new way of working so that everyone in the system knows what to do and why, how, and when to do it, and how to adjust when necessary (Scoville and Little 2016) 2. Standard work should include a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities. (Silver et al 2016) 3. Make measurement systems permanent. 4. Develop Standard Operating Procedures (SOP's)to reflect the changes in practice, 5. Teach new approaches when inducting newly appointed staff, (Green et. al, 2019)	New processes were developed as the POA service was established, staff working in this service developed the pathways, tweaking them as the work progressed. This made it easy to embed the practice changes, demonstrating the benefits of supporting staff at the frontline to guide and lead practice improvement. It allows improvement to evolve overtime, embedding it as it progresses. Formal documentation of SOP's was not completed, in this instance it did not impact on the service, as it is delivered by a small number of people and easier to sustain. One new member of staff was appointed and were trained in the new way of working.
Continue to Measure	
1. Continue to measure, it provides objective information to determine if improvement is being sustained. (Green et.al, 2019) 2. Apply quality control which involves monitoring the system for stability, detecting emerging process problems, and taking steps to address them - special causes (Scoville and Little 2016). 3. Apply a continuous cycle from PDSA to SDMA throughout the improvement journey. The cycle of improvement moves to: Standard work, Doing, Monitoring and Adapting (Scoville and Little 2016). 4. Measurements should focus both on numbers and on experiences which ties into the need of keeping communication lines open throughout the cycle of improvement. (The NHS Scotland)	Performance measures on POA activity, were reviewed fortnightly, process measures for example theatre cancellations, percentage of patients having surgery being pre-assessed and start times in neurosurgery theatre were reviewed intermittently. A presentation on performance was used which provided the necessary information. This project did move from PDSA to SDMA, progress and issues were discussed fortnightly and appropriate actions taken. The qualitative feedback was focused on as this provided the meaning behind the hard data and guided the revisions that were required.
Develop robust systems	
1. Build contingencies for known exceptions, there are usually some exceptional conditions under which the change may not perform optimally or of which there is no previous experience. (Green et.al, 2019). 2. Adapt as part of the SDMA cycle for sustainability. It requires constant monitoring to pre-empt problems and subsequently	From the outset, the project team were concerned about the length of notice on dates for surgery they get from medical teams, they predicted that it would be challenging to get all teams on board to refer patients to the POA service. This was a constant feature in the project and is evident in the PDSA cycles with various changes being tested, therefore contingencies were

testing changes through PDSA cycles to stabilise the improvement (Scoville and Little 2016).	constantly being built into the processes. In late 2018, the allocation of a theatre session for low complex neurosurgical procedures in a neighbouring elective hospital led to a cohort of patients being referred to the POA service. This was accommodated and was delivered seamlessly as there was capacity within the service. Continuous engagement and monitoring allowed for problems to be pre-empted and dealt with as they arose which naturally created a robust approach to delivering improvements.
Plan to continually improve	
1. Acknowledge and accept that the healthcare environment is complex and is constantly changing whereby new processes can quickly become old processes that do not support the levels of performance experienced (Green et. al, 2019). 2. Continue to apply techniques of setting goals, identify change ideas and measurement in response to patients' needs, known best practices and policy changes (Green et. al, 2019). 3. Create a culture that supports continuous improvement, the continuous search for opportunities for all processes to get better. (Green et. al, 2019) 4. Understand the system and processes that require improvement, identifying problems leading to poor quality, making improvements, adapting to constant changes inherent in complex systems whilst acknowledging that this effort and mind-set is required to create a culture for quality improvement (Mondoux 2017).	This project is an example of how challenging it can be to make improvements in a complex system. The neurosurgical service is complex, it is a national specialty, treating emergent, urgent, and elective patients. The team were relentless in their efforts to develop the POA service, showing evidence that they recognised the complexity of the service. This improvement initiative led on to the commencement of Day of Surgery Admissions (DOSA) pathway for appropriate patients and more recently has expanded to provide pre-assessment screening of all patients with brain tumors being transferred from external hospitals.

9.10 Conclusion

This study presents the implementation of an anaesthetic Pre-Operative Assessment (POA) service for neurosurgical patients undergoing elective surgery. Establishing a POA service was identified by the improvement team as a potential approach in addressing the causes of theatre start time delay.

The service was built from the start with resources and physical location quickly organised. Existing administration staff took responsibility to implement referral pathways to the service. Data was used to identify demand and capacity for the service.

The improvement team followed the steps in the Model For Improvement (MFI) methodology. The study was well planned and used the PDSA cycles to get to the core of the challenges that made expanding the service slow. A key strength of the improvement team was their efforts to focus and plan for long-term implementation and sustainment. They were relentless in their approach to continuously grow and develop the service and put in place the systems to support this.

The results of the study demonstrated that the numbers of neurosurgical patients having pre-operative assessment increased to a median of 17 patients being assessed per week. Over 60% of elective patients having surgery were assessed. It also led to the establishment of a DoSA service for neurosurgery, and in 2020 the concept spread to patients awaiting transfer to Beaumont Hospital for surgery.

CHAPTER 10 - CASE STUDY 6

10.1 Introduction

This study was undertaken in the Plastic Surgery service. Following on from the improvement work in the DoSA service, which is described in chapter 7, a focus on improving specific teams start time performance was deemed the most appropriate next step. Start times for plastic surgery procedures was noted to be an issue. Baseline data was collected and discussed with two consultant Plastic Surgeons who were interested in focusing on one procedure which is long and complex and is performed frequently. The procedure is called DIEP reconstruction. It is performed on females post mastectomy (removal of breast) and in layman terms is known as breast reconstruction.

The pathway for patients undergoing this procedure is: following a diagnosis of breast cancer, patients have a mastectomy procedure. On occasion a patient will have both a mastectomy and breast reconstruction (DIEP) at the one time but commonly, a patient will have a mastectomy and months later have their breast reconstruction. Patients undergoing this procedure are generally young, fit, and healthy and rarely present with other medical conditions. Following a consultant review, the patient will be admitted on the morning of surgery to the DoSA unit. Procedure duration ranged from eight to ten hours at the time. Post-operative management is complex, the patient is cared for in a single room on a ward which is heated at a specific temperature and requires close monitoring by nursing staff.

Plastics Surgery consultants were interested in trialling a pre-admission pathway for this patient group, seeing it as potentially a practical approach to dealing with a problem of understaffed medical teams whose busiest time is in the morning, reviewing and managing inpatients making it difficult for medical teams to admit patient’s on-time on the morning of their surgery.

Theatre start times were retrospectively measured on 10 theatre lists between September 2018 and January 2019, showing a median delay of 20 minutes.

Causes for delay were due to delayed medical admission on the morning of surgery. Four interventions were tested:

1. Preadmission of the patient on the afternoon prior to their surgery; this involved full medical admission including consent, medication prescription, clinical assessment and Type and Screen blood sample.
2. Creating a schedule of planned DIEP cases, a minimum of 2 weeks ahead of surgery date.
3. Patients to attend anaesthetic pre-operative assessment prior to surgery.
4. Nursing admission to be completed during pre-admission.

10.2 Methodology:

The Model for Improvement by the Institute of Healthcare Improvement (IHI) was applied in practice to plan, test, analyse and implement the improvement interventions. The model for improvement (MFI) incorporates three questions and the PDSA cycle.

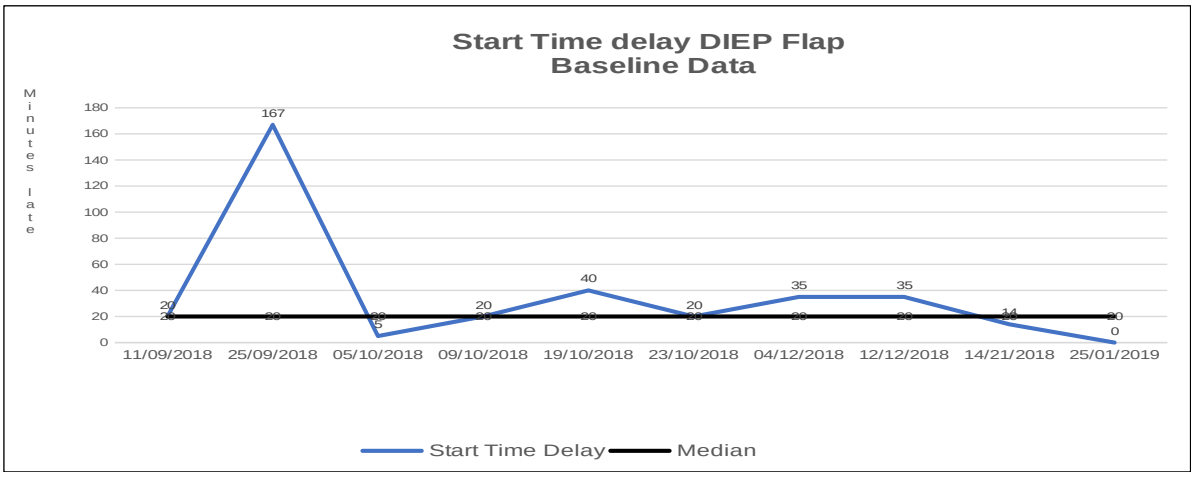
10.2.1 Question 1. What are you trying to accomplish?

The aim of the study was to reduce theatre start time delay from 20 minutes to 5 minutes for all patients undergoing DIEP reconstruction between March 2019 and July 2019.

10.2.2 Question 2. How will you know a change is an improvement?

Retrospective data measuring start time performance on 10 theatre lists between September 2018 and January 2019 was collected and analysed. It showed a median delay of 20 minutes. Causes for delay were also analysed and found that late medical admission on the morning of surgery was the main reason for delay. Figure 29 demonstrates baseline data.

Figure 29 : Case study 6. Theatre start time delay Baseline data



10.2.2.1 Measurement Plan

The following measures will be collected and reviewed to determine if the changes implemented leads to an improvement.

1. Theatre start time delays (Outcome measure).
2. Process Measures:
    - Patient attended Pre-admission,
    - Time patient ready in DoSA,
    - Feedback from medical and nursing staff,
    - Patient anaesthetically pre-assessed.

10.2.3 Question 3. What changes can you make that will result in an improvement?

10.2.3.1 Formation of a project team

A multidisciplinary improvement team was established which included three Consultant Plastic surgeons and their medical teams, admission staff, DoSA nurse manager, two theatre nurse managers, anaesthetic nurse manager, theatre porter, registration staff, and the surgical directorate nurse manager. There was commitment amongst the team to test the concept of a pre-admission service. Concerns were raised regarding notification of planned surgery dates as it takes time to co-ordinate preparation for the appointment and provide adequate notice to the patient.

The team stepped out the processes required to deliver a pre-admission service. From this, the change ideas were identified. These included:

10.2.3.2 Change ideas

1. Early notification of planned surgery dates for patients by the medical team.

2. Patient to attend anaesthetic pre-operative assessment.

3. Plan a pre-admission appointment for the patient on the day prior to their operation.

4. Notify the patient of their planned surgery date, pre-assessment and preadmission appointments.

5. Inform the medical team, DoSA nurse, healthcare records and registration department of the pre-admission appointment.

6. Inform the ward managers of the date for surgery so that an isolation room can be planned for in advance as well as nursing resource increased for close monitoring of the patient post-surgery.

10.3 Testing changes in practice

The team identified the changes that they predict will result in improvement. The next phase in the quality improvement cycle involves testing interventions in practice to determine if they result in an improvement. The PDSA (Plan, Do, Study, Act) cycle is a framework to test the change ideas. The PDSA process is described in detail in chapter four, section 4.8. The following are the PDSA cycles for this study.

10.3.1 PDSA cycle 1

PDSA Improvement Cycle 1	
Aim: Step out the actions and responsibilities to develop a pre-admission pathway**.**	
Prediction: The team were positive and felt the changes to practice could be implemented. Concerns were raised regarding sufficient notice of planned surgery dates.	
Plan	Starting March 26th, a patient undergoing a DIEP reconstruction will be pre-admitted the afternoon

	prior to surgery. To achieve this the following actions are required: Surgical admissions officer to: - Inform the patient of the pre-admission appointment, - Book preadmission appointment for the day prior to surgery with the DoSA nurse manager, - Arrange for the patient's healthcare record to be delivered to DoSA, - Inform the medical team member of the patient's appointment time, - Inform patient registration of the patient's attendance, - Refer the patient for anaesthetic pre-operative assessment. Consultant Plastic Surgeon to: - Inform admission staff of planned surgery dates for patients two weeks ahead of operation day, - Inform their medical team and agree a time for the patient to attend for pre-admission on the day prior to surgery. - Meet the patient in the DoSA unit on the morning of surgery at 07:45 for site marking. DoSA Nurse manager to: - Ensure patients healthcare record is available, - Complete a nursing admission. Measures to be collected include: - Theatre start time, - Time patient ready in DoSA, - Feedback from medical and nursing staff, - Patient attended Pre-admission, - Patient anaesthetically pre-assessed, Review progress with the team after each test and review formally after 10 cases.
Do	On March 21st, 2019 the 1st patient was pre-admitted for surgery.
Study	**Data Review** Theatre Start time delay: Patient 1- 10 minutes, (March 22nd) Patient 2- started on-time (March 26th). **Team feedback/Process change reviews.** - Pre-admission appointment went according to plan. - Both patients were ready by 08:00 and arrived in theatre reception at 08:05. - When the patient arrived in theatre on day 1, their trolley was not prepared

	(positioned properly). - The warming blanket was not placed on the trolley. - Surgical admissions officer had to follow up with the team for upcoming surgery dates. - Medical admitting team and DoSA nurse felt the pre-admission appointment was very well organised, calm and they could spend time with the patient instead of the usual rush at 7:30 in the morning to prepare patients.
Act	Staff in theatre reception to organise trolley preparation and set up prior to the patient's arrival. Consultant surgeon / team to inform the admissions officer of planned surgery dates for upcoming patients.

10.3.2 PDSA cycle 2

PDSA Improvement Cycle 2	
Aim: Streamline theatre reception process to ensure set up of equipment is complete.	
Prediction: The theatre team felt that the changes required could be delivered once good communication regarding planned DIEP surgeries was in place.	
Plan	- Prior to the next case on 5th April: - Organise a meeting to review the process in theatre reception for nursing staff and porter, - Admissions officer to discuss future dates for procedures with the consultants with the aim of creating a schedule of cases, - Admissions officer will refer patients for anaesthetic pre-assessment, - Measure for another 4 cases.
Do	A meeting with theatre staff was held at the end of March to discuss streamlining the reception process. This involved. - Theatre manager to be informed of upcoming DIEP cases by the theatre department manager. - Theatre CNM to inform the anaesthetic nurse and porter of planned cases so that; a) the warming blanket is ready and placed on the trolley and b) the operation trolley is in the requested position.
Study	**Data Review** On the 5th of April (3rd test) the theatre started on time. **Team feedback/Process change reviews.** - Preadmission appointment occurred as planned, - Patient was pre-operatively assessed by the anaesthetic nurse, - Patient had site marking at 07:45, - Patient arrived in theatre reception at 08:05, - Trolley was ready and in the correct position,

	- Admissions officer was receiving future dates for surgery.
Act	Continue to test for the next 4 cases.

10.3.3 PDSA cycle 3

PDSA Improvement Cycle 3	
Aim: Scale up the test by monitoring the next 4 cases on the pathway	
Prediction: The team felt very positive about the initiative and that it could be sustained long-term	
Plan	Review each case and formally meet as a team after 4 cases.
Do	Monitor start time and get feedback for the next 4 cases.
Study	**Data Review** - On 15th May (test 4) theatre start time was 10 minutes late, - On the 21st of May (test 5) theatre started 15 minutes late, patient required a further anaesthetic review, - On 14th June (test 6) start time was 30 minutes late. This was due to the temperature regulation system in the theatre not working. Specific temperatures are required for this type of surgery. - On 18th June (test 7) start time was 18 minutes late, this was due to the patient waiting for site marking. **Team feedback/Process change reviews.** - All 4 patients were pre-admitted and had attended anaesthetic pre-assessment. - Feedback from the medical team was very positive as regards a planned and calmer approach when admitting patients. - All patients had their trolley and warming blanket ready in theatre reception.
Act	1. Remind consultant of the timing for site making. 2. Monitor if consultant anaesthetic review in theatre reception continues to impact on start time. 3. Continue to review another 5 cases. 4. Organise a formal meeting to plan for sustainability of the improved process in August.

10.3.4 PDSA cycle 4

PDSA Improvement Cycle 4	
Aim: Continue to scale up testing and discuss site marking with consultants.	
Prediction: A solution should be easily achieved as the medical team are very motivated to sustain the improvements made**.**	
Plan	1. Discuss with the surgeon the timing of site marking. 2. Schedule a team meeting for July. 3. Monitor start times and get feedback from staff on delays.
Do	The surgeon was emailed regarding site marking.
Study	**Data Review**

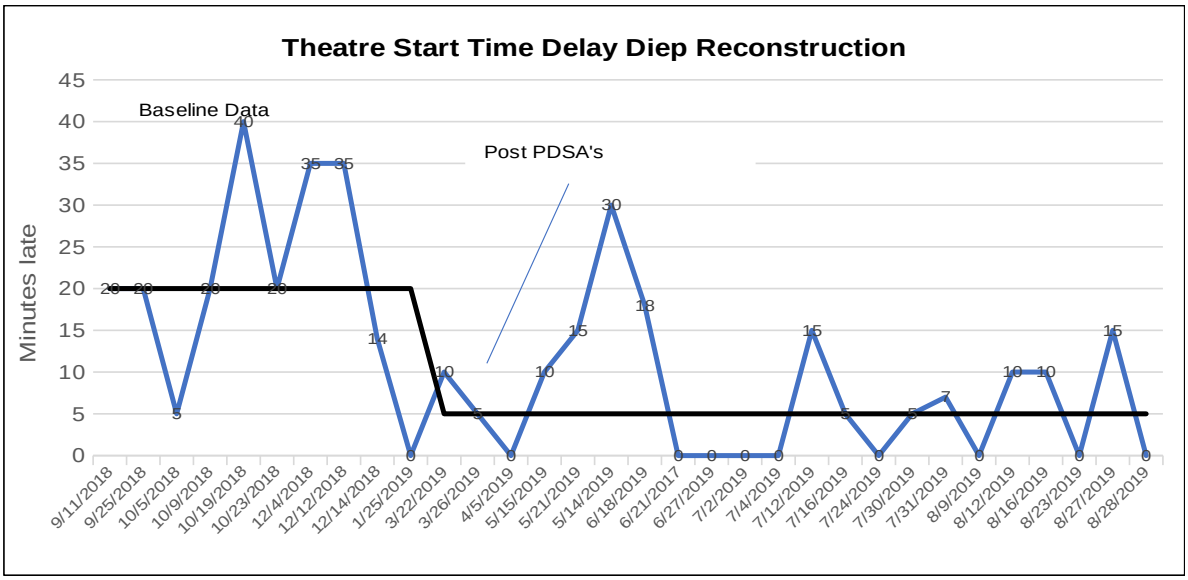
	The following 4 cases all started on time (pt. number 8,9,10 & 11). The 12th patient (12th July) was not pre-admitted due to changes in the theatre schedule. All other patients were. - Pre-admitted, - Had nurse-led anaesthetic pre-assessment, - Had site marking on time on the morning of surgery, - Had their trolley and warming blanket ready in theatre reception. **Team feedback/Process change reviews.** The admissions officer created a template with the planned dates for surgery, pre-assessment dates, pre-admission dates and this was circulated to theatre, medical teams, patient flow department and the surgical wards. The impact was that wards had longer notice to plan additional nursing staff as these patients needed one to one nursing on the 1st night post-op and a heated single room which can be difficult to organise. At the time, these procedures normally overran in theatre past 16:30 requiring additional nursing staff. Advanced notice facilitated planning staff appropriately. Feedback was very positive from the ward and theatre nursing staff. Planning to sustain progress included: 1. A presentation to teams newly appointed to Beaumont hospital in July outlining the process for pre-admission. 2. Practices of scheduling patients ahead, planning pre-admission and pre-assessment were well embedded and although one admission officer had taken the lead on this, they handed over the role to their colleague when absent.
Act	1. Continue to monitor outcome and process performance. 2. Review new issues that arise with the team and continue to make necessary changes and review impact.

10.3.5 PDSA cycle 5

PDSA Improvement Cycle 5	
Aim: Continue to monitor and plan for formal implementation and sustainment.	
Prediction: The team believed that the improvements achieved could be sustained.	
Plan	1. Schedule a team meeting for August to plan for formal implementation. 2. Continue to monitor start times and get feedback from staff on delays.
Do	A presentation to medical staff was delivered in July and a team meeting was planned for late August.
Study	**Data Review** Of the following 10 cases, up to the end of August- 3 lists started on-time and 5 started within 5 minutes. **Team feedback/Process change reviews.**

	The main cause for delay related to site marking
Act	1. Lead consultant will address site marking delay, 2. Continue to monitor outcome and process performance, 3. Formalise implementation plan.

Figure 30: Case study 6. Theatre start time delay post intervention.



10.4 Implementation

In September 2019, the improvement team led by a consultant plastic surgeon agreed the following plan to sustain the improvements made and to continue to focus on reducing variation. At this point, the improvements made were embedded. Table 20 outlines the implementation plan agreed by the team.

Table 20: Case study 6. Implementation plan

Implementation Plan September 2019

Medical Team

1. Plan surgery dates 2 weeks in advance.
2. Inform admissions team of planned dates.
3. Perform pre-admission on the day or within a few days prior to surgery.
4. Consultant to mark surgery site on the morning of surgery.

Admissions Staff

1. Inform the patients and agree planned dates for surgery and pre-admission appointments.
2. Update and circulate a template to all team members involved in the patient journey. This includes the following information:
    a. Patient name and age,
    b. Date of operation,
    c. Date of Anaesthetic pre-assessment,
    d. Date and time of pre-admission appointment,
    e. Patient informed,
3. Circulation list includes medical team, DoSA nurse, POA nurse, theatre manager, ward manager, patient registration, and healthcare records department.

Theatre manager

1. Inform anaesthetic nurse rostered on duty on the day prior to surgery to prepare for patient.
2. Inform theatre porter to have the trolley set up as required.
3. All necessary equipment set-up on the afternoon prior to surgery.
4. Monitor start time performance and review causes for delay following each list.
5. Escalate issues to the Theatre manager.

DoSA Nurse Manager

1. Prepare for preadmission appointment.
2. Complete nursing admission.
3. On the morning of surgery, escort the patient to theatre at 08:00.

Improvement team

1. Review start time performance and causes for variation monthly.
2. Improvement lead to address issues outside of the control of the improvement team.

10.5 Spread of Improvement Learning

The Plastics surgery medical team were very engaged and were keen to replicate the pre-admission process for combined cases performed with the ENT service. This surgery is very complex and requires specialist pre-operative preparation. In November 2019, consultants from both specialties, consultant anaesthetists, specialist ENT oncology nurse, ENT nurse manager and the theatre nurse manager stepped out pre-operative requirements. These procedures can take 10 to 12 hours, require large quantities of specialist equipment, double the level of theatre staff and specialist post-operative nursing care in a high-observation isolation room on a ward. Demand for these cases is growing and is predicted to be one case per month for 2020. Three planning meetings were held. The team also decided to start a communication ‘huddle’ on the week ahead of surgery. In January 2O20, the 1st case was performed. Feedback was very positive, the theatre day flowed more easily, and clinicians felt that the operation was shorter due to

improved efficiencies. The team regrouped following the case and shared the learning from the day and tweaked the plans for the 2nd case in February 2020. Due to Covid-19 further cases were deferred due to the risk to patients having surgery during this time.

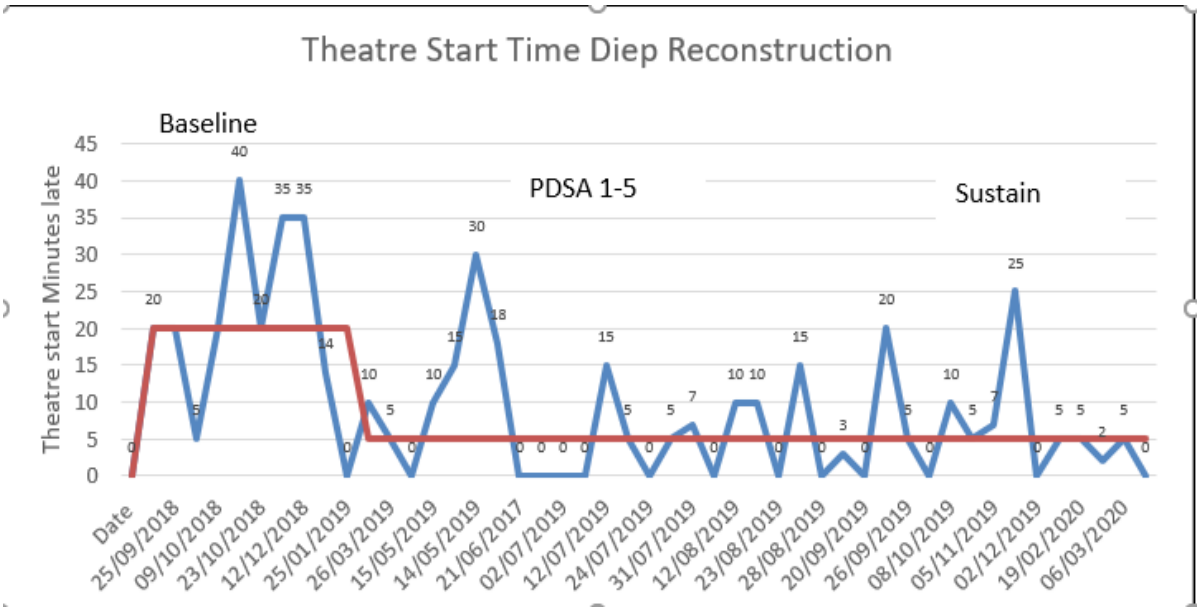
10.6 Sustaining Improvements

In December 2019, a review of theatre start time showed that performance was sustained at a median of 5 minutes. Some variation continued, this was due to one patient not attending pre-admission, and one patient delayed having site marking. However, at the end of November both lists started on-time. Practice changes were embedded. The implementation plan was adhered to.

10.7 Sustaining Improvements Long-term

In the timeframe from January 2020 to the start of Covid-19 in March, start time delay remained at a median of 5 minutes. The pre-admission pathway was well embedded with good adherence to standard work, monitoring of performance and continuation of work towards reducing variation. Figure 31 demonstrates the start time performance throughout the improvement cycle, from baseline, to intervention to sustaining improvements was achieved.

Figure 27: Case study 6. Theatre start time delay sustainment phase.


Theatre Start Time Diep Reconstruction
Baseline
PDSA 1-5
Sustain
Theatre start Minutes late
45
40
35
30
25
20
15
10
5
0
Date
25/09/2018
09/10/2018
23/10/2018
12/12/2018
25/01/2019
26/03/2019
15/05/2019
14/05/2019
21/06/2017
02/07/2019
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23/08/2019
28/08/2019
20/09/2019
26/09/2019
08/10/2019
05/11/2019
02/12/2019
19/02/2020
06/03/2020

10.8 Evidence of Continuous Quality Improvement

The team continued to monitor delays and work towards addressing variation in start time performance. This was evident in a sustained reduction in start time delay up to February 2020.

In conjunction with the initiative described in section 10.5, the consultant plastic surgeon and theatre nurse wanted to streamline the phase from ‘patient entry into theatre to ‘surgery start’. They mapped out this phase and worked on instrument preparation and creating specific preference instrument sets.

Secondly the template devised by admissions staff was adapted for other long complex procedures. It led to the creation of a theatre diary which was shared with theatre and ward staff.

10.9 Learning from the study

This section will evaluate the case study under the following headings, which relate to the research question, which is:

Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?

Firstly, the results of the study will be summarised. This will be followed by a tabled outline of the factors that contributed to improved performance, compared with those identified in the literature reviewed. In addition, the contribution of using an improvement framework will be presented, outlining how the process and steps in the model were followed. Finally, a review of how well the improvements were sustained in practice will be discussed through a comparison with recommendations from the literature described in chapter four.

10.9.1 Results

Overall start time delay reduced from a median of 20 minutes to 5 minutes between March 2019 and March 2020.

10.9.2 Interventions that led to improved performance.

Outlined in table 21 are the interventions that led to improved performance. These can be summarised under the headings of; (i) interdepartmental communication (ii) streamlined theatre reception process.

Table 21: Case study 6. Factors that contributed to start time improvement.

Concept	Factors that contribute to this/Evidence in practice	Evidence in literature
Interdepartmental Communication	Communication across all staff and departments involved in delivering care for patients undergoing DIEP reconstruction. A template was created with relevant information i.e., dates of surgery, POA, Pre-admission dates which was updated and circulated weekly.	New finding
Streamlined theatre reception process	Preparation of the procedure trolley and placement of warming blanked was in place by the time the patient arrived at the theatre reception	New Finding

10.9.3. Application of the model for improvement in practice

The application of the model for improvement in practice is outlined in table 22. There was strong evidence of adherence to the principles of the science of improvement, for example people's experiences and knowledge of the problem and possible solutions were articulated and involvement of staff across the episode of care brought a system-wide approach to the fore. Measurement was evident throughout the project and addressing variation drove PDSA cycles. Knowledge developed as the project progressed and was applied to another procedure in the Plastic Surgery service. Three fundamental questions were incorporated and addressed, there was a clear and smart aim, good measurement, and positive brainstorming of ideas to improve. PDSA cycles were clear and the study of the impact of changes was deep which led to further cycles of improvement. Once the changes that led to improvement were established a formal implementation plan was developed with clear roles and responsibilities defined.

Table 22: Case study 6. Application of QI methodology

Theory	Evidence in practice
Model for Improvement Three Fundamental Questions	**Question 1. What are you trying to accomplish?**
	The aim of the improvement initiative was clear and SMART. **S**pecific: Establish a Pre-admission pathway for patients undergoing a DIEP reconstruction procedure. **M**easurable: Achieve an on-time theatre start for all patients having this procedure and all patients to have pre-admission appointment prior to theatre **A**chievable: Elements of the pre-admission pathway have been developed in case study number 2; these were included in developing the pathway **R**ealistic: A well organised and efficient Pre-admission pathway is feasible with appropriate planning **T**imely: Timeframes within which the change would be tested, and outcomes measured were clear in the aim statement.
	Question 2. How will you know the change is an improvement?
	Baseline measurements of start time was retrospectively collected, the reasons for delay were subsequently collected. Outcome and process measures were recorded so continuous evaluation was feasible, 1. Patient having a pre-admission appointment prior to surgery, 2. Patients having anaesthetic pre-operative assessment, 3. Theatre start time.
	Question 3. What changes will you make that will result in improvement?
	Combining in depth knowledge from admission, DoSA, theatre nursing and medical team staff on the requirements for establishing a pre-admission service along with the learning from previous case studies supported the team in identifying the changes required.
PDSA Cycle	There were five PDSA's in this improvement initiative. A clear aim of the specific cycle and the predicted outcome of the change were included. There were tasks involved in each PDSA and good evidence within the study phase of reviewing what happened both qualitatively and quantitatively. Clear actions from each cycle of change were featured in subsequent PDSA's.
Implementation	A structured approach to implementation was included in the study. The team agreed each person's role and responsibility. One of the consultants agreed to deal with clinical issues as they arose. A plan was put in place for monitoring and review of progress and issues arising.
Spread	The learning from this study built on the learning from the previous studies relating to improvements in pre-operative organisation and planning and the importance of a multidisciplinary approach to system-wide improvement. Later, in 2019, a further initiative to develop a pre-admission pathway for patients undergoing highly complex surgery by the plastics and ENT service commenced. Learning from this project has been applied but more importantly, the motivation and willingness to continuously focus and work towards improving the efficiency of

	perioperative practice was evident.

10.9.4 Sustaining improvements

In evaluating the study against the theoretical recommendations for sustaining improvement, outlined in table 23, the following learning has been gained. Firstly, in supporting the human side of change, there was excellent engagement, willingness, and commitment by all team members. Regular feedback on issues as they arose was evident which supported staff with problem solving and understanding the complexities of making improvements. A clear process for implementing standard work was defined and continued after the improvements were embedded. Measurement continued throughout the project improvement cycles, variation in performance was analysed and efforts to address this were taken on by the consultant team. This improvement was well planned and was not affected by unpredictable events which made sustainment more achievable. The learning gained was applied to other parts of the theatre process and spread to a different more complex procedure demonstrating the drive for continuous improvement.

Table 23: Case study 6. Comparison of factors that contributed to sustainment of improvements with theoretical recommendations.

Theory	Evidence in practice
Psychology of change 'The Human side of change'	

1. Connect with individuals' hearts as well as minds so that team members internalise the "rightness" of the change, (Green et. al, 2019) 2. Remind people why work is needed" requires engagement to connect with people's emotional, cognitive, and behavioural styles. (The NHS Scotland. NHSS) 3. Celebrate to reinforce successful behaviour with recognition and have a marker to remind people that the new way is better than before (Green et. al, 2019) 4. To continue the work after the initial enthusiasm has dissipated the use of improvement huddles create an opportunity to support the continuity of the interventions in practice, to anticipate problems and review current performance. (Silver et al, 2016)	The improvement team were focused on the outcome from the start, there were advantages for all team members for example: Admissions staff received adequate advanced notice of dates for surgery, this led to: 1. Patients received sufficient notice of their surgery date, 2. Patients had anaesthetic pre-operative assessment, 3. Patients arrived ready to DoSA on the morning of surgery, 4. Nursing staff on the post-op ward had sufficient time to plan for additional staff to care for the patient and to organise an isolation room, 5. Medical team members were able to allocate time for the patient's pre-admission appointment which fitted into their work commitments and was carried out in a calm manner. These benefits led to instilling the rightness of change. The team met less frequently as the project progressed but often enough to monitor performance, deal with issues and maintain momentum and motivation.
Implement Standard work	
1. People need to be informed about the change, trained and supported in the new way of working so that everyone in the system knows what to do and why, how, and when to do it, and how to adjust when necessary (Scoville and Little 2016) 2. Standard work should include a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities. (Silver et al 2016) 3. Make measurement systems permanent. 4. Develop Standard Operating Procedures (SOP's)to reflect the changes in practice, 5. Teach new approaches when inducting newly appointed staff, (Green et. al, 2019)	1. The pre-admission pathway was documented for the team to follow. 2. A template with the planned dates for surgery, pre-assessment appointment date and time, pre-admission appointment date and time was developed and circulated to all the relevant staff. The admissions officer took responsibility for this and when they moved to a different area the work was handed over and continued. 3. When a new clinical team commenced working in the service mid-way through the project, an education session was held on the new pre-admission pathway.
Continue to Measure	
1. Continue to measure, it provides objective information to determine if improvement is being sustained. (Green et.al, 2019) 2. Apply quality control which involves monitoring the system for stability, detecting emerging process problems, and taking steps to address them - special causes (Scoville and	Theatre start time was measured continuously with 35% of cases starting on time and 59% starting within 5 minutes. Over the duration of the initiative a median of 5 minutes delay was sustained. Variation in start time was analysed as it occurred, the main reason was the timing of site marking which was

Little 2016). 3. Apply a continuous cycle from PDSA to SDMA throughout the improvement journey. The cycle of improvement moves to: Standard work, Doing, Monitoring and Adapting (Scoville and Little 2016). 4. Measurements should focus both on numbers and on experiences which ties into the need of keeping communication lines open throughout the cycle of improvement. (The NHS Scotland)	addressed with the medical team
Develop robust systems	
1. Build contingencies for known exceptions, there are usually some exceptional conditions under which the change may not perform optimally or of which there is no previous experience. (Green et.al, 2019). 2. Adapt as part of the SDMA cycle for sustainability. It requires constant monitoring to pre-empt problems and subsequently testing changes through PDSA cycles to stabilise the improvement (Scoville and Little 2016).	The pre-admission pathway could be described as a linear approach. Once the process was established with clear roles and responsibilities the initiative became well-embedded. The context was well understood, and external factors did not interfere with the provision of the service.
Plan to continually improve	
1. Acknowledge and accept that the healthcare environment is complex and is constantly changing whereby new processes can quickly become old processes that do not support the levels of performance experienced (Green et. al, 2019). 2. Continue to apply techniques of setting goals, identify change ideas and measurement in response to patients' needs, known best practices and policy changes (Green et. al, 2019). 3. Create a culture that supports continuous improvement, the continuous search for opportunities for all processes to get better. (Green et. al, 2019) 4. Understand the system and processes that require improvement, identifying problems leading to poor quality, making improvements, adapting to constant changes inherent in complex systems whilst acknowledging that this effort and mind-set is required to create a culture for quality improvement (Mondoux 2017).	The success of this project led to the commencement of a further initiative for complex combined Plastics surgery and ENT procedures. Plastic surgery consultants were very motivated and keen to spread the learning to a more complex procedure that they perform with ENT consultants. This initiative required comprehensive planning as it involved co-ordination between two specialties. This initiative which included pre-admission was applied for two patients, the feedback from both was very positive.

10.10 Conclusion

This case study presents the implementation of a pre-admission pathway in the plastic surgery service between March 2019 and February 2020. The pre-admission pathway was implemented for patients undergoing DIEP reconstruction. A reduction in start time delay from a median of 20 minutes to 5 minutes was achieved and sustained. Improvements were achieved through the following interventions: - (i) notification of planned surgery dates (ii) developing a pre-admission pathway (iii) communication (iv) team willingness and clinical leadership (v) streamlined theatre reception process.

The Model for Improvement methodology was applied throughout the study with strong compliance to the planning and testing phases. A formal implementation and sustainment plan were developed and were well embedded in practice when reviewed in February 2020. The learning gained from this study have been applied to case study number 1 and to further work by the plastic surgery team for combined complex procedures with the ENT specialty.

CHAPTER 11 – FINDINGS AND DISCUSSION

11.1 Introduction

This chapter will provide an analysis of the six case studies presented to answer the research question which is.

> *Explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and how can these be sustained long-term?*

The findings that support and strengthen existing literature and new findings specific to this study on the factors that contributed to improving and sustaining operating theatre efficiency will be presented throughout this chapter. An analysis of process issues that resulted in start time delays is outlined followed by the practice changes that were implemented in the perioperative process which led to improvement in theatre efficiency. Spreading the learning gained from the interventions implemented will be described.

A key focus of this study is to understand the factors that contributed to and affected long-term sustainability of improvements. A comparison of the use of a sustainment model in practice is outlined. The contribution of the project team's role in implementing and sustaining improvements is described to emphasise the importance of the human side of change and finally, the application and benefits of applying a scientific improvement methodology in practice will be discussed.

11.2 Causes for delays in theatre start times

This section will describe the problems that were identified across the six case studies which led to delayed start times in the operating theatre. A comparison of these findings with those presented in the literature review will be discussed. New findings relating to this study will be presented.

11.2.1 Delay factors that concur with the literature

There are common inefficiencies in the perioperative process that resulted in start time delays which are similar to those referred to in the literature. These included; (I) inappropriate first patient scheduled on the theatre list as demonstrated in case studies 1, 3 and 4, (ii) late medical admission of patients on the morning of surgery in case studies 1, 3 and 4, (iii) delays with patient registration in case studies 1, 2, 3 and 4,(iv) late transfer of the patient to theatre was evident in case studies 2, 3, 4 and 6, and (v) patients having assessments and investigations performed on the morning of surgery was evident in case studies 1,2,3,4 and 5. These findings in the context of the case studies carried out support, reinforce and concur with the findings in the literature.

11.2.2 Delay factors unique to this study

Unique to the case studies presented were three specific findings which were new to these studies. These included (i) nonadherence to theatre list order, (ii) unavailability of healthcare records and (iii) lack of a post-op bed or trolley to recover patients post-operatively. These problems arose in three of the case studies, 1, 3 and 4 which were undertaken in the General/ Breast surgery, Day surgery and DoSA services.

11.2.1.1 In adherence to theatre list order

This problem arose in case study number 1, 3 and 4. Medical teams schedule procedures on an electronic theatre system with a requirement to do so by 2pm on the day prior to surgery. This creates a planned theatre list which is viewed by theatre, day ward and DoSA staff. This information guides the staff in theatre on procedure set up for example, instruments and equipment required for the first patient. It guides the nursing staff in the DoSA and day case services to which patients to prepare first for theatre.

According to ward staff, it takes approximately 20 to 30 minutes for one patient to be admitted and prepared for theatre by nursing and medical staff. Therefore, it is important that all services are preparing the correct first patient. In case study number 1 (General/ Breast surgery service), between three and four patients are

scheduled on each theatre list, this includes a mix of day patients and inpatients. A problem arose whereby at times the medical team submitted the theatre schedule without approval from the consultant surgeon and consultant anaesthetist on the preferred order . On the morning of surgery last minute changes to the list order were made due to either patient needs or consultant surgeon preference.

In case study 3, in the day ward service, adherence to theatre list order was affected by a practice in the day surgery service when patients arrived for admission. Patients queued initially for registration according to a first come, first-served basis following which the nurse would commence their admission and preparation for theatre. The order of the theatre list was not considered when patients were being prepared which led to delays if a different patient was scheduled first for theatre.

In case study 4 in the DoSA service, list order was affected when a change to the process for admitting day case patients led to these patients being re-directed to the DoSA area to wait for confirmation of a post –operative trolley before going to theatre. This led to changes to list order on the morning of surgery to deal with the issue of unavailable bed capacity.

The problem of nonadherence to theatre list order, whereby the 1st patient scheduled on the theatre list is changed on the morning of surgery for a patient scheduled further down the theatre list results from many factors as evident across the three case studies. In summary they included planning the order of the theatre list without consideration for consultant preference, medical and anaesthetic history, pre-operative requirements on the morning of surgery, post-operative bed availability, and timing of both registration and nursing admission. This problem was not evident in case study number 2, 5 and 6 as in case study 2 and 6 only one procedure was scheduled on each theatre list (Oesophagectomy and DIEP reconstruction) and case study 5 focused on anaesthetic pre-assessment of neurosurgical patients.

11.2.1.2 Timely availability of Healthcare records

This problem was evident in case studies 1, 3 and 4. In case study 1, the initial challenge was to have the patient's healthcare records available for the weekly

planning meeting between the surgeon, anaesthetist, and nurse during which they discussed the upcoming theatre list and reviewed each patient's clinical status to ensure the required preparation was completed in advance. It also helped the team decide the appropriate 1st patient on the theatre list and pre-empt any anaesthetic risks.

The difficulty was agreeing who would order and collect the healthcare record and have it available for the weekly review meeting. The options were the secretarial staff to the medical team, but they already had limited resources, the surgical team was considered but this could not be a consistent solution and was an inappropriate use of medical staff time. Finally, after a few weeks of different solutions being tried, the theatre secretary took on this role. Further on in this study, availability of healthcare records on the DoSA unit on the morning of surgery became a problem when the theatre secretary was on leave and this role was not reassigned or a contingency plan put in place to take on this duty. This resulted in significant delays over a four-week review in 2019.

In case study 3 and 4 the problem was similar; healthcare records were delivered late to both units on the day prior to or morning of surgery preventing a review by nursing staff pre-operatively to check patient's clinical requirements and identify any outstanding preparation. This delayed preparing the patient on the morning of surgery as the first-time healthcare records were reviewed by the nursing team was when the patient was admitted.

11.2.1.3 Unavailable bed capacity

This problem was also experienced in case studies number 1, 3 and 4. Patient cancellation for non-urgent elective surgery due to unavailable bed capacity was a long-standing problem in the hospital. When this occurred, non-urgent patient's surgery was cancelled, this was agreed for the most part on the day prior to theatre**.** However, in late 2017 following a change to the admission process for day case patients, achieving an on-time theatre start was affected in all three case studies. It led to day-case patients waiting in the day ward until there was confirmation of a bed. Decisions regarding bed allocations were made later in the morning when discharges were identified. At this time patients did not go to theatre

until a potential bed was identified as it created a blockage in theatre recovery which led to a backlog in patients getting into theatre.

Furthermore, staff on the day ward found it difficult to manage inpatients admitted via ED along with elective day case patients. Patients were transferred to the DoSA unit to wait for surgery. This caused overcrowding in the DoSA unit and a shift away from day case patients having surgery first as was the norm. Consequently, inpatients were scheduled first which led to an under-resourced DoSA service which only had one staff member having to prepare between five and six inpatients for theatre by 8am. In the theatre department, staff made regular phone calls to the patient flow department and admission services to check which patients were ready for theatre and had a post –operative bed before they could proceed with the 1st patient going to theatre.

Table 24 compares the causes for delay across the six case studies with those reported in the literature.

Table 24: Chapter 11. Causes of theatre start time delay compared with the literature.

Problem causing start time delay	Case Study number	Evident in the literature
Inappropriate first patient scheduled on the theatre list.	1, 3,4	Yes
Non- adherence to theatre list order.	1,3,4	No
Late medical admission of patients on the morning of surgery.	1,2,3,4,6	Yes
Timely availability of healthcare records.	1,3,4	No
Delays with patient registration.	1,2,3,4	Yes
Unavailable post-op bed or trolley.	1,3,4	No
Late transfer of the patient to theatre.	2,3,4,6	Yes
Patients requiring assessments and investigations on the morning of surgery.	1,2,3,4 &5	Yes

11.3 Interventions that contributed to improvement in theatre efficiency

The following section will present the interventions that were implemented to address the problems outlined in the previous section and discuss how they contributed to improvement in theatre start time.

A comparison of the interventions applied across the case studies and those described in the literature will be outlined to support the literature from the context of these case studies. Finally, this section will also present the new interventions that were implemented which demonstrate the significance of applying solutions specific to the source of the problems experienced locally.

11.3.1 Interventions applied that support existing literature.

To answer the research question of which factors contributed to improvement in theatre efficiency mainly relating to start times, a summary of the interventions that proved successful were analysed and compared to the literature. As with the problems identified, there are similarities with the interventions applied across the six case studies and those that were evident in the literature. These included; (i) identifying an appropriate non-complex patient who had been pre-operatively assessed to be the first patient on each list which was an approach used in case study number 1, (ii) streamlining the registration process which was applied in case study 3,4 and 6 , (iii) patients undergoing pre-operative anaesthetic assessment as was established for neurosurgery patients in case study number 5, connecting OPD appointment with pre-assessment anaesthetic appointment which commenced in case study number 2, linking pre-admission and pre-assessment in case study 6, and (iv) patients attending a pre-admission clinic which was a pathway developed for patients in the plastic surgery service in case study number 6 and was in the planning stage in case study number 1 at the end of 2019. Summarising the interventions across the six case studies and comparing them to practice reported in the literature further supports the research on the impact of these interventions as contributing to efficiency in start times.

11.3.2 Interventions applied unique to this study

Findings that were unique to the case studies presented can be themed under the headings of a) inter-departmental planning and b) streamlining the handover process in theatre reception and c) implementing an earlier theatre start time for long procedures.

11.3.2.1 Interdepartmental and interdisciplinary communication

In case study 1, a new intervention involved weekly planning by the multidisciplinary team (consultant surgeon, consultant anaesthetist and theatre

nurse) to discuss planned patients for the following week's theatre list. The purpose of this meeting was to identify potential clinical risks, plan the most appropriate and time–efficient list order based on each patient's procedure and medical history. Further on, the PA set up a planning huddle with the medical team on the eve of their theatre list to co-ordinate each person's role on the morning of surgery to ensure a contingency plan was in place to deal with unforeseen demands to attend to other patients.

In case studies 3 and 4, to manage the impact of an unavailable post-operative bed or trolley on the morning of surgery due to changes in the admission process of day case patients, a daily afternoon meeting involving the day ward manager, DoSA manager theatre manager and patient flow co-ordinator was held. The theatre list for the following day was reviewed, the 1st patient on each theatre lists was confirmed, and a post-op trolley was organised by the patient flow department.

Specifically, in case study number 3, phone communication between the day ward and theatre was made every morning at 07:45 to confirm if the first patients for each theatre whereby a day case was scheduled first was ready to walk to theatre at 08:00. This helped theatre set up for the appropriate case and if there was an issue with the first patient, they could progress onto organising for the second patient with enough time to achieve an on-time start.

This concept was spread into case study number 6 whereby the admission team co-ordinated the plastics surgery patients for admission and developed a template outlining planned future surgery dates, anaesthetic pre-operative assessment dates and pre-admission dates. This information was circulated to the theatre department, DoSA unit, pre-operative assessment, healthcare records and registration department and allowed these services to plan their episode of the patient's pathway.

System-wide problem-solving approach was a new way of working. Day ward, DoSA and theatre previously worked independent of each other even though they all had the same purpose and goal and relied heavily on each other for a smooth pathway for a patient having elective surgery. It helped form relationships across the perioperative system resulting in improved communications and inter-service

planning. This new approach is evident across all case studies, there was a connection formed between theatre and external services, communication either in the form of daily huddles or team huddles as seen in case study number 1, 3 and 4 or notification protocols in case study number 2 and 6 which contributed to achieving greater theatre efficiency.

11.3.2.2 Streamlining handover process

In case study 4, the theatre nursing team and DoSA nurse manager worked on streamlining the handover process for patients scheduled first on the list. A problem arose when the DoSA nurse walked patients to theatre and waited to handover the patient to the theatre staff. The longer the DoSA nurse was away from the unit the longer it took to get subsequent patients ready. The theatre reception nurse at this time in the morning would be checking in an average of eleven patients so that each theatre could start their list.

The change involved, the DoSA nurse completing the pre-operative checklist as usual and once they were confident that the patient was completely ready for surgery, they would escort the patient to the reception area, inform the theatre reception nurse that the patient had arrived and was ready for surgery and the patient was guided to their designated waiting area. The DoSA nurse would return to their unit and continue to prepare the remaining patients for surgery. The reception nurse checked-in the patient. It reduced time spent waiting for a theatre reception nurse to accept the patient, this time was reallocated to speeding up preparation of other patients admitted on the morning of surgery. Handover processes were also a factor for patients undergoing DIEP procedure in case study 6 and in case study 2 for patients undergoing oesophagectomy procedures. A second check-in of the patient was carried out by the anaesthetic nurse prior to the patient transferring into the theatre to confirm patient readiness for anaesthesia and surgery.

11.3.2.3 Implementing an earlier theatre start time for long procedures.

In case study number 2, to reduce theatre overruns for a long procedure the example being oesophagectomy which is performed by the upper gastro-intestinal service a change to the theatre start time from 08:30 to 07:30 was introduced. Achieving an earlier start time required revision to the existing pre-operative pathway to ensure all the necessary preparation was timed appropriately. It

involved earlier medical and nursing admission on the morning of surgery and a multidisciplinary team effort by the registration staff, specialist nurse, DoSA and theatre nursing, consultant surgeon, medical team, and the consultant anaesthetist to have the patient and theatre ready on time.

11.3.2.4 Timely availability of healthcare records

The new approach to addressing this issue was evident in case studies 1, 2, 3, 4 and 6**.** In case study number one whereby the healthcare record was required for the list planning meeting between the surgeon, anaesthetist and theatre nurse, a process was established for which the theatre secretary took responsibility to pull information from the surgical teams scheduling diary and using this information to request patient's healthcare record in sufficient time for review. As the project progressed, to address the problem whereby the healthcare record was not available in the DoSA unit on time on the morning of surgery an additional process was put in place to ensure the theatre secretarial staff member delivered the medical chart to the DoSA unit on the afternoon prior to surgery.

In case studies 2, 3 and 4, to ensure availability of the patient's healthcare record in the DoSA unit and Day ward, a system was put in place between these areas and the healthcare records department whereby all medical charts for the following days admission were delivered by 12 md on the day prior to surgery so that nursing staff had time to review clinical information for the following day.

In case study number 6, the admissions staff member who co-ordinated the planning of pre-operative preparation (anaesthetic pre-assessment and attendance at pre-admission clinic) devised a template that was circulated to the relevant staff involved in patient preparation which was used to order the healthcare records for the pre-admission appointment on the day prior to the patient's surgery.

11.3.3 Conclusion

In summary, answering part one of the research question which is: what improvements contribute to reducing start time delays, the first attempt to do this is to understand the problems causing delays to ensure the appropriate solutions are tested in practice. In the six case studies reviewed there were similarities with

common problems reported in the literature except for a) in adherence to theatre list order, b) unavailability of the patient's healthcare record and c) a significant issue which was available bed capacity.

Interventions that resulted in improvements are similar to changes reported in the literature. However, new findings, for example interdepartmental and interdisciplinary communication to plan patient preparation, list order and bed availability post-op, realigning the pre-admission pathway and starting theatre early all proved successful in reducing start time delays. Supporting improvements in all six case studies led to spreading the learning from each study and testing it in subsequent studies in different contexts. This approach contributes to a continuous improvement approach to improving theatre efficiency.

11.4 Spread of learning across the studies

The key learning's gained as each case study progressed, led to a continuous growth in knowledge and understanding about the functioning of the operating theatre service and specifically the factors that contribute to its efficiency. Examples of this are evident in case studies number 1 & 2, the earlier studies from 2016. As new interventions were being trialled in these case studies mainly in pre-planning patient preparation, multidisciplinary communication and planning for upcoming lists, anaesthetic pre-operative assessment, streamlining the pre-operative phase and the admission process on the morning of surgery, the successes of these interventions were naturally reaching across practices in the DoSA service and creating an interest and enthusiasm for change in both the day ward and DoSA unit. The practical learning and the enthusiasm for improvement led to the commencement of the 3rd and 4th studies in these services.

Furthermore, the challenges of lack of bed capacity, its impact on planning and delivering of the theatre service and the long-term sustainability of improvements elevated the learning on complex systems and how change can be made within them. Assimilating the learning's from the four case studies on problem identification, application of interventions, creating improvement teams and sustaining improvement in complex healthcare systems and applying this to case

studies five and six has contributed to using a model for improvement that is much broader than implementation through focusing on sustainment.

The spread of learning gained from each improvement made is absent in the literature reviewed. Each study reported in the literature led to an improvement either in one specific specialty with some studies taking a theatre wide approach however the studies did not describe how learning was spread between studies Context is an important consideration in improving quality which is why spreading the learning and testing interventions in various conditions is important in learning about spreading improvements.

11.5 Sustaining Improvement long-term

This section focuses on sustaining improvement in the complex setting of healthcare. It involves linking the six case studies presented to the research question which examines how improvements are sustained. The importance of longitudinal studies and how this contributes to analysing sustainability will be discussed. A review of how improvements were sustained over time will be presented. Recommendations for sustaining improvements in practice will be used to evaluate if the studies applied this theory and if it contributed to sustainability. Finally, new findings on the impact of context and complexity on sustainability will be presented.

11.5.1 Study Duration

It is feasible to examine the concept of long-term sustainability as five of the six case studies were undertaken between 12 and 20 months which provides ample study duration to explore sustainability. A detailed analysis of the factors that contributed to sustained improvement was undertaken between six- and twenty-four months post completion in five case studies.

Eleven studies that focused on improving operating theatre start time presented in the literature spanned between two months and five years. Reference to the factors that contributed to long-term sustainability was not included. There is a gap in the literature on improving efficiency in operating theatres where sustaining improvements is discussed in detail. New findings of this research study relate to planning for sustainment.

11.5.2 Analysing if improvements were sustained

Analysis of the case studies between six- and twenty-four-months post completion involved using the sustainability guide by the Institute of Healthcare Improvement's (IHI) whitepaper on sustaining improvements. The recommendations for achieving sustainment were used to compare if these factors were considered across the case studies. The sustainment cycle that the IHI uses involves; Standard work, Doing the new practices, Monitoring performance and progress and Adapting to changes in performance. It is abbreviated as SDMA. (Ref- Scoville). The following section will review each of these stages of the sustainment cycle across the case studies. Firstly, a summary of the outcomes sustained will be presented.

11.5.2.1 Outcomes sustained

A review of outcomes sustained between six- and twenty-four-months post project completion in five of the six studies identified that in four of the case studies there is evidence of better performance when compared to baseline data (case study 2 & 3) with two of the studies showing sustained improvement from project end (case study 5&6) of which one showed even better performance.

Case study 1, when reviewed 12 months post project completion, showed a median start time delay of 10 minutes which was an increase in delay from project end but an improvement from baseline performance of 16 minutes. Case study 2 had a slight increase in delay from 0 to 5 minutes following project end but sustained a significant improvement from 48 minutes pre-intervention. The findings from the first 2 case studies show that both continued to sustain an improved performance from baseline without a dedicated focus i.e., implementation and sustainment plan for 12 months with practice changes that led to improvement being well embedded in study 2 but less so in study 1.

Both studies were also reviewed 2 years post project completion. At this time case study 1 had deteriorated significantly with start time delay increasing to 40 minutes when measured on seven theatre lists demonstrating the impact of the lack of standard work, monitoring and adapting to process changes that occurred. Case study 2 remained at 5 minutes delay but experienced new causes for variation in performance requiring further PDSA cycles.

Case study 3 demonstrated an increase in delay from project end but achieved a slightly better than baseline performance reducing delays from 26.5 to 23 minutes. Change practices were well embedded, the factors that contributed to a deterioration in start time performance were team specific which spurred the next phase of work which was commenced with the plastic surgery service described in case study 6.

Case study 5, reviewed 12 months post project completion showed an improvement following project end increasing the number of patients attending anaesthetic pre-operative assessment per week from 16 to 17. Finally, case study 6 which was reviewed 6 months post project completion and found sustained improvements achieved in reducing delays from 20 minutes to 5 minutes. The next section will provide a summary of compliance within the studies of adherence to SDMA cycle.

11.5.3 Implementing Standard Work

The literature on implementing standard work presented in chapter 4, section 4.8.2, suggests that “standard work includes a written narrative of the improvement activity that describes the process steps, their sequence, the approximate amount of time required, and personnel responsibilities” (Silver et.al., 2016). Across the first three case studies, formal implementation of standard work was not evident. In case studies 1,2 and 3 written protocols or guidance on the new change practices were not developed. In addition, Green et.al (2019) recommends that standard work also involves “making measurement systems permanent, developing standard operating procedures to reflect the changes in practice, teaching new approaches when inducting newly appointed staff, including new roles in job descriptions, incorporating new activity into individuals’ personal objectives, etc”. Likewise, a detailed implementation plan outlining these key roles and responsibilities was not established.

Learning at this point from the first 3 studies did influence case studies 4, 5 and 6. In case study 4 a detailed implementation plan was developed but this study ended soon after. Case studies 5 and 6 benefited from the learning from earlier studies and put formal plans in place to embed new work practices with responsibility for monitoring performance and managing the change in practice. In case study 1 when the team reconvened in 2019 they identified a project lead and implemented

a system for monitoring performance and variation, and continued to do PDSA cycles to adapt to process changes.

11.5.4 Doing the work / implementing new practice changes

It is evident that in case studies number 2, 3, 5 and 6 that the changes to practice which led to improvement were well embedded when reviewed six to twenty-four months post project end. Although the level of improvement in start times did slip in studies one, two and three, changes to practice were continued.

In case study one, (reviewed 2 years post project completion) weekly multidisciplinary team review of patients for surgery on the following week to identify pre-operative requirements and potential risk factors continued but list order was not consistently adhered to and the medical team were intermittently late arriving to DoSA to admit the patient on the morning of surgery.

In case study two, (reviewed 2 years post project completion) pre-operative planning, attending anaesthetic pre-operative assessment, notification to theatre of dates for planned cases, scheduling one procedure on the theatre list continued however, rostering theatre staff to prepare the theatre and receive the patient in theatre reception was not adjusted when the start time changed from 07.30 to 8am.

In case study three, (reviewed 6 months post project completion) change practices on, reviewing the theatre system to plan for the 1st patient on each theatre list, healthcare record reviews and commencement of theatre paperwork ahead of the day of surgery and communications with theatre staff if they had any concerns about patient readiness for the following morning continued.

In case study four in the day surgery service, practice changes were not continued due to a change in the admission process for day cases which led to day case patients being reassigned on the morning of surgery to the DoSA unit.

In case studies five and six, practice changes were well embedded when reviewed twelve and six months respectively post project completion.

11.5.5 Monitoring Performance

Continued monitoring of performance involves measuring outcome measures and observing for variation. On reviewing if outcomes and causes of variation were continually measured, it was found that this was not so in case studies 1 and 2

when reviewed 2 years post project completion. The impact of not continuing to measure in study 1 was evident when increasing start time delay in 2019 led to an analysis of the causes for delay which found, unavailable healthcare records on the morning of surgery along with changes to list order, which caused lengthy delays in theatre start times on the morning of surgery.

In case study 2, when the team regrouped in 2019 to discuss how they could restore on-time theatre starts the causes for delay became clear. The team were not aware that the changes to theatre staff start times were impacting on the time patients were being transferred into the theatre.

In case studies 3, measurement of variation was on an infrequent basis as it was felt that it would be more appropriate to work with individual teams to spread improvements across the services. Case study number six is an example of this.

In case study 5 pre-operative assessment attendance and causes of periods of lesser attendance were reviewed fortnightly. Likewise, in case study six, start time performance and causes of delay continued to be measured post project completion.

11.5.6 Adapting to process changes and problems

Regular team reviews of improvement progress and challenges strengthened by monitoring performance and having a clear understanding of each person's role and responsibility in the new practices continued in case study number 3, 5 and 6 post project completion. In case study 3, the DoSA manager continually escalated process issues both with medical teams and theatre. In case study 5 and 6, there was a system in place for reviewing performance and acting on problems that the teams were faced with. The benefits of teams continuing to monitor performance, discuss and address challenges is that they developed skills to analyse problems and worked towards addressing these as they arose, which contributed to a continuous improvement cycle.

In case studies 1 and 2, a system was not established to continue to sustain improvements. The four stages outlined in the IHI guidance are interconnected. For example, if standard work practices including assigning responsibility for leading, managing and performing new work practices and if performance was measured then the team would have visibility on slippage in performance and would have

clarity on why this was occurring through analysing variation. Therefore, implementing a system to proactively address new problems through further PDSA cycles which was required in case study 1 and 2 in 2019 to restore improved performance would support the team to adjust to revised processes.

The findings from the studies concurs that if a sustainability plan which incorporates; a) monitoring performance, b) standard work, c) doing the work which involve changing practice and d) adapting to problems when they arise then long-term sustainability can be achieved.

The recommendation from the IHI was applied in practice in case studies five and six. This attention to planning sustainment of improvements could be contributed to applying the learning from earlier studies. Case studies 5 and 6 started in 2018 which at this point a lot of lessons had been learnt from undertaking the first four case studies along with greater academic learning on the application of the model for improvement. The learning gained offers a practical example of how quality improvement is a skill that needs to be practiced and repeated to continuously evaluate the process. Reference to applying a sustainability approach is not present in the literature on improving operating theatre efficiency. Therefore, these findings can build on the improvements reported in the existing literature.

Acknowledging the findings above, it is important to explore other reasons why three of the case studies show continued and sustained improvement. Already discussed is the fact that learning's from earlier studies (1, 2, 3 and 4) relating to planning for sustainment was applied in studies five and six and that there was only slight deterioration in theatre start time in case study number 2 which was addressed. Further analysis of case studies 2, 5 and 6 compared with 1, 3 and 4 illustrates how the study context and complexities of the processes involved in the studies needs to be incorporated into the sustainment plan.

11.5.7 Impact of context on sustaining improvement

In practice case studies two, five and six were able to follow a systematic approach to planning, testing, implementing and sustaining improvement. This is not to under-estimate the work involved in each phase of these studies. Particularly in case study five it took a lot of effort to increase the number of referrals to the pre-assessment service. All the studies required, improvement team willingness,

problem identification through performance data monitoring and team feedback, reorganising and re-ordering of existing processes and application of an implementation and sustainment plan. Early start for long procedures, implementing anaesthetic pre-operative assessment and preadmission pathways, all of which streamlined processes for elective patients which inevitably led to improvements in start times. The team had a purpose which when supported with the application of change theory or a framework to carry out the improvement and a model to sustain improvements led to a successful outcome. One key contributing factor to the success of these studies is that the improvements made were within the power of the front-line team and were not challenged by external factors outside of their control.

In contrast, case studies 1, 3 & 4 were not as straight-forward. The linear, simpler approaches were applied but the context was complicated. These studies were impacted upon by external factors. In 2017, mid-way through these studies, a change in the admission pathway for day case and DoSA patients was introduced in an effort to reduce waiting times in the emergency department for unscheduled care patients along with a need to admit elective/ scheduled care patients making it difficult to sustain changes in a fast changing and unpredictable environment.

The impact for theatre was that it took additional time in the morning to get information regarding the potential of post-operative bed availability and for permission for the patient to proceed to theatre. In the DoSA unit additional patients needed to be prepared for theatre, there was uncertainty around which patients would go to theatre first and medical teams were vying for space to admit patients. This change created significant delays on the morning of surgery which impacted on case studies number one, three and four.

The experience in practice was that a new problem had arisen which was difficult to put some form of control on. It took time to get a handle on it, to begin to understand and articulate what was happening. It was difficult to determine if process changes were going to be short-term or if it was going to become the standard approach to admitting elective patients on the morning of surgery.

These findings bring a complexity to the improvement process. This is new learning as the improvement literature on efficiency in the operating theatre does not present in detail the complexity of the environment in which the change is being

made. Drawing from the literature on the theory of complexity science helps to make sense of environment in which changes were being made. Comparing the definition Braithwaite, (2018), of a complex adaptive system which is “dynamic, complex, unpredictable, and built on interconnected relationships and parts” is similar to operating theatre systems. Both systems consist of a number of variables and the unpredictability of their interactions make it hard to impose order.

It was this learning about context and complexity of the study environment that led to applying frameworks for sustainability to more recent studies 5 and 6. This acceptance of complexity also led to the reenergising of the improvement teams in study one and two. During 2019, both studies were revisited to see how they were progressing and re focused on both applying the sustainability model of: continuous performance review, monitoring and managing variation and regular team reviews. By February 2020 case study 1 was 8 months on and case study 2 was 5 months on with applying the SDMA cycle of sustainment. Both studies had achieved improvement in performance but most importantly the team are continuously working on making improvements.

11.6 Contribution of frontline staff to improving efficiency

The following section will describe the contribution of improvement teams in implementing change at the frontline. The literature on the science of improvement presented in chapter 4 includes the human side of change as one of the domains of profound knowledge which is fundamental for developing changes that result in improved outcomes. This section will reflect on the key contribution that people make to improvement. This will be presented under the headings of; (i) engagement with frontline staff and establishing improvement teams, (ii) the improvement team’s role in creating change ideas, (iii) commitment to testing changes in practice, (iv) the team’s ability to adjust and adapt to challenges demonstrating the reality of practice improvements in a complex environment and finally (v) the motivation and enthusiasm to sustain improvements.

11.6.1 Establishing Improvement Teams

The initial stages in case studies 1, 2, 5 & 6 involved engaging with consultant surgeons, consultant anaesthetists and theatre nursing staff to discuss the main

causes of inefficiencies in their theatres. The DoSA and Day ward teams in case studies number 3 and 4 consisted of an extension of the teams in case studies 1 & 2. A common theme emerging was the problem of late theatre start times. Of greater significance across all teams was the level of willingness to understand the causes for delayed start times and improve current performance. This was a good starting point to focus improvement efforts on.

Across all the case studies presented, once the willingness to improve on performance was established the next step involved getting a picture of current start time performance and an understanding of the factors that frequently impacted on start times. This was done through collecting quantitative data on theatre start times and reviewing the probable causes for delay. Once a baseline understanding of the extent of the problem and the issues that needed to be addressed was clearer, a formal improvement team was established.

An understanding of the probable causes of the problems helped determine the appropriate team composition. This consisted of representatives from both, theatre staff (consultant surgeon, consultant anaesthetist, nursing, and support staff) and staff who are responsible for delivering the service in the pre-operative phases. Examples include staff working in the DoSA unit, day ward, pre-operative assessment, specialist nurses, porters, theatre administration, patient registration, healthcare records and admissions department staff. This represents the inclusion of the wider system knowledge from the point in which the patient is prepared until they undergo surgery. In chapter 4, the science of improvement refers to appreciation of the system as one of the components of profound knowledge which is fundamental to quality improvement. This was evident across the improvement teams established.

11.6.2 Identifying change ideas

Across all the case studies the ideas for change came from the improvement teams. Their analysis and understanding of the causes of problems that led to delayed start times, guided where changes in processes were required. In all the case studies, ideas for change were initially focused on the pre-operative phase of the patient's surgical journey. In summary these ideas for change involved; anaesthetic pre-operative assessment, scheduling appropriate 1st patients, pre-admission planning, planning activities that are required to support timely patient

readiness i.e., availability of healthcare records, necessary tests and investigations completed and, communication between clinicians about the patients planned for surgery (anaesthetist, surgeon, and nursing). These practices are well documented in the literature and are recognised as contributing to operating theatre efficiency.

As the studies progressed, the improvement teams had to learn to balance the implementation of changes that had led to improvement in efficiency at the same time as adjusting and dealing with unpredictable events that challenged achieving the intended aim of the improvement initiative.

This was evident in case studies 1, 3 & 4 when unplanned changes in the admission process for day cases affected patient readiness for theatre on the morning of surgery. The improvement teams came up with the idea of daily communication huddles to plan the following days theatre list. The team gathered all available and relevant information to plan the most appropriate 1st patients taking into consideration what had been learnt from current experience.

In case study one, in the sustainment phase, when faced with the problem of a medical team member being delayed completing medical admission on the morning of surgery, mainly due to them dealing with other inpatients or being under-resourced, the team suggested holding a briefing the day before surgery to plan which team member would take on responsibility for admitting the patient on time on the morning of surgery and which team member would be assigned to managing inpatients.

In case study number 5 the PDSA's presented exemplify the constant testing of ideas to develop the pre-operative assessment service. The team trialled various forms of communication, starting with email, engagement, attending consultants' meetings, all common methods to promote a service, however when these methods were not achieving the optimum outcome, the team adopted more flexible methods to engage with medical teams and consultants. For example, the admission staff asked the medical teams to identify patients they planned to admit for surgery in the coming weeks when they submitted a request for the patient to be added to the waiting list. Frequently they only received notification of scheduled patients a few days prior to surgery. Concurrently, the pre-operative assessment nurse linked into existing practices that the medical teams had for scheduling

surgery, creating a process whereby appropriate patients were automatically referred for pre-operative assessment.

This was new learning for the teams; owning their ability to create ideas and make improvements by, for example, daily cross-departmental communication to plan for on-time theatre start, a medical team briefing to agree the team's responsibilities on the morning of surgery, embedding the referral process to the pre-operative assessment service when the processes became more complex.

There can be a vast number of good ideas presented to address issues affecting efficiency in healthcare. However, the importance of linking the change ideas with the true causes of problems is critical to successful improvement. New learning comes from the team's ability to identify creative new ideas when faced with challenges. This approach demonstrates the need for a continuous problem-solving approach, being creative with testing out new ideas, applying context specific solutions relevant to local problems experienced and learning to appreciate that in large and complex systems the symptom is not necessarily where the problem lies.

11.6.3 Commitment to testing changes in practice

Applying potential improvement ideas in practice was the next phase of the improvement cycle that all six teams engaged in. The teams planned the changes that would be made to see if an improvement could be achieved, stepping out the actions that were required to trial the changes as presented in the 'Planning' phase of the multiple PDSA's. They agreed when they would action the change and subsequently carried out a test of change referred to in the 'Do 'phase of the PDSA. Feedback from the team on each iteration of the change process was a key part in determining if the changes made had led to improvement, along with the measurement of the performance that the team sought to improve. This is presented in the 'study phase' of the PDSA cycle.

Reflecting on the impact of the changes creates an opportunity for learning, and through this learning the team decided whether the intervention had worked, or whether it needed to be trialled for longer and in different contexts or, alternatively, the team decided that the intervention did not result in improvement and needed to be abandoned or altered. An example of this was in case study one: the team's initial aim was for a day case patient to be scheduled first, but it quickly became clear that this might not always be appropriate. This led to an invitation to the DoSA

nurse to work on improving the process for inpatients being admitted on the morning of surgery.

Likewise, in case study number 5, the initial approach for referring patients to the pre-operative assessment service was an automated referral once the patient had a planned date for surgery. However, within a week of testing this in practice, it was evident that the existing practices for allocating dates for surgery did not allow sufficient time for a pre-assessment appointment to be organised. This depth of analysis allowed the team to critically evaluate the impact of changes in an environment where it is safe to test out a concept or theory. The teams were exposed to how complicated it can be to make a system better, and the level of commitment required to continuously try to solve problems.

Finally, in the 'Act' phase of the PDSA cycle, having studied the impact of the trials, the teams planned the next steps, and continued to make change relevant, timely and context appropriate.

Actual changes to practice evidenced in the literature reviewed are similar across all case studies where changes were outlined in the PDSA cycles. New findings of the improvement team's role in continuous improvement are demonstrated by the multitude of cycles required to achieve improvement. This involves the team constantly adapting to the unforeseen events as the projects progressed. This serves as a powerful example of the approach that is required in a complicated and complex system which is absent in operating theatre improvement studies described in the literature.

11.6.4 Adapting and Adjusting to challenges

The team's ability to respond to challenges when interventions were being tested and in the early stages of implementation was evident across the six case studies presented. The challenges faced when working on improving efficiency was not discussed in the literature. The detail of the case studies presented here demonstrates the complexity of the context in which change is being made and the skills and approaches required to deal with issues as they arise.

For example, in case study number one, the team needed to have the healthcare records available for review a week ahead of surgery. The initial solution attempted was for the surgical directorate to organise for the healthcare records to be made

available. However, due to resourse limitations, the team secretary was not able to co-ordinate the healthcare records pre-operatively. An alternative local solution in theatre was tested which proved successful. The solution involved the theatre secretary taking responsibility for ordering and co-ordinating healthcare record movement as required for review and admission. Secondly, it was not always feasible for the 1st patient scheduled to be a straight-forward day case. Therefore, DoSA patients were prepared so that they could be scheduled 1st on the theatre list if appropriate. Implementing this required additional effort by the improvement team to involve the DoSA service in the improvement service.

In case study number 2, when the team was challenged with the continuation of the early start for the long oesophagectomy procedure, a compromise was reached whereby start time changed to 8am instead of 7.30, half an hour earlier than regular start time.

Similarly, in case study number 3 and 4, changes in the process for admitting day-case patients due to lack of bed availability impacted on DoSA efficiency as day case patients were reassigned to the DoSA area to wait for a bed to become available. This led to DoSA patients (inpatients) being re-scheduled to 1st on the theatre list without the DoSA manager being aware in sufficient time to have the patients ready for theatre. The approach chosen by the team was to involve the patient flow department in planning the followings day's theatre list order, predicting bed availability, and agreeing appropriate first patients across all theatre lists.

In case study number 5, the improvement team were challenged with getting sufficient referrals to the service. They tried a variety of approaches with the medical teams to promote the service and continued to increase referrals for pre-operative assessment.

In case study number 6, following a number of changes in the pathway for patients under the plastics service, the main reason for delay which was site marking was taken on board by the consultant group and dealt with appropriately.

Developing a robust system to deal with unforeseen challenges as they arose in the way that is described above, demonstrates the resilience of the team. From problem solving, to dealing with issues when they arise, adapting to changing circumstances, thinking differently, and accepting that change is slow and can be

difficult and unpredictable. This mind-set allowed the improvements gained to be built on as new evidence or changing needs emerged.

11.6.5 Improvement Team Motivation

The intrinsic motivation and enthusiasm to improve the efficiency of the theatre service is evident within each of the six improvement teams. Frontline staff were not pressured to get involved or to commit to improvement; their motivation arose from a genuine desire to make the service better. Across all teams this approach prevailed, through challenges which required redesigning of processes or systems.

Long term team motivation waned in case studies number 1, 2 and 4. For example in case study 1, the factors that impacted on sustaining improvement became complicated. They were outside of the control of the team as was experienced with bed issues and cancellations or late decisions on the morning of surgery. The team found it difficult to maintain motivation and, over time, their understanding of the specific problems became clouded by their assumption that the causes for delay were due to external factors. On the contrary, it became clear when a review of causes for delay was undertaken in 2019, that the following internal problems were impacting theatre start times:

- Healthcare records unavailale on the morning of theatre,
- Surgical team late arriving to DoSA to admit the patient,
- Change of list order,
- Inappropriate patient scheduled 1st on the theatre list.

These problems were all within the power of the team to address. The learning gained was that the external factors that indeed created upheaval and an unpredictable working environment clouded the other issues that were affecting start time. New learning, not discussed in the literature on improving operating theatre start time, relating to maintaining staff motivation when managing change processes, is the need to understand the specific causes of the problem, through engagement, feedback, and data collection. The process mapping used in case study number 1 in 2019 was a powerful method to discover and make visible the actual problem.

When these findings were discussed with the team, they immediately reengaged and were enthusiastic about addressing the problems. A team member took on the

lead role to collect data, undergo process mapping, identify issues for delays, organise team reviews and drive new interventions. These included the confirmation of theatre schedules 3 working days ahead of the theatre day, communicating this with the team and organising a short team brief on the day prior to surgery to plan patient preparation on the morning of surgery.

In case study number 2, the changes to practice were well embedded and had become part of the normal way of working. The motivation to monitor and continuously achieve the earlier start time waned so there was some slippage in start time. There was not a significant reduction in performance but the emphasis on improvement was less focused. However, similar to case study number 1, when the improvement team reconvened to look at start times, they were willing to do this immediately and were enthusiastic about making it better. The team needed to be guided and supported to sustain the improvements previously achieved.

The learning gained is that the team needed the support to continue to drive, monitor, and facilitate a proactive approach to problem solving to keep the improvement cycle active. Leadership support is critical if frontline staff are to engage in a culture of continuous quality improvement whilst carrying out their normal role. Active quality improvement requires engagement, analysis, problem solving and managerial support.

In case study number 4 where the aim was to improve the theatre start times for day cases scheduled first, the team initially maintained a motivation for improvement in a system that was slightly unpredictable and complicated. However, as the study progressed it became exceptionally challenging to sustain a system that could plan appropriately for day cases scheduled first. Eventually the project ended when the day ward was used predominantly for unscheduled care patient.

However, the new learning from quality improvement sustainability gained over the duration of the case studies has encouraged a mind-set of problem solving, process analysis, improving incrementally through small cycles of change and developing a robust system that adapts to unforeseen changes.

Across the remaining case studies number 3, 5 & 6, DoSA, Neurosurgery pre-operative assessment and preadmission pathway for a Plastics surgery procedure,

team motivation and enthusiasm remained constant. Throughout these studies, individuals had taken on leadership roles to drive and sustain the improvements whilst fully understanding that it was not straight-forward and that unforeseen events are an element of the improvement journey that teams need to pre-empt and deal with as part of the change process. All teams required support with data analysis, facilitation, and problem solving to continue to sustain new improved work practices.

11.6.6 Conclusion

This section provides insight into the fundamental role that staff play in improving the quality of patient care. The improvement teams in each case study consist of frontline staff who were hugely motivated and enthusiastic about improving the service they work in. Their commitment was evident in their initial efforts to drive improvements in practice. This was followed by their ability to create ideas for change, using their knowledge, experience, and analysis of data to support their ideas. The team formation in all the studies was broader than theatre staff alone. Theatre staff started to work with their colleagues outside of theatre department, the formality of this being a very new concept, a wider system approach to improvement was achieved. The team demonstrated a real strength in testing changes in practice, this was a real feature of their role. They planned the tasks involved in each test and studied the outcomes. Leaders emerged in the studies, people who wanted to take on the responsibility and use their initiative to try different ways when challenged.

The greatest learning regarding the human perspective on change is that frontline staff are motivated and committed but they need systems build around quality improvement so that it becomes common everyday practice to engage with staff on performance, issues arising, challenges and to problem solve and involve the right people who can contribute to making care better. Enthusiasm did wane when sustaining the change became difficult but once the teams were facilitated to revisit the problem, they did so willingly. This demonstrates their motivation and most importantly shows that for sustainable improvement to be achieved support systems need to be developed and implemented with the same energy and formality as the earlier planning and testing phases of the improvement cycle.

11.7 Application of an improvement model in practice

This section will review the impact of applying a Quality Improvement (QI) methodology on achieving improvement in practice. Chapter 4 presented the Quality Improvement methodology as a systematic approach to achieve this. It is recommended by Dixon-Woods & Martin, (2016)) that strict adherence to a QI methodology is vital for improvement. The chosen methodology in this study was the Model For Improvement (MFI) used by the Institute for Healthcare Improvement. This formal approach to plan, test, implement, spread, and sustain improvements in operating theatre efficiency is applied in each of the six case studies presented.

This section will summarise if compliance with the methodology contributed to improved outcomes. The three fundamental questions will be discussed. These are:

1. What are you trying to accomplish?
2. How will you know the changes is an improvement? and
3. What changes will you make that will result in improvement?

Following this compliance with the PDSA cycles will be reviewed and finally an examination of the implementation of changes in practice and the spread of improvement learning.

11.7.1 Applying the Science of Improvement

This component of the model was a strong feature in all six case studies. The planning phases of each study involved frontline staff who were responsible for contributing to episodes of the patient pathway. There was also a system wide perspective in each study whereby relevant staff outside of theatre were part of improvement teams. Therefore, there was a wealth of subject matter expertise from the patient pathway perspective.

Data on baseline performance and variation was collected and reviewed by the team, this helped focus on addressing areas for improvement. Linking process issues to team membership was evident in case study 2 ,4 and 6. In case study 1, 3 and 4 concerns were raised in the initial stages regarding bed availability which

led to the patient flow department being involved in implementing solutions. Similarly, in case study 5 (neurosurgery pre-assessment), a real challenge for the team was to develop a consistent referral system, this required commitment from medical staff. The learning gained from matching causes of variation and team composition contributes to building knowledge on factors that contribute to improvement in practice.

A combination of subject matter expertise on the impact and causes of operating theatre inefficiencies specific to each study along with the use of data and a wider-system-wide approach contributed to building knowledge that was used to define the problem in each case study and identify change ideas which progressed the study from an assessment phase to a testing phase.

11.7.2 Adherence to The Model for Improvement

The model uses 3 key questions to define the aim of the project, identify the changes that are required to achieve the aim and the measures that are required to determine if the changes have led to improvement. Each of the case studies does this very well. There is evidence of a SMART aim in each study meaning that it is specific, measurable, achievable, realistic, and timely. Also strong across all studies is the identification of change ideas, changes decided by the frontline team that they predicted would lead to improvement to test in practice. Outcome measures are well described and planned for; however, process and balancing measures were not quantitatively produced. The learning here is that these are important to determine that the changes identified and being tested lead to improvement. This is evident in the PDSA cycles when each PDSA consists of many tasks and it can become unclear which specific task is trialled in practice.

In all the case studies there are a number of PDSA's involved. Detailed planning of the change, applying it in practice and studying the impact of changes was evident in all studies. Rapid testing of change under various conditions is recommended in the testing phase.

In case study 1, bed issues were predicted as a problem from the start. The study was running for three months before it became an issue, and the change could be tested under these conditions, it was a consistent problem for the first quarter of 2017.The action resulting from this issue involved engagement with the patient flow

department to explore if bed allocation for elective patients could be worked on as it was also a problem in case studies 3 and 4. In case study 2 when start time for oesophagectomy changed from 07:30 to 8am, this was not tested or studied in practice to determine its impact, doing so may have been identified earlier the tweaks to morning process required in theatre and avoided the slippage in start time performance.

PDSA cycles do contribute to testing changes in complex settings. This was evident in case study 1, 3 and 4 where the study environment could be described as complex. These studies were affected by unpredictable external factors which they could not control initially. As the studies progressed additional PDSA's were required. For example, in case study one, additional PDSA's were trialled in the implementation and sustainment phases, in case study 3, PDSA's were ongoing for 18 months to adjust to the changing processes and in case study 4, PDSA's in the latter stages of the initiative were reacting to unplanned changes in patient's admission pathways. These 3 studies demonstrated how improvements were achieved through the continuation of PDSA cycles. A key learning in practice was that in complex systems, testing of changes is required to continue to achieve sustained improvement.

11.7.3 Developing an Implementation plan

Developing a formal implementation plan was inconsistent across the studies. Changes made that led to improvements during the PDSA cycles drifted into being implemented in practice. The transition between testing and implementation was fluid. In case study 1,2 and 3 there was no formal implementation plan. The changes became embedded without outlining clear definition of the roles and responsibility for the change. Training on new practices, identifying a leader for continuation of the improvements and establishing responsibility for monitoring performance, problem solving and sustaining team momentum to continue to drive improvement were absent. This became a problem when the studies experienced a deterioration in performance as a continuous improvement approach was not in place. In case studies 1 and 2, start time performance gradually deteriorated, similarly this was not addressed or escalated. In case study 3, although there was very strong leadership in the DoSA service, a system was not in place to deal with the situation they were faced with. This did change for subsequent case studies,

4,5 and 6 whereby a more formal approach to implementation was established with clear responsibility for sustainment assigned.

Although formal implementation plans were not always in place, practice changes did become embedded. It demonstrates that some improvement practices continued following the testing phase as they were well-planned, had strong team commitment and were achievable in practice. However, in a complex system like operating theatres attention to developing good implementation plans is required to sustain improvements especially when there are many system-wide intertwined processes which are prone to change without consideration of the impact that they have on each other.

11.8 Conclusion

This chapter presents the finding for the six case studies whereby changes were implemented in the practice setting to improve efficiencies in operating theatres. It uses the learnings from the studies to examine the factors that contribute to start time improvement and if long-term sustainment was achieved.

To commence the causes for delay of theatre start time are identified and details of interventions to address the problems are outlined. Both are compared to those previously reported in the literature which supports existing research and new findings are identified which grows a body of knowledge in this area.

The spread of improvement learning in the perioperative setting is presented, detailing how the learning progressed from the earlier studies and how this was applied in subsequent initiatives. Knowledge was also spread on the use of improvement methodologies and change in complex setting which contributed to greater sustainability in later studies.

A key component of the research question is how improvements in theatre efficiency were sustained long-term. This was achievable as the majority of the studies were undertaken over a sufficient period of time which allowed a deeper analysis. Efforts to sustain improvements are compared to how the literature in improvement science was applied in practice in each study. This is explored in detail. Also discussed is the context in which the study was undertaken and how this was important in understanding change in complex systems.

A key feature of quality improvement is the role that people play in achieving better outcomes for patients and the service. The contribution of frontline staff in implementing changes in practice and in sustaining improvements in the long-term is described under a number of headings.

Finally, the contribution of applying a quality improvement methodology in achieving better outcomes is analysed. The phases of the methodology in planning, testing, and implementing changes are compared to the approaches taken in practice.

CHAPTER12 - CONCLUSION AND RECOMMENDATIONS

12.1 Introduction.

This study explored the factors that contribute to improving start time performance in operating theatres and examined how improvements were sustained in practice. This final chapter gives an account of the overall study, summarising each of the previous chapters. It evaluates the research findings and presents the contribution that this study makes to existing knowledge on improving operating theatre efficiency in acute hospitals. Finally, it outlines the limitations of the study and makes recommendations for future research in this area of practice.

12.2 Review of chapters

Chapter one introduces the study, outlining the aims and objectives of the research and the rationale for undertaking the research. This is followed by a summary of each chapter. Chapter two provides a review of the literature. It begins with a brief description of the concept of quality and quality improvement in healthcare which sets the context for the study. As a practice-based research study, the research is centered around the practice of operating theatres in acute hospitals. The literature review homes in on one of the dimensions of quality which is efficiency and examines how it is understood and measured in operating theatre practice. The literature review draws on studies that have made improvements in the area of start time performance, which is a key component of efficiency. Reviewing the literature identified a lack of theory relating to sustaining improved outcomes in practice which led to developing a research question which specifically looks at this concept.

Chapter three presents a case study methodology which was deemed an appropriate research methodology to structure, guide and plan the study. Case study methodology captures real-life context and complexities within the environment in which the study is taking place by allowing for intensive analysis whilst focusing on tight specific units which can be cross analysed to provide a

deep and rich understanding of a case from which learning can be gained. In this research, each case study is a specific change initiative all aiming to improve efficiency. The study reflects the complexity of the operating theatre service but breaks it down into specific studies to simplify it and learn from each one separately and collectively. To answer the research question, there is a need to attempt to make changes in practice. Making change is helped by using a change methodology to actively, plan, test, implement and sustain changes in practice. Chapter four describes the change methodology which is the Model for Improvement that is used in the study.

The research findings include six case studies which set out to implement process improvements in practice in order to achieve better theatre start time performance (5 studies) and 1 study which focuses on implementing a pre-operative assessment service which came from a review of start times and the causes of start time delay. The findings from the research are presented in chapter 11 and themed across all studies in order to answer the research question which explore what improvements in the perioperative process contribute to reducing operating theatre start time delays and the factors that contribute to sustaining improvements long-term.

12.3 Contribution to theory

12.3.1. Contribution to empirical theory

Firstly, I will describe the contribution of my work to empirical theory. For the projects studied, which are presented as 6 case studies, all resulted in improved performance. 5 of the studies (Case study 1,2,3,4,6) focused specifically on reducing theatre start time delays and case study 5 relates to improving pre-operative assessment. Case studies (1,2,3,4,6) achieved the following improvements in start time performance on project completion. Case study 1 improved start times by reducing delays from a median of 16 to 5 minutes, case study 2 likewise reduced delays from 48 to 0 minutes and overruns from a baseline finish time of 19:30 to 16:55. Case study 3 demonstrated a reduction in delayed start times from 26.5 to 10 minutes. Case study 4 reduced delayed start time from 20 to 10 minutes and case study 6 also led to improved start times, reducing delays from 20 to 5 minutes. Finally, case study 5 which focused on implementing anaesthetic pre-operative assessment for elective neurosurgery procedures

achieved 17 patients per week having pre-assessment following establishment of the service. This led to an increase from 7 % to 60% of all neurosurgical elective patients having anaesthetic pre-assessment.

Furthermore, the study examines if improved outcomes were sustained post project completion. This relates to the research question on sustaining improvements in the long-term. There is a significant gap in the literature on sustaining improvement outcomes relating to operating theatre efficiency. This study brings new theory to this field. It evaluates if sustained outcomes were sustained between 6- and 12-months post project completion by revisiting five of the six studies. In four of the case studies, there is evidence of better performance when compared to baseline data (case study 2 & 3) with two of the studies showing sustained improvement from project end (case study 5 & 6) of which one showed even better performance.

Case study 2 had a slight increase in delay from 0 to 5 minutes following project end but sustained a significant improvement from 48 minutes pre-intervention. Case study 3 demonstrated an increase in delay from project end but achieved a better than baseline performance reducing delays from 26.5 to 23 minutes. Case study 5 showed an improvement following project end increasing the number of patients attending anaesthetic pre-operative assessment per week from 16 to 17. Finally, case study 6 sustained a reduction in delays from 20 minutes to 5 minutes. This is a significant contribution of the study and sets the context for answering the research question which examines how improvements can be sustained in practice.

12.3.2. Contribution to theory on factors that cause delay in theatre start time.

The following causes for theatre start time delay unique to this study include: - nonadherence to theatre list order, timely availability of healthcare records, unavailable bed capacity and patient's complexity for example patients who required medical attention and or investigations on the morning of surgery. These factors were evident in case studies, 1, 2 and 3.

In addition, the studies enhance the existing body of knowledge on factors that are commonly referred to in the literature as affecting theatre start times, section 2.6.1 in the literature review presents the following causes of delay which were also identified in this research: - delays in registration, transportation, lack of pre-

operative evaluation, unavailability of staff, lack of appropriate patient pre-operative preparation, and patient delays.

From change projects studied in the field of operating theatres, new interventions were identified that led to improvements in performance. These include: - interdepartmental and multidisciplinary team communication huddles in case studies 1, 3 & 4, streamlining the handover process between ward nurse and theatre reception nursing staff, evident in case study 4 and subsequently applied in case study 2 and 6. Implementing an earlier theatre start time was the focus of case study 2 and timely availability of healthcare records was evident in case studies 1, 2,3,4 & 6.

12.3.3 Contribution to theory on factors that sustain improvement in practice.

There is a gap in the literature on operating theatre efficiency as to how improved efficiencies are sustained. This study used a sustainment model to support sustaining quality improvements in practice which was developed by the Institute of Healthcare Improvement (IHI) (section 4.8). This model was used to evaluate the factors that contribute to sustaining improvement in practice in this study. Two key new findings in the field of operating theatre efficiency that support sustainment of improvement in practice were identified. These include:

1. Lack of an implementation plan
2. Lack of a sustainment plan

The studies demonstrated how the absence of planning and doing both of these key components in the improvement cycle resulted in process changes not being sustained. This is evident in case study 1, 2 and 3.

In case study 1 (section 5.4) an implementation plan is outlined for the project, however when the project ended the following actions were not supported: -

1. Start time performance and variation were not monitored, Figure 5, section 5.7 demonstrates that start time delays were increasing and there was variation in performance in the last quarter of the project, however a process was not in place to monitor performance and address issues.

2. Team communications to discuss progress, issues or variation that were impacting on start time were not happening, therefore the team did not have a route to address issues or solve problems.
3. Lack of allocation of roles and responsibilities to ensure continuation of practice changes. For example, when roles changed regarding healthcare record availability contingencies were not put in place and this problem which had been previously addressed resurfaced.
4. There was no identified leader to co-ordinate performance monitoring, team feedback on current status to address problems or escalate issues appropriately at the end of the project.

The IHI sustainment approach refers to a cycle of standard work, doing the work, monitoring performance, and adjusting the process as required. These key components of the model are not planned for or actioned in case study 1. The project ended in December 2017 without a plan to sustain the changes in practice (section 5.9.4). The team disbanded post project finish. When problems arose at the end of 2018, systems and structures were not in place to measure the reason for this and address the issues which required refinement of the process.

Similarly, in case study 2, (section 6.4), a detailed implementation plan is not outlined. Changes in practice were well embedded at the end of the project (section 6.6), however when there was a planned adjustment to start times in 2018 the impact of this was not monitored. Likewise, when issues arose regarding nurse availability to take handover from DoSA staff in theatre reception the 4 key sustainment components of the IHI sustainment model outlined above were not in place (see table 6.9.4.1). This resulted in slippage in performance in start time for which there was no system in place to measure the reason for this and address the issues which required refinement of the process.

To further support the importance of a detailed implementation and sustainment plan, case study 3 refers in section 7.4 to the transition from testing changes in practice to implementation as being seamless. Practice changes were well embedded on review at project completion (section 7.6), however the four key components of the IHI model were not in place. This became a problem when reviewed in early 2019 whereby issues regarding patient readiness and bed availability resurfaced.

In case study 4 a detailed implementation plan was developed outlining the changes to practice and key responsibilities. However, the plan did not include monitoring of performance or identification of a leader. Subsequently compliance with the implementation plan was not adhered to (section 8.6) demonstrating the need for leadership and monitoring of standard work as well as performance.

In comparison, in case study 5 and 6, implementation plans incorporating monitoring, leadership, standard work and team meetings (section 9.4) and in case study 6 (section 10.4) and sustainment of improved outcomes described in section 9.7 and 10.7 are evident. Section 9.7 presents how the project team adapted to changes in referral rates and continued to adjust their work to increase referrals until achieving increasing numbers of patients attending the service. Both of these studies showed improved sustained performance from baseline and project finish with case study 5 continuing to improve.

The following table provides a summary of the common themes that led to improving and sustaining improved theatre efficiency.

Table 25: Chapter 12 Common themes demonstrating improved and sustained performance.

Summary of common themes that demonstrate improved and sustained improvement				
Case Study	**Interventions**	**Performance improvement achieved**	**Sustainment Plan**	**Sustained improvement achieved**
1.	1.Identifying an appropriate 1st patient to be scheduled on a theatre list 2. Planning for patient readiness 3. Multidisciplinary planning of theatre schedule	Reduction in start time delays from 16 to 5 minutes	1.Some changes were embedded, i.e. multidisciplinary planning of theatre schedule 2.Monitoring of performance and variation had stopped once the project ended 3.Causes of variation were not identified 4. Implementation and sustainment plan not developed.	Performance sustained 15 months post project commencement 24 months post project commenced start time delay increased to 10 minutes, further increasing when measured over a 4-week period to 40 minutes but reduced to 13 minutes with additional interventions.
2.	1. Multidisciplinary team communication regarding scheduling of cases 2. Implementing a pre-operative pathway 3. Earlier theatre start time	Reduction in start time delays from 48 to 0 minutes and overruns from a baseline finish time of 19:30 to 16:55	1. Practice changes embedded and continued. 2. The impact of a change in start time mid-way through the project was not monitored which led to an increase in delays. 3. Causes of variation were not identified. 4. Implementation and sustainment plan not	24 months post project commenced, start time delay increased to 5 minutes.

			developed.	
3.	1.Identifying an appropriate 1st patient 2.Planning Patient readiness 3.Interdepartmental communication 4.Planning for post-operative bed a day ahead of surgery	Reduction in start time delays from 26.5 to 10 minutes.	1. Practice changes embedded and continued. 2. Monitoring and causes of variation were not identified. 3. Implementation and sustainment plan not developed	24 moths post commencement performance sustained. At 30 months post commencement start time delay increased to 23 minutes
4.	1.Communication/Cross-departmental planning 2.Planning for patient readiness 3.Planning for post-operative bed a day ahead of surgery	Reduction in start time delays from 20 to 10 minutes	This project ended after 6 months due to a change in the admission process for day case procedures, therefore sustainment could not be evaluated.	
5.	1.Notification of Planned surgery date 2.Continuous communication and feedback on referral process to POA and impact of service	16 patients per week having pre-operative assessment. This led to an increase from 7 % to 60% of all neurosurgical elective patients having pre-assessment.	1. Practices continued to be embedded. 2. Implementation and sustainment plan which included: a) Continuous measurement of performance b) Continued proactive approach to addressing issues c) Adapting to the changing needs of the service.	18 months post project commencement the number of patients attending POA clinic increased from 16 to 17 per week.
6.	1.Interdepartmental Communication to plan theatre date and preadmission appointments 2.Implementing a pre-admission pathway for patients	Reduction in start time delays from 20 to 5 minutes	1.Practices well embedded 2.Adherence to standard work, 3.Monitoring of performance 4.Continued efforts to reduce variation	12 months post commencement, start time performance sustained

New findings in the studies presented above answer the research question which is what factors contribute to improving start time performance in operating theatres and what factors contribute to sustaining improvements. In addition, other key findings have come from this study which will contribute to theory on quality improvement in operating theatres.

12.4 Additional Key Findings

Other new finding in these studies which contributes to theory include a) spreading improvement concepts b) detailing a step-by-step account of doing quality improvement in practice using an improvement methodology in the field of operating theatre and c) role of improvement teams in making change in practice.

12.4.1 Spreading improvement

The literature on projects to improve operating room start time performance presented in section 2.5.4 specifically describe the local improvement, they do not advance to showing how the quality improvement interventions were spread and applied in other areas of practice. Each of the improvement initiatives presented in this research outlines how interventions that led to improved outcomes were transferred to other specialties and service. Operating theatres provide a rich environment for spreading interventions from one theatre, medical team, or service to another. Sections 5.5, 6.5, 7.5, 8.5, 9.5 and 10.5 all refer to how interventions were adopted in other improvement projects. Furthermore, this research details the willingness and motivation of the teams to improve other areas within their practice which was a feature of case study 5 and 6.

2.4.2 Applying QI methodologies in practice

Secondly, in the literature on start time improvement studies, only six of the studies use a change methodology to implement improvements in practice. The details of how the methodologies are used in practice is not included. This research applied a quality improvement methodology in each study and presents a step-by-step approach on how to implement change in practice.

Each study outlines the phases from planning which includes team formation, problem analysis, baseline data review, change ideas to the testing phases where PDSA cycles are outlined. Presenting the iterative component of the PDSA cycles demonstrates the effort and time that is required to make changes that lead to improvement and illustrates the complexity of the system within which change is being made.

Using a systematic approach in undertaking quality improvement created a structure for the study. It guided the process, ensuring that there was in-depth

planning during which the improvement team was formed with all relevant staff involved. Understanding the problem; getting to the root cause of problems was given the amount of time required to identify the causes of inefficiencies. This ensured that the appropriate solutions were put in place.

The PDSA or testing cycle of the methodology ensured that the team don't go straight to implementation of a change without testing it in practice to see if actually led to improved performance, it allows for tweaks to be made during this phase if the interventions are not making a difference. The methodology places great emphasis on measuring the impact of improvement. This is key to proving that the changes are actually improving quality.

Following a methodology has been very beneficial in describing and documenting the improvement initiative. It enhances the skills and knowledge required to undertake QI in practice and helps articulate the quality improvement process which aids sharing of learning. The approach used to document the improvement journey provides further opportunity to share both the initiative and the methodology used both locally and nationally.

An identified weakness of the Model for Improvement is that the model consists of three fundamental questions and the PDSA cycle. Following this approach is an excellent first step in planning changes that may lead to improvement in quality, but it doesn't provide guidance on how to implement and sustain changes that result in improvement. This information is available in the text's books and literature on applying the model but for frontline teams attempting to use the model in practice it needs to be easily followed and compliment the improvement approach. I have found overtime that if the 3 fundamental questions and the PDSA cycle were combined with the implementation and sustainment cycle of SDMA (Standard work, Doing, Monitoring and Adapting) it would provide a more complete approach to the cycle of change in practice.

Furthermore, the recommendations on the ramping up of PDSA cycles from small cycles of change to testing change under various conditions can be challenging, it depends on the process or practice one is trying to improve. In the real world one can't always create different conditions for example in case study one, it would be inappropriate to test interventions when a patient was canceled for surgery unless

this was happening in reality. Likewise, it is sometimes difficult to test a change on one or a few patients as it may be unsafe and too cumbersome to change a way of working for a small number of patients. Application of the model can be hugely supportive for change but requires some flexibility in how it is applied in all contexts. What is necessary is that each phase of the model is considered and discussed with the improvement team.

The SQUIRE guidelines referred to section 4.10 are used to layout the quality improvement process. Documenting quality improvement using this format contributes significantly to the literature on how to do quality improvement in practice and provides a practical reference for healthcare staff to follow and learn about how to present and describe quality initiatives.

At the end of each case study, a comparison between how the QI process was followed in practice with the QI methodology guidance is presented to reflect on compliance with the model so as to learn from both the strengths of using a scientific model and form where the studies were challenged in complying with the guidance for example in implementation of changes in practice and sustaining improvements. The findings strengthen the theory for the need for the same effort and time to be given to these stages of improvement as the early planning and testing phases.

12.4.3 Importance of frontline teams in improving processes

A section in chapter 11 is devoted to the role of frontline teams in improving efficiencies (section 11.6). The literature reviewed on improving theatre start time performance does include the work that frontline staff did in the change process. However, this study contributes to the theory on frontline staff's role in driving change in complex settings. Section 11.6.4 presents examples of the frontline team's ability to enable change in complex settings through adapting to the challenges they faced and exploring new ways to achieve better outcomes.

Furthermore, this research contributes to a body of knowledge on frontline team motivation in section 11.6.5. Of significance is the need for staff to be supported through implementation and sustainment. Examples of this are in case study 1 and 2 when performance slipped and there was a lack of focus on improvement, the team reengaged quickly and worked on making additional changes to regain the

outcomes previously achieved. It demonstrates the intrinsic motivation of frontline staff to make the system better, but it reinforces the need for consistent and formal processes or systems to enable and support staff to continuously drive improvement by having the capability and skills to know when processes are deteriorating, and problems are arising which need to be solved locally or escalated.

12.5 Limitations of the study

Every research study has its own limitations, challenges, and successes. Acknowledging these limitations does not reduce the quality and value of the study; it enriches theory on what is required to improve operating theatre efficiency and the factors that contribute to sustaining improvement and allows for discussion and critique of the findings which opens up the opportunity for further studies.

A limitation of this study was that it was undertaken in one hospital setting. It is an in-depth study which brings to light the challenges that frontline staff face in making improvements in complex settings. The interventions implemented relate to the causes of variation in performance which may not be experienced in other settings in the Irish healthcare system. Applying this approach in a similar setting will allow testing of interventions implemented within a different culture to determine if they lead to improved outcomes which will further support these interventions as making a difference to theatre efficiency.

A second limitation of this study is the time available to explore if and how improvements are sustained over longer periods of time. The improvement programme in operating theatre in Beaumont hospital started with planning of quality improvement interventions, these studies needed to progress for sustainment of improvements in practice to be evaluated which took time. The earlier studies which commenced in 2016/2017 allowed for evaluation 12 months post project completion, from which learning was gained on the systems that were required to support sustainment of improvement. Applying a systematic approach to the sustain phase of improvement with the same planning, implementation and monitoring as was applied to starting off on the improvement cycle is touched on in

the latter studies but time limitations did not allow for evaluation of this learning on the long-term impact of this approach on sustaining improvements.

12.6 Recommendations for further research

I believe that this study has provided a good foundation for advancing further research in the area of developing a system for sustaining improvements in practice. This could incorporate existing sustainment models that I used for example the IHI, but a study that would look at building this model into the daily work of leaders and managers would enhance the complete cycle of quality improvement.

12.7 Conclusion

To conclude, my research contributes significantly to an existing body of knowledge on operating theatre efficiency specifically in the area of start time performance. I have added to the theory of the causes for inefficiencies in theatre start time along with providing new theory on innovative ways to improving start time performance. My in-depth studies on implementing process change over a sufficiently long enough period of time allowed me to get an understanding of why improved outcomes are not sustained as true change in practice, interestingly I found that this part of the improvement cycle is not planned for or actively managed and supported. Throughout the study, other new findings came to light which include how we spread good work and practices, this happened with little effort across the improvement initiatives. From the perspective of using a change methodology which is recommended for all complex improvement efforts, I was able to reinforce my findings by comparing the theory behind the model for improvement with how change was undertaken in practice. The step-by-step approach to implementing change in practice will support students and practitioners in doing and writing quality improvement which will build capability in this area and contribute to improving quality in healthcare.

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