Improving Surgical Outcomes

in Greater Manchester

A Thesis submitted to the University of Manchester for the

Degree of Doctor of Medicine in the Faculty of Biology,

Medicine and Health

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CONTENTS

APPENDICES

LIST OF FIGURES AND TABLES:

Tables:

Abstract

Background: Post-operative complications are recognised as a significant problem for patients and healthcare professionals alike. In the post-pandemic world, ensuring institutions have structured, feasible and implementable pathways to reduce the burden of postoperative morbidity and mortality has never been more important. ERAS+ is a surgical pathway that focuses on patient education and preparation through surgery school and prehabilitation principles, supporting a focussed in-hospital stepped recovery programme which prioritizes early mobilization, establishment of nutrition, chest recovery using incentive spirometer and oral health care measures. It has previously been shown to be successful in a single tertiary hospital in reducing post-operative pulmonary complications and length of stay (LOS) following major surgery.

Methods: Greater Manchester ERAS+ (GM ERAS+) was a Health Foundation supported programme which set out to implement ERAS+ in colorectal surgical patient pathways across seven acute NHS hospitals in Greater Manchester. GM ERAS+ for colorectal patients was implemented between 2018 and 2020 using quality improvement methodology and aimed to replicate the benefits seen in the original implementation.

Results: Overall, all 7 sites implemented ERAS+ successfully for colorectal pathways, with 1472 colorectal surgical patients taking part in the scale up of GM ERAS+ between April 2018 and December 2019. Sites with historical LOS demonstrated a reduction in LOS following implementation of ERAS+. From factorial analysis; surgery school, early mobilisation and early nutrition interventions were the ones most associated with a reduction in LOS. Detailed analysis of hospital sites A and E, where data collection was in place for the duration of the programme, demonstrated that implementation of ERAS+ was associated with a reduction in PCP, statistical significant improvement in LOS and a reduction in 1 year mortality rate. Qualitative analysis of the findings of GM ERAS+ implementation identified facilitators and barriers for implementation, with the 'implemenability' of ERAS+ examined in detail.

Conclusions: The GM ERAS+ colorectal surgical pathway was successfully implemented into seven GM NHS institutions. This system level implementation delivered excellent patient outcomes and confirmed that the pathway was transferable out of a single centre. ERAS+ supports the triple aim of improving patient experience of care; improving population health by reducing complications and reducing the per capita cost of healthcare.

Declaration

No portion of the work referred to in this these has been submitted in support of an application for another degree or qualification of this or any other university or institution of learning.

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I am the medical lead for the ERAS+ programme and led the design and development of the original ERAS+ programme at Manchester Royal Infirmary between 2013 and 2016. I then was appointed as NHS Innovation fellow in 2016 by NHS England. In this role I led the design and implementation of the GM ERAS+ programme supported by Health Foundation funding, which again I led. During implementation of GM ERAS+ I chaired the implementation steering group and acted as ERAS+ expert supporting site implementation.

Dr Angella Bryan provided statistical support to examine patient outcomes from the quantitative data produced in the programme. The figures in the quantitative results were produced in collaboration with Simon Wickham, part of the Haleo/Aqua quality improvement team. The qualitative interviews were undertaken by members of Aqua evaluation team with me supporting the interpretation and generation of relevant themes and sub-themes, alongside providing reflection on the clinical implications.

Parts of the studies described herein have been presented at the following meetings and published in paper and abstract form:

Presentations:

International

1) **EBPOM World Congress July 2022 –** Prehab4Cancer implementation
2) **EBPOM World Congress July 2019 –** Prehab4Cancer design

National

3) **Health Foundation Celebration Event Oct 2020 –** GM ERAS+ Implementation
4) **ERAS+ UK Society Presentation Nov 2019 –** GM ERAS+ Implementation

Abstracts:

System-wide implementation of ERAS+ in Greater Manchester **R. Loveridge**[1], D. Nethercott[2], C. Moore[3], L. Darwin[4], R. Ekambaram[5], G. Faulkner[2], J. Allen[6], C. Forrest[3] and **J. Moore**[3]

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Prizes:

HSJ 2022 Winner - Partnership of the Year

Prehab4Cancer – GM Active and GM Cancer

HSJ Partnerships Awards 2022 – Non-commercial partnership of the Year

Prehab4Cancer – GM Active and GM Cancer

EBPOM World Congress 2021 – 1st Place Oral presentation

Title – "Virtual Prehab4Cancer – remote service delivery model"

ERAS Society UK 2019 – 1st Place Oral Presentation

Title – "Implementation of ERAS+ across Greater Manchester"

HSJ 2019 Surgical Innovation - Highly commended

GM ERAS+ Implementation

Publications in peer reviewed journals (see Appendix 8)

1) Feasibility and outcomes of a real-world regional lung cancer prehabilitation programme in the UK. Bradley P, Merchant Z, Rowlinson-Groves K, Taylor M, **Moore J***, Evison M* (*Joint senior authors). British Journal of Anaesthesia, 2022, Jul 13.

2) Nutritional screening in a cancer prehabilitation programme: A cohort study. Burden ST, Bibby N, Donald K, Owen K, Rowlinson-Groves K, French C, Gillespie L, Murphy J, Hurst SJ, Mentha R, Baguley K, Rowlands Ash, McEwan K, Merchant Z, **Moore J.** Journal of Human Nutrition and Dietetics. 2022 Jul 1.

3) Prehabilitation and preparation for surgery: has the digital revolution arrived? Durrand J, **Moore J**, Danjoux G. Anaesthesia 2022 June 77;6:635-639.

4) Prehabilitation and Rehabilitation in Older Adults with Cancer and Frailty. Merchant, Z, Denehy L, Santa Mina D, Alibhai S and **Moore J**. 2022. In *Frailty in Older Adults with Cancer* 2022, (pp. 155-176). Springer, Cham.

5) Surgery school—who, what, when, and how: results of a national survey of multidisciplinary teams delivering group preoperative education. Fecher-Jones I, Grimmett C, Carter FJ, Conway DH, Levett DZ, **Moore JA**. Perioperative Medicine. 2021 Dec;10(1):1-9.

6) Implementing a system-wide cancer prehabilitation programme: the journey of greater Manchester's 'Prehab4cancer'. **Moore J**, Merchant Z, Rowlinson K, McEwan K, Evison M, Faulkner G, Sultan J, McPhee JS, Steele J. European Journal of Surgical Oncology. 2021 Mar 1;47(3):524-32

7) The care of older cancer patients in the United Kingdom. Gomes F, Lewis A, Morris R, Parks R, Kalsi T, Babic-Illamn G, Baxter M, Colquhoun K, Rodgers L, Smith E, Greystoke A. **Moore J**, Simcock R. ecancermedicalscience. 2020;14.

8) Delivering perioperative care in integrated care systems. Bougeard M and **Moore J**. Clinical Medicine 2019 19(6): 450-453.

9) Impact of a peri-operative quality improvement programme on postoperative pulmonary complications**. Moore JA**, Conway DH, Thomas N, Cummings D, Atkinson D.. Anaesthesia. 2017 Mar;72(3):317-27.

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CHAPTER ONE

Introduction

1.1 **The development of modern-day perioperative practice, modern day challenges and solutions**

Over the last 60 years there has been a steady and progressive evolution in how surgery is delivered and also how patients are viewed in the surgical process. This has led recently to the development of perioperative medicine which aims to position surgical patients at the centre of their own care. To understand just how far surgical and anaesthetic practice has developed over the last half century, the observational cohort study by Beecher and Todd in 1954 is an excellent place to start [1]. As well as recognising the journey our speciality has taken, it also allows us to consider a number of similar challenges that still remain. The authors developed a network of collaborators in ten University hospital in the USA to examine anaesthetic and surgical practice over a 5-year period between 1948 and 1952 and documented the analysis of 599,548 anaesthetics for all types of surgery performed during this time. The breadth of what they undertook is remarkable and their study is pivotal in understanding the evolution of perioperative practice that was occurring following the second world war. Interestingly at this juncture a number of aspects of anaesthetic practice had remained largely unchanged since Ether was first administered more than 100 years before by Morton in the Ether dome on the 16th of October 1846 [2].

As if to prove a point, during the study period, Ether remained the dominant inhalational anaesthetic in US anaesthetic practice. However, the use of Cyclopropane, a non-combustible anaesthetic gas unlike the very flammable Ether, was becoming more popular in American anaesthetic practice over the study's 5-year period of observation. This would be superseded by a new anaesthetic gas, Halothane, discovered in 1951, which would become the dominant anaesthetic gas until the 1980's when it was replaced by similar but safer anaesthetic compounds such as Isoflurane. It is important to remember the role played by the United Kingdom and specifically the North-West of England in the development of anaesthesia at this time. Prof Michael Johnson was the first to administer Halothane to a patient in 1956 at Manchester Royal Infirmary, Manchester, following its development at the nearby ICI (Imperial Chemical Industries) plant in Widnes. Johnstone would later publish the results of Halothane use in 500 patients [3] and ICI would continue to innovate anaesthesia agents, developing the intravenous anaesthetic agent propofol in 1977. As well as allowing a smoother induction of anaesthesia, propofol was also much less of an airway irritant compared to the existing intravenous anaesthetic compounds such as thiopentone, which had been developed by Lundy in the 1930's [4]. This property would work symbiotically with the recently developed supraglottic airway, the laryngeal mask [5] which was

replacing the need for the more invasive endotracheal tubes for some surgeries and so supercharging the evolving world of ambulatory and day case anaesthesia. Today with the development of green anaesthesia and the need to reduce volatile anaesthesia's CO2 footprint [6], propofol has become for many the anaesthetic agent of choice as part of total intravenous anaesthesia (TIVA). There also appears to be gathering evidence of specific benefits of propofol over volatile anaesthesia in cancer resection surgery. Micro RNA expression analysis in colorectal cancer patients after surgery has indicated an inhibitory effect of propofol on cancer related pathway such as proliferation and cancer migration compared to volatile anaesthetics [7]. In addition, propofol also appears to attenuate the immunosuppression effects of surgery. Retrospective observational trials also support the potential beneficial role of propofol over inhalational agents by demonstrating an association with better survival long-term outcomes in patients having received propofol for cancer resection surgery [8, 9]. There are now a number of large RCTs amongst them, VAPOR-C trail (NCT04074460) and GA-CARES trial (NCT03034096), investigating TIVA vs inhalational agents in cancer resection surgery and associated long-term survival. They should help us understand what constitutes optimal anaesthesia for future major cancer surgery.

Back in 1954, Beecher and Todd [1] also noted the increasing use of the muscle relaxant, Curare, in US anaesthetic practice. Curare had only recently been introduced into global anaesthetic practice by Griffith and Johnson in Montreal in 1942 [10]. Muscle relaxants were facilitating the increased use of endotracheal intubation and controlled ventilation, which was in turn allowing better control of a patient's physiological state during anaesthesia and supporting more complex and prolonged surgery. It was noted however by Beecher and Todd in their review that patients exposed to Curare commonly had more cardiovascular and respiratory complications and a higher mortality after surgery. They don't offer much in the way of explanation, except to criticise the use of muscle relaxants. They fail to comment on the benefit of curare in helping avoid the previously very high toxic doses of anaesthetic agents that would otherwise have been needed to prevent a patient from moving. The reason for more complications after its use is likely partially explained by the extent and complexity of the surgical procedure being undertaken facilitated by the use of Curare and as such the patient being at higher risk of complications. Also importantly was the likely underuse of muscle relaxant reversal agents such as the anticholinesterase, pyridostigmine at the end of surgery. It has since been well recognised that under reversed muscle relaxation causes direct harm to patients, with residual paralysis causing unrecognised aspiration for several hours after anaesthesia and directly leading to pulmonary complications [11]. Unfortunately, patients in the 1940 to 50's given paralytic agents during surgery were likely commonly very awake,

paralysed and avidly aspirating following completion of surgery. It would take another innovator from the North-west of England, Liverpool's T. Cecil Gray, to help establish safer anaesthesia in the form of 'balanced anaesthesia'. This model of anaesthesia consisted of intravenous induction (thiopentone), muscle relaxation (curare), light general anaesthetic with inhalational anaesthesia, small dose opioids, controlled ventilation, and routine reversal of muscle relaxation at the end of the case with pyridostigmine. This combination reduced the doses of each anaesthetic agent required and was found to markedly reduce the postoperative morbidity and mortality associated with anaesthesia [12]. This would become known as the 'Liverpool technique' and launch modern anaesthesia [13]**.**

Subsequent muscle relaxant development by pharma has generated newer agents that have helped improve patient safety further and supported new techniques such as opioid free anaesthesia [14]. Alongside this, has been the development of a new generation of muscle relaxant reversal agents such as sugammadex developed in the late 1990's [15]. These compounds use a novel chemical structure which supports chelation (encapsulation) of the muscle relaxation producing a stable inert NM-sugammadex compound that can be excreted by the kidney, rather than the anticholinesterases that affectively compete with the muscle relaxations at the N-M junction. These new agents ensure that muscle relaxant effects can be rapidly and reliably reversed and has allowed more profound and deep muscle relaxant to be readily used to support new surgical techniques such as robotic surgery. The complete reversal offered by sugammadex also helps resolve the aspiration risk at the end of surgery and indeed has been shown in comparison with neostigmine (more modern anticholinesterase) muscle reversal agent to reduce the risk of pulmonary complications in a comparative study [16]**.**

Alongside documenting evolving anaesthetic practice in 1950's America, Beecher and Todd [1] describe the influence of patient and surgical factors in surgical patient outcomes and recommend the need to study these in depth to help improve practice. They refer to patients' evaluation before surgery as being "good risk" meaning of good physical status and "bad risk" meaning of poor physical status, noting the differences in outcomes for these patient groups. Following surgery, of the population of all 599, 548 surgical cases studied, 7,977 died. This gives an overall in hospital mortality for surgery of 1 in 75 patients. Death was more common in children under 10 following surgery and in adults over the age of 60. They make a powerful argument from 1954, that surgery and anaesthetic practice should be examined routinely, and medical advancement undertaken to improve surgical outcomes. They further suggest that death from surgery/anaesthesia because of its high incidence and significant anaesthesia episodes (over 8,000,000 at this time in the USA),

should be considered as a significant public health problem, "Any agent or agency which regularly and systematically injures a considerable number of citizens each year is a public health problem". Unfortunately for the UK, it would take until the turn of the 21st century and the 2001 publication of the Bristol public enquiry into avoidable cardiac deaths in children at Bristol Royal Infirmary in the 1980s-1990s, for UK healthcare to understand that surgical outcomes needed to be in the public arena to help re-establish public confidence and introduce surgical accountability [17]**.** Following the publication of congenital cardiac surgery outcomes in 2004 [18], by the 'Dr Foster' unit at Imperial College, the NHS would begin to record and publish national cardiac surgical outcomes, which would lead to the creation of other national surgical datasets [19]. Regular national reporting has supported sequential improvements in the standards of surgical care, including the centralisation of specialist surgical care with the recognition that specialist surgeons working in specialist teams in high volume centres achieve better outcomes for patients [20]. The publishing of surgical outcome data has also supported better evaluation of patients prior to surgery.

The concern had been that in publishing data about surgeons and their unit's outcomes, surgical teams may become more risk averse and so prevent patients who may benefit from higher risk surgery actually having it [21]. Indeed, these higher risk patients maybe the ones to benefit most in terms of symptomatic improvement and longevity if surgery was successful. Understanding patient risk thus becomes paramount and the need to assess patients in a robust patient centred multidisciplinary way with the opportunity to look to optimise patients before surgery becomes more important. In their introduction Beecher and Todd [1], predict this as they draw particular attention to the role of the anaesthetist in the total care of the surgical patient and suggest that there is "compelling reason why surgeon and anaesthetist, engaged as they are in a common task, cannot with profit pursue separate goals. The two great goals are facilitation of therapy (the surgical procedure in this case) and the patient's safety". The specialty of perioperative medicine in anaesthesia has grown directly from this need to improve patient care within a team of professionals and has expanded to include surgical and cancer nursing specialists, physiotherapists, dieticians, occupational therapists, pharmacists with the patient and their support network at the centre of this team as the primary member.

Through the 1990's surgery and anaesthesia colleagues developed further understanding of the surgical stress response and perioperative inflammatory processes and their link to patient complications and outcomes. Perioperative innovations designed to counteract these processes developed including more minimal access surgery, advancements in physiological monitoring

during surgery, provision of post-operative care units to continue this monitoring, and new anaesthesia and analgesia techniques. This has all contributed to improvements in patient safety from surgery, reduced perioperative mortality and enhanced patient's recovery. There will next be an examination of the current challenges that remain for modern day perioperative care as well as further developing the role of the patient and their family as we plan surgery.

1.2 Modern day perioperative challenges

There are around 350 million surgical procedures performed each year worldwide and the use of surgical treatments is increasing with approximately 1 in 10 people undergoing a surgical intervention each year in high-income countries [22]. Anaesthesia related mortality is estimated to have decreased by 100-fold over the last 100 years [23], and so anaesthesia for the majority is safe and certainly better than 1954, with estimated risk for an ASA 1 (American Society of Anaesthetists), lowest risk patient, of peri-operative mortality of 0.02% and complications of 2% [24].

Whilst major advances in peri-operative care have improved the safety of surgery, the advances in surgical practice have also opened up surgical access for older and more frail patients. As such there remains considerable global morbidity and subsequent health economic burden associated with major surgery. In the recent international, prospective Vision cohort study peri-operative complications were recorded in the 30 days following major surgery in patients aged 45 or over [25]. Of 40,004 patients studied, 715 died in the first 30 days of surgery giving a 30-day mortality rate of 1.8% for global in-patient surgery. Patients undergoing surgery in Africa had a 30-day mortality rate of 6.5% compared to 1.1% for patients in North America, Europe, and Australia. 10% of patients had undergone urgent/emergency surgery and this was independently associated with a higher risk of mortality. 69% of deaths occurred after surgery during the index hospital admission, whilst 29.4% of deaths occurring within the first 30 days happened following discharge from hospital. Understanding that around 100 million patients aged over 45 undergo inpatient noncardiac surgery each year, the Vision authors postulate that around 1.8 million adults die within 30 days of more major non-cardiac surgery each year globally despite the sequential advances in peri-operative care [26, 27]. Major surgery thus remains a high volume worldwide killer and is now the third commonest cause of death after cancer and cardiovascular disease, with more deaths than HIV, malaria and tuberculosis combined [28]. 44% of the deaths in the vision study were attributable to major bleeding, MINS (myocardial injury after non-cardiac surgery) and

sepsis, and the authors suggest these should be a focus of post-operative care to prevent post-operative mortality, with attention to the treatment of post-operative hypotension and hypoxia.

The Vision authors chose to focus on 30-day mortality to give a composite of the impact of major surgery, however it is very likely that they vastly underestimate the genuine impact of major surgery in terms of patients' future longevity and functional quality of life, and its overall global socioeconomic consequences. When we look beyond the first 30-90 days to 1 year plus following surgery, we see a persistent survival disadvantage for patients that have experienced post-operative complications following their index surgical case. In 2005 Khuri and colleagues [29] combined the American National Surgical Quality Improvement (NSQIP) program database and long-term Veterans Association dataset to examine the survival of 105,951 patients following intermediate to major surgery for an average follow-up of 8 years. They determined that the development of a post-operative complication was an independent and on-going predictor of long-term mortality and was more important that preoperative patient risk and intraoperative factors in deciding long-term survival after major surgery (figure 1.1).

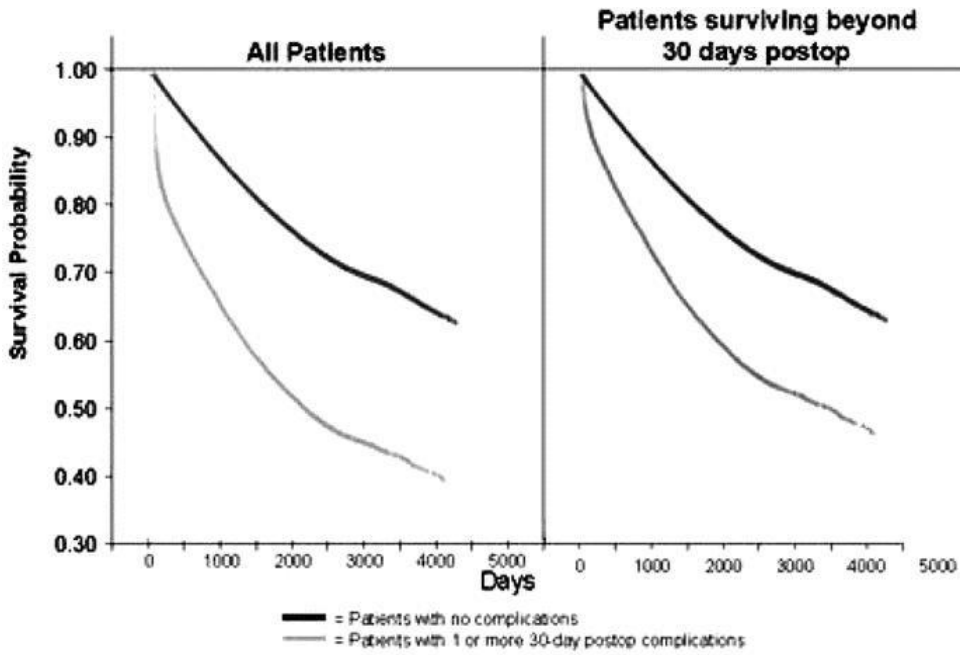

Figure 1.1 Comparison of long-term survival in patients following major surgery with and without complications in 8-year follow-up. (Khuri, S.F *et al)* [29].

This finding was confirmed in UK [30] and Dutch [31] populations who were followed up for 6 years after surgery and determined that post-operative morbidity was associated with premature death in surgical populations. From a reasoning perspective it seems intuitive that a patient who

develops post-op complications is more likely to die in the 90 days or even up to 1 year after their major surgery 'insult'. What is less clear is why patients should have an on-going longevity disadvantage up to 6-8 years after their surgery episode ended. Evidence examining the link between postoperative complications and shorter life expectancy, after year 1 is surprisingly limited. We do know that patients who experience a more complicated recovery after surgery are more likely to have a functional decline in physical and psychomotor health after surgery. Some not returning to their baseline function and independence. This reduction in physical ability and mobility will predispose to a spiral of deconditioning and loss of muscle function (sarcopenia), accelerated by poor protein deficient common as we age with associated impact from any associated cancer progression [32].

Toner and Hamilton [33] in their review of complications after major surgery suggested several further potential pathophysiological mechanisms for why patients with complications after surgery may die sooner in the years following their surgery: As seen in non-surgical populations [34, 35], prolonged inflammation associated with surgical complications may drive accelerated atherosclerosis and amyloid deposition, which in turn contributes to the development and progression of chronic cardiovascular and neurological disease. Prolonged immunological dysfunction may accompany post-op complications and predispose to cancer progression and opportunistic infection in the period following surgery. Induced apoptosis may be exaggerated in patients with more severe post-op complications, similar to that seen in patients experiencing critical illness [36]. Elevated and prolonged level of oxygen free radical release, heat shock proteins, cytokines and endogenous glucocorticoids may all increase cellular apoptosis following complicated surgery. This could lead to the loss of functional tissue in essential organs reducing organ reserve and leaving the patient predisposed to injury during further illness.

1.3 Implications for perioperative medicine

The recognition of the impact of post-operative complications on long-term outcomes intensifies the need to further improve peri-operative care for patients. This is particularly the case for patients with reduced functional reserve, frailty, and cancer. This highest risk surgical group is defined as surgical patients with an aggregate 90-day mortality rate of greater than 5% [37].

We can approach better peri-operative care through 3 complementary processes: surgical pathway design, patient optimisation and supporting the patient's and family role in surgery. The first is to examine and improve the surgical process in an attempt to minimise the surgical insult

and perioperative stress response thus asking patients to recover from a less traumatic process which should help support better recovery. This will lead into an introduction to my MD, the scaling of the ERAS+ (enhanced recovery programme after surgery plus) [38] aiming to reduce respiratory complications after surgery and improve outcomes for patients across Greater Manchester (GM) as the GM ERAS+ programme, supported by the Health Foundation.

The second is examining how we may improve patient factors which we know have an influence upon surgical outcomes, including baseline physiological and psychological fitness, nutritional status, anaemia, management of chronic health conditions and modification of lifestyle elements including smoking and alcohol. The design of the Greater Manchester regional level Prehab4Cancer programme is included in the Appendix Publications associated with this MD.

Finally, the role of the patient in their surgical pathway will be considered, with a review of patient education and its role in achieving better outcomes, and also how we might ensure surgical patients remain at the centre of their own care with a review of patient centred outcomes measures and the role of shared decision making.

1.4 Perioperative solutions

1.4.1 Better surgical pathway – enhanced recovery pathway

Kehelt in his ground-breaking work from Denmark in 1995 aimed to minimize the physiological stress and neuroendocrine response endured by patients undergoing major colonic surgery by putting in place a series of multimodal interventions **39[39]** . In a short series of 9 patients, he described the use of laparoscopic (minimal access) surgery, epidural anaesthesia, early nutrition and mobilisation in combination to produce a significant reduction in post-operative complications and hospital length of stay. This technique would become known as fast track or enhanced recovery after surgery (ERAS) and would come to revolutionize surgery. More elements, based upon best practice and available evidence base, have been added to the bundle overtime, expanding at times to more than 20 elements and incorporating multiple types of surgery including emergency surgery [40] and overseen by a new international body, the ERAS society [41]. Benefits associated with ERAS have included demonstrable consistent reduction in length of stay, reduction in post-operative complications, improvement in quality of life as well as a reduction in healthcare costs [42, 43]. An ERAS pathway is typically divided up into 3 phases, preoperative, intraoperative and post-operative, with the various 20 or so ERAS elements of best practice spread across these phases. The contribution from each of these elements is difficult to ascertain and

there appears to have been an agreement from healthcare surgical teams to accept the offer of individual incremental gains in combination [44]. To support this approach, there is good evidence that increasing compliance to ERAS elements is associated with better clinical outcomes and reduced length of stay [45].

Despite its inception in 1995 and widespread international recognition at the time, ERAS implementation in the UK by 2009, remained fragmented and largely limited to 40-50 NHS centres with ERAS champions and enthusiasts. Recognising this, the NHS Enhanced Recovery Partnership Programme with Department of Health central funding was established to support ERAS implementation and by 2011, more than 86% of NHS providers in England and Wales had ERAS in place with at least one surgical speciality involved [46]. The national programme was very successful in reducing length of stay and complications with no increase in readmissions for major cancer surgeries (colorectal, urological and gynaecological) as well as major orthopaedic surgery [47]. However further pump priming funding for the continuation of the programme particularly for ERAS specialist nurses, was not forthcoming as it was argued at the time that the cost savings realised through the programme should have made the ERAS intervention cost neutral.

The ethos of bundling best practice does appear to have successfully cemented within healthcare practice but what constitutes best practice appears genuinely debatable as the evidence base for most of the elements in a typical bundle are often weak [48]. A review of 25 international colorectal centres in 2019 demonstrated that in practice, centres commonly differ in what they wish to use from the menu of ERAS interventions [49]. Going further colleagues have wanted to understand if they could replicate the benefit of ERAS but with a much more streamlined approach and Levy and colleagues have focused on the immediate postoperative period of the major surgical pathway and the aim for patients to be able to DRink, EAt, Mobilize (DREAMing) [50]. Using QI methodology Loftus et al demonstrated that a focus selectively only on the DREAMing elements outlined by Levy, was successful in achieving a reduction in complications and length of stay [51]. They reasoned that in achieving the end points of a patient being able to eat, drink and mobilise, patients must be receiving high quality anaesthesia and analgesia combined with good surgical technique that is helping to minimise the surgical stress response. This furthers the understanding that good post-operative care should centre on good functional recovery as a primary end point of itself, with the aim of achieving a mobile and independent patient as soon as possible.

In 2013 in Manchester, at Manchester Royal Infirmary in my role as clinical director of the Critical care and with a research interest in peri-operative care, I led work exploring how we may improve the care of our major surgical patients. Leading a multidisciplinary perioperative working group, it

was decided to focus on reducing pulmonary complications associated with major surgery. Postoperative pulmonary complications (PPCs) are one of the most common (2-40%) and significant complications following major surgery and are associated with an increased hospital stay and short and long-term mortality [52, 53]. In a similar way to the DREAMing team, we were keen to understand if a more focused peri-op ERAS process might achieve similar outcomes to the more elaborate ERAS pathways, assuming that many of the elements had already become embedded as good practice. Indeed, ERAS had been implemented successfully in our institution as part of the national ERAS roll out in 2011 with widespread uptake of: ERAS nurse, on the day admission, more minimal access surgery, goal directed fluid therapy, carbohydrate loading and best practice anaesthesia and analgesia. Despite these ERAS implementations across multiple surgical specialities, a prevalence audit in early 2013 of PPC amongst major surgical patients in our institution demonstrated a high PPC rate of 19.3% (16/83).

With our data demonstrating a significant burden of PPCs in the major surgical cohorts at our institution, a multidisciplinary ERAS+ team was formed with surgical, anaesthetic, critical care medical staff, nursing, allied health and pharmacy representation. This team met with major surgical patients who had undergone surgery at our institution to help co-developed a new surgical pathway with a focus on reducing PPC. Cancer and vascular specialist nurses enabled patient and family listening events to support initial co-design and later for feedback as part of implementation of the ERAS+ pathway. As described in the original ERAS+ publication [38], a five-stage quality improvement project was undertaken to design and implement a model of surgical care with a particular focus on reducing PPC, built on ERAS principles, which we termed ERAS+ (figure 1.2).

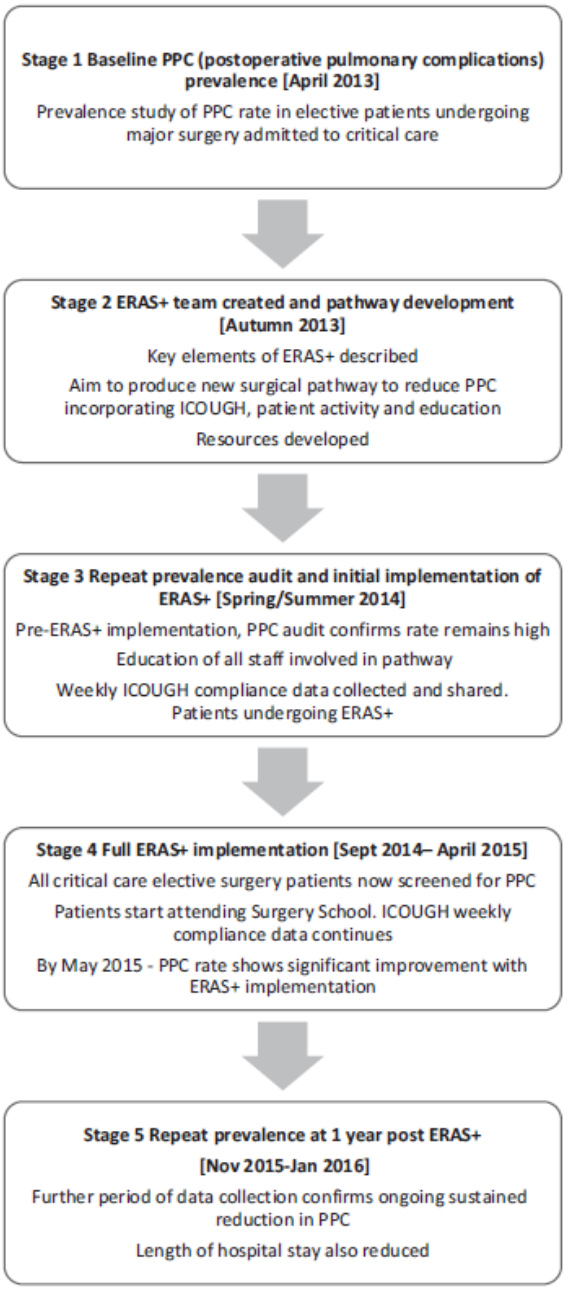

Figure 1.2 ERAS+ design and implementation stages. (Moore *et al*) [38]

A review of the literature at the time highlighted that a simple respiratory care bundle ICOUGH had been successful in reducing PPCs in surgical patients as part of a before and after trial in a large teaching hospital in Boston, USA [54]. The adverse effects of surgery and anaesthesia on lung mechanics includes impaired ciliary clearance, sputum retention, lung atelectasis, silent aspiration with secondary bacterial infection [55]. The ICOUGH bundle [54] aims to counteract these processes through the use of 5 elements, **I**ncentive spirometry to help with lung re-expansion combined with **C**oughing and deep breathing exercises; **O**ral health care with twice daily toothbrushing and chlorhexidine mouthwash to reduce bacterial colonisation and so reduce

bacterial load of aspirated secretions, **U**nderstanding by patients and caregivers to support the implementation of ICOUGH interventions; **G**etting out of bed and bed **H**ead elevation which aim to help removal of secretions and prevent aspiration. In ERAS+, we amalgamated ICOUGH with our existing ERAS elements of pre-operative alcohol and smoking cessation advice, exercise advice, intra-operative goal directed fluid therapy and multimodal analgesia techniques alongside minimal access surgical and drains where possible and promotion of early nutrition and oral fluids as supported by DREAMing [50] (table 1.1)

	Pre-operative	Intra-operative	Postoperative
ERAS (baseline)	Advice to cease smoking and reduce alcohol intake	Intra-operative fluid management techniques, including use of oesophageal Doppler, pulse contour analysis and/or echocardiography	Multimodal analgesia: local anaesthetic infusion via epidural and tissue plane blocks. Minimisation of i.v. opioid use.
	Pre-operative carbohydrate-rich drinks (2 h and 8 h)	Normothermia	Physiotherapy session for chest and mobilisation
	Day of surgery admission	Minimally invasive surgery, minimise drains	Early enteral nutrition (oral or jejunal) with cessation of i.v. fluids
	Cardiopulmonary exercise testing (CPET)		Early removal of surgical drains
ERAS+ (additional elements added to baseline ERAS)	Surgery School invitation ICOUGH-UK YouTube channel	No change	ICOUGH prescription Breathing and coughing exercises with incentive spirometry every 4–8 h
	Deep breathing exercises with incentive spirometers		Mobilisation twice daily
	Increase usual physical activity by at least 50%		Twice-daily toothbrush and chlorhexidine mouthwash
	Oral health advice		Prepare for recovery at home
	Nutritional advice		

ERAS, enhanced recovery after surgery; i.v., intravenous.

Table 1.1 Comparison of ERAS and ERAS+ components (Moore *et al)* [38].

The ERAS+ project at Manchester Royal Infirmary ran from April 2014 to Jan 2016 with patient outcome date data collected by critical care audit team. Data collected included ICOUGH compliance, PPC rate, major complications, mortality and LOS data. A steering group utilised standard QI methodology supported data analysis and developed and adopted a number of new interventions. Two of the most successful innovations were patient educational tools in the form of Surgery School and ICOUGH TV developed with patient groups. Patients reported that an educational process walking them through the ERAS+ pathway would be extremely helpful, and this proved to the case with the co-design and introduction of patient facing Surgery School. A 60–90-minute weekly session where upcoming major surgical patients and families were invited to attend a MDT (medical, nurse, physiotherapist, dietician, pharmacist) led educational session on the elements of ERAS+ and other areas of surgical preparation in a group setting with opportunity for questions and answers. To further support patients ICOUGH UK TV channel

https://www.youtube.com/channel/UCvOamR8Sb4RXENr56fvRehA was set-up on you tube with hospital developed information videos including safe mobilisation, oral healthcare, that patients and families could view in their own time. These proved extremely helpful for patients who were unable to attend Surgery School. The development of the patient's role in surgery is developed further in the final section of this literature review.

The implementation of ERAS+ in single institution study proved very successful with a sequential improvement in PPC rate from baseline of 19% to a rate of 8.7% by the completion of the intervention. This was associated with a reduction in hospital Length of stay for mixed major surgical cohort from 12 days to 9 days.

The success of the ERAS+ work at Manchester Royal Infirmary leads directly into this MD where the development and impact of the Greater Manchester ERAS+ project [GM ERAS+] where ERAS+ is introduced into 7 new NHS acute hospital sites in GM as a Health Foundation supported implementation project between 2017 and 2020. There is an analysis of the intervention and the facilitators and barriers to implementation are explored supported by qualitative interviews.

1.4.2 Optimising patients for surgery

The growth of the speciality of perioperative medicine over the last 20 years has facilitated a focus on what major surgery pathway could look like as we look to optimise patients for major surgery. Previously surgical convenience and waiting times dictated when patients had surgery, rather than understanding what factors may be improved by a perioperative team and what surgery or treatment should be offered supported by a more formal evaluation process with multidisciplinary planning for both benign as well as cancer patients. We now need to consider an integrated, multidisciplinary approach from the contemplation of surgery through to full recovery [56].

The term 're-engineering care' was coined by Grocott et al [57] in their examination of peri-operative care in 2019. They highlighted again the needs of a growing population undergoing surgery with increasingly complex medical needs and setting this against the US Institute for Healthcare Improvement's triple aim of improving patients experience of care; improving population/public health and reducing the per capita cost of healthcare [58]. From this position they argue the need to be able to ensure that patients are fit enough for the proposed treatment. Rather than using the traditional model (figure 1.3) in which pre-operative assessment happens very close to the surgical episode instead we should instead look to move to a more patient centred pathway with physiological evaluation and perioperative MDT occurring much earlier in the patient pathway when surgery is contemplated (figure 1.4).

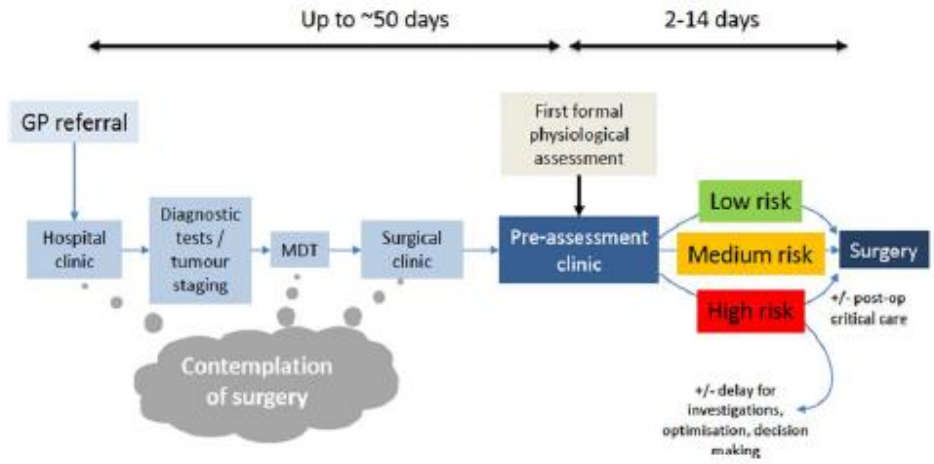

Figure 1.3 Traditional pre-operative pathway. MDT, multidisciplinary team. (Grocott *et al*) [57]**.**

Supporting patient and family's understanding of the risk of surgery much earlier in the pathway should encourage much more genuine shared decision making [59], as we at the same time gather information about what matters to patients in terms of potential pathway outcomes. Similarly, this gives us the time frame to intervene to improve surgical risk, both through optimising chronic health conditions or improving baseline physiological, nutritional and psychological well-being in readiness for the surgical challenge ahead.

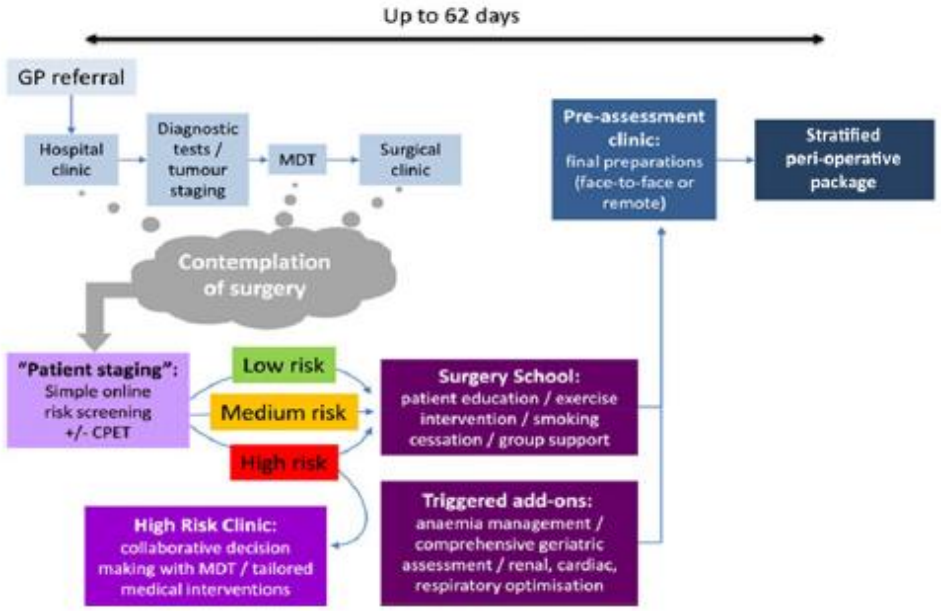

Figure 1.4 Proposed 're-engineered' pre-operative pathway. (Grocott *et al*) [57].

As mentioned previously we particularly want to identify those patients deemed at higher risk with a predicted mortality of 5% or greater with major surgery. Poor 'physical fitness' reliably predicts

adverse post-operative complications as noted by Beecher in 1954 **1** when such patients were labelled as 'bad risk'. There are a number of pre-operative tools including cardiopulmonary exercise testing that have established pre-operative risk stratification and supported better shared decision making. The surgical stress response increases the body's demand for oxygen, with aerobically unfit patients struggling to meet these demands and resulting in secondary organ dysfunction. Specific CPET variables derived from bicycle ergometer during incremental exercise can identify these less fit patients who will develop anaerobic metabolism at lower work rates compared to more fit patients. CPET variables such as peak oxygen consumption, (VO2 peak), anaerobic threshold (AT) and ventilatory equivalents for carbon dioxide clearance have been particularly linked to peri-op outcomes [60, 61]. There are additional field tests such as the 6-minute walk test [62], incremental walk test [63] and sit to stand [64] that also provide reliable information about patient fitness as well as providing targets for improvement. Alongside physiological testing for major surgery, broad screening for the presence of frailty and pre-frailty has been increasingly recognised as important in the setting of all surgery [65]. Frailty is defined as a decrease in physiological reserve across multiple organ systems and is associated with increased vulnerability to external stressors [66]. The frailty phenotype has five variables (unintentional weight loss, self-reported exhaustion, low energy expenditure, slow gait speed and weak grip strength) which should be screened for alongside increasing dependency on others for everyday tasks [67]. If the presence of frailty or pre-frailty is detected in patients planned to undergo major surgery, a more in-depth comprehensive geriatric assessment (CGA) should be performed, and a geriatrician involved in the care of the patient alongside a broader MDT to help determine overall risk and potential management strategies including optimisation if surgery is decided upon [68].

Alongside determination of frailty and solutions in the form of prehabilitation which aims to improve multiple elements of health (exercise, nutrition, psychological well-being) prior to surgery and is explored in the next section, we should also look to optimise patients' chronic health conditions in the pre-operative period. There should be a particular focus on diabetes, hypertension, cardiovascular and respiratory disease using patient partnerships with primary and secondary care. The Department of Health surgical improvement vehicle 'Getting It right' developed initially in orthopaedic surgery and now being deployed in most other surgery types, supports an overview of healthcare processes such as better management of chronic health conditions. It identifies a national standard of care for surgical procedures utilising a dashboard of clinical and performance data for provider sites, this is then supported by senior clinicians visiting providers to offer bespoke advice and recommendations [69]. Re-orientation of pre-op

pathways also supports correction of anaemia utilising iron replacement where appropriate, understanding that anaemic patients have increased risk of complication and death after major surgery [70]. Blood management strategies should extend into the perioperative period to avoid unnecessary blood transfusion in the perioperative period which is associated with immunomodulation, cancer progress and worse outcomes [71]**.** As part of pre-operative planning, we also need to set peri-operative targets for intra-operative managements, where we seek to prevent secondary complications through avoidance of for example hypotension which is now increasingly recognised as being an important determinant of post-operative outcomes and not a benign phenomenon as previously thought [72]. Following surgery, post-operative monitoring and location of care are very important and supported by determination of fitness prior to surgery. The new Enhanced Postoperative care units or level 1+ units provide 24-48 hours close observation with 1 nurse to 4 patients and promote the uptake of ERAS principles, whilst managing post-operative hypotension or bleeding [73] which as determined in the Vision study [25] are excellent targets for preventing postoperative mortality.

1.4.2.1 Prehabilitation

A decline in physical performance as we age is common, and the development of pre-frailty and frailty phenotype can be accelerated by a lack of physical activity and other modifiable risk factors such as poor chronic health, poor nutrition, smoking and alcohol. Reduced activity accelerates the development of sarcopenia (muscle loss) which will be further worsened by the other processes such as the catabolic effects of cancer. From what might be a very low baseline, all patients undergoing major surgery experience a reduction in functional status postoperatively followed by a recovery period [74], **a** in figure 1.5 below.

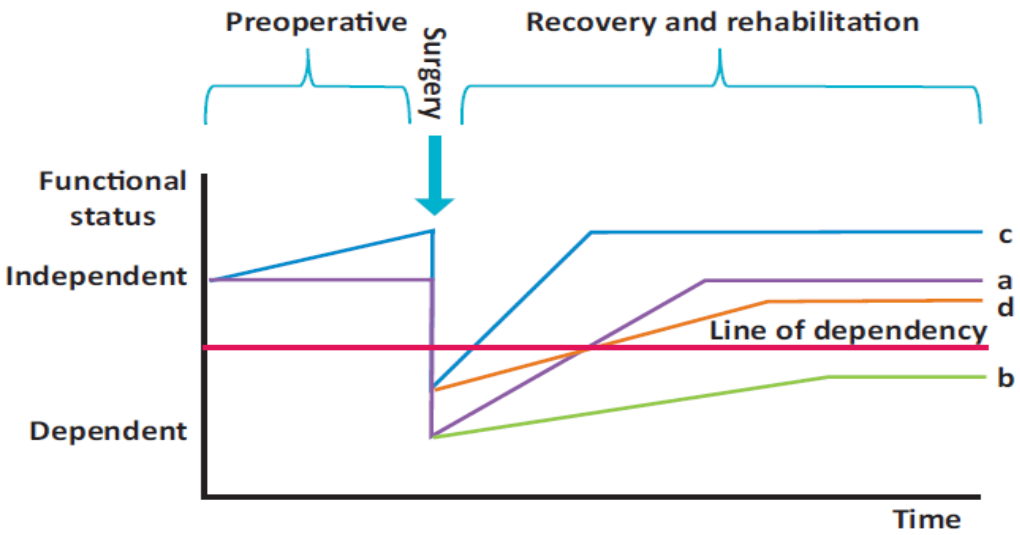

Figure 1.5 The prehabilitation concept - a) all patients undergoing major surgery experience a reduction in functional capacity postoperatively followed by a recovery period. b) Patient suffering a complication may experience a slower and incomplete recovery threatening longer term independence. c) prehabilitated patients are better placed to cope. d) Should a complication occur, prehabilitation might be crucial to safeguarding longer term functional status and independence. (Durrand *et al*) [74].

As explained previously, those patients that have a significant complication, particularly those with significant underlying frailty will likely have prolonged recovery, may well have long-lasting functional disadvantage and a greater dependency which is associated with shortened survival (b in figure 1.5). To mitigate this, the concept of Prehabilitation has gained substantial traction in perioperative medicine as we look to provide better resilience and outcomes for higher risks patients undergoing major surgery, and particularly in oncological resection. Prehabilitation is the process of providing a 'personalized, multimodal, needs-based interventions designed to improve the physiological, metabolic and psychological resilience of an individual prior to an expected major stressor', in our case, major surgery [74] (c in figure 1.5).

Although advocated now as multimodal, most evidence for prehabilitation comes from unimodal exercise intervention [75, 76]. Exercise is different to normal physical activity and involves an escalating exercise stimulus which should be prescribed, monitored and adjusted based upon regular fitness assessments. Exercise can either be delivered as moderate continuous training at

sustained intensity above AT (anaerobic threshold) or as High Intensity interval training (HITT) which alternates periods above AT with lower intensity periods. HIT appears to offer great efficiency in terms of increasing aerobic capacity more quickly and direct supervision of exercise appears better in generating exercise efficacy compared to non-observed exercise [77].

Aerobic and muscle strengthening exercise interventions in major surgical patients have been shown in single centre RCTs to be safe and effective in increasing objective markers of fitness prior to surgical intervention. They have also demonstrated a reduction in post-operative complications and hospital length of stay [78]. However, this hasn't been the universal findings in all studies and some patients seem not to respond to exercise intervention and are termed 'non responders' [79]. This appears to affect up to 30% of patients in some studies. There remains as yet an absence of demonstrable impact on long-term benefit associated with the utilisation of prehabilitation. To investigate non-responders and to derive efficient exercise regimens at a patient level, there is on-going research around the minimum 'dose of exercise' that maybe required by patients [80]. This also looks to determine additional anti-cancer effects that maybe derived from exercise beyond simply improving fitness [81]. Alongside ensuring reliability of exercise prescription and fidelity of the exercise intervention, researchers have also deliberated that some patients may require additional interventions alongside exercise to help generate improvement and now alongside aerobic and strengthening, multimodal prehabilitation models seek to address the common deficiencies of mental and nutritional well-being evident in cancer patients.

1.4.2.2. Role of nutrition and psychology

Nutrition

The importance of nutrition and its role in cancer management and surgical cancer care specifically has been increasingly recognised over the last 30 years. It is estimated that the deaths of 10-20% of cancer patients can be attributed to malnutrition rather than the cancer itself [82, 83]. Malnutrition is defined as "inadequate nutritional intake and/or increased nutritional requirements that result in negative clinical outcomes" [84]. The risk of developing malnutrition in older adults is associated with the effects of the tumour, side effects of cancer treatment, cancer cachexia, and any associated anorexia related to aging. Older patients with head and neck or gastrointestinal cancers are at the highest nutritional risk [82]. Malnutrition is an independent risk factor for reduced survival, greater functional decline, poorer quality of life, and longer recovery

times for older patients with cancer. It is also a major risk factor for poor treatment responses, cancer-related toxicity, infections, and longer hospital stays [85].

Malnutrition is a key risk factor in patients undergoing major surgery and the body's response to major surgery commonly induces a catabolic state, which can be profound if associated with post-operative infection and other significant complications. Malnutrition commonly co-exists with frailty and sarcopenia, a large meta-analysis of older adults going into hospital showed that 84% of patients were frail, with 37% of also being sarcopenic and 66% malnourished. Malnutrition screening should be utilised in all major surgical patients and a malnutrition universal screening tool (MUST) score is commonly used to identity malnourished and at-risk patients [86]**.** Specific evaluation and management should be instigated for those patients identified as malnourished and should form part of the evaluation pathway in those surgeries where it's prevalence is most common (upper GI cancer, head and neck cancer, pancreas cancer, inflammatory bowel disease).

Generally, a food first approach is used for dietetic intervention aiming to ensure correction of malnutrition with a focus on sufficient protein content (1.5-2.0 g/kg daily) which is all tailored around the increased energy expenditure for the exercise competent of prehab [87]. Meta-analyses of RCTs comparing nutrition prehabilitation alone or in combination with exercise have shown that multimodal prehabilitation significantly reduced the length of stay of patients following cancer surgery although the number of studies is currently small [79, 88].

Psychology Well-being

Psychological health has also increasingly been recognised as important in perioperative practice, particularly with regards to cancer, where its role is now seen as a fundamental element in multimodal cancer prehabilitation [89]. Psychological morbidity in the form of depression, poor self-efficacy levels and anxiety are understandably very common in cancer patients and provide targets for perioperative intervention. Strategies including preoperative educational and behavioural support sessions, mindfulness with relaxation techniques and hypnosis seem to show benefit although the evidence for such interventions is considered as small at this current time [90]. Exercise is seen as a powerful psychological support tool and focus on supporting psychological well-being through quality-of-life measures, with the role of the exercise coach potentially doubling as a support mechanism [91]**.**

An empirical study of 102 families of palliative care patients was undertaken to identify the prevalence of psychological morbidity in family members. Beck Depression Inventory-derived

distress was identified in one-half of patients, one-third of spouses and one-quarter of offspring, suggesting that psychological distress reverberates substantially throughout the nuclear family. Anger was significantly more common in the offspring, who perceived their families to have poorer communication, cohesion and more conflict than their parents, suggesting that information about the illness may not be adequately transmitted to them. The family as a group is the most appropriate recipient of care, and family meetings are advocated to promote communication, support and mutual understanding [92]**.**

There understandably remain concerns around how long we should take to attempt to impact on a patient's fitness in the pre-op period versus the trade off against cancer progression. Prehab advocates seem happy that cancers such as colorectal are less likely to progress quickly and so patients can be offered more preparation time compared with lung cancer for instance, which tends to be a more aggressive catabolic tumour. There seems agreement that a 4-week period exercise programme can be afforded for most cancer types and this time period will give sufficient time to improve cardiovascular fitness and strengthening [93].

Other preop optimisation strategies including anaemia management and medication optimisation are commonly added to prehabilitation programmes. There is also increasing interest in the utilisation of prehabilitation as one of the elements of ERAS programmes. The implementation of the Greater Manchester Prehab4Cancer prehabilitation which I have led on, has attempted to build on the GM ERAS+ programme with a system wide prehabilitation programme for patients undergoing major colorectal, lung and Upper GI major oncological resection surgery [94]**.**

1.4.3 The role of the patient in surgery

Finally, in this literature review, there is a focus on the role of the patient and their family around the time of their surgery. This will cover patient education and the idea that surgery provides a 'teachable moment' where we can aim to improve health far beyond surgery. There will then be an exploration of factors that matter to patient in patient reported outcomes which will leads into the role of perioperative shared decision making.

1.4.3.1 Patient education prior to Surgery

'Teachable moment'

The important benefit of patient education prior to surgery has been recognised since pre-surgery education programmes were first described in the USA in the 1960's. At this time Nursing teams

were observing that the preoperative instruction they were giving to patients was helping reduce patient reported anxiety before surgery, allay fear about post-operative pain and supported early post-operative mobilisation. Up to this point, it seems to have been generally believed that a lack of knowledge on the patients' behalf would be beneficial in reducing patients fear of impending surgical events [95]. Beecher and Todd [1] as mentioned previously don't include patient perspective or role in their review from 1953. Indeed, the initial patient educational programmes were developed and taught to patients solely by surgical nurses. Surgeons and anaesthetists appear to have had very little input into this process, likely seeing their domain as the theatre environment and post-op recovery as something less important and subsequently left to the nursing teams to lead.

Healy in her publication from 1968 [96], further explored the emerging importance of patient education and evidences its impact through a pseudo randomised trial (patients being randomised dependent upon the day of the week) of pre-op education vs no education in a population of over 300 surgical patients, undertaken by the surgical nursing team in her institution. Pre-op training was given to patients on the night before surgery and consisted of a set of instructions given to an individual patient by one of the attending nurses. Family members if in attendance with their relatives were included in the education package and asked to reinforce the instructions to their relatives in the post-op period. The education mainly focussed on what to expect in the post-operative period, including pain and drain management and a set of instructions (deep breathing exercises, turning, coughing, how to mobilise) to improve chest and abdominal recovery. Of the 181 surgical patients who underwent the pre-op training, length of stay was 3-4 days shorter than the cohort of 140 patients who had not undergone training. Patients who had received the pre-op education package reported feeling more confident and less anxious about their upcoming surgery.

1.4.3.2 Group Pre-operative sessions

Another American surgical nurse, Mexxanote [97], building on the work of Healy, seems to have been one of the first healthcare workers in the literature to recognise that group instruction for patients undergoing surgery may provide additional benefit over single person instruction. She reports noticing the established benefit of group sessions in prenatal and postpartum obstetric care and also in the management of diabetes and wanted to understand if group learning would better support patients in preparation for surgery. In her surgical unit, she studied 24 patients undergoing major surgery. She took small groups of patients, usually around 4 at a time, for 30-minute sessions on the evening before surgery and gave them detailed post-operative instructions

in preparation for surgery, including breathing exercises, pain control suggestions and activities to undertake in the initial post-op period. There was then an opportunity for a group discussion around surgery and opportunity to answer any questions.

Following surgery, the majority of patients (23/24) were interviewed again by Mexxanotte before discharge about their experience with the pre-operative group session. She reported that patients generally felt more prepared after their group session, were able to undertake expected activities more easily and had enjoyed meeting with other patients in a group. Of the 23 patients interviewed only 2 stated that they would have preferred a 1-1 session rather than a group and that was because they would have preferred more time to ask questions. She concluded by suggesting that these 30 minutes pre-op group instruction sessions were efficient in healthcare terms: teaching a number of patients rather than just 1, priming patients in post-op instructions and so reducing nursing time in the post-op period and producing patients who feel better prepared and less anxious.

Despite the success of the American patient training programmes in the 1970's it was evident that UK surgical practice in the 1990's was still underserving patients. Several studies [98] including a review of patient knowledge of operative care in 1993 undertaken in a District General Hospital by Williams highlighted the information gap that patients were experiencing [99]. More than 60% of patients reported receiving poor explanation prior to surgery and more than 40% stated that they desired further information. This failure to support patients was being exaggerated at the time by the move to ambulatory surgery and more on the day admission, so reducing the time nurses would have to meet with patients prior to surgery. It would take the introduction of Enhanced Recovery programme in the UK to help move forward patient preparation and education.

1.4.3.3 Enhanced recovery programmes and role in patient education

The evolving enhanced recovery programmes 1990s-2000s built extensively on the role of patient education and in line with the need for on the day admission, moved education events to the presurgical ERAS outpatient clinics [100]. The Enhanced Recovery After Surgery [ERAS] models taught patients about stepped recovery model and daily goal setting in the post-operative period [101]. This form of patient preparation however tended to be taught in 1:1 patient to health professional setting and did not bring patients together in groups. Patient education was being undertaken by the increasing number of ERAS nurses that were being introduced into surgical practice to support the role out of ERAS surgical programmes [46].

Preoperative education in a group setting began in the UK and Ireland in orthopaedic ERAS programmes, in the early 2000s some 30 years after the initial work in the USA. These new education group events became known as 'Joint Schools' and were generally led by ERAS nurses supported by allied health professionals providing sessions on post-operative mobilisation and pain management. Following ERAS methodology these schools focused on the stepped recovery principle of what patients should do in the post-operative period and tended to include only minimal pre-operative preparation. There was little involvement if any from anaesthesia although anaesthetic techniques of spinal and general anaesthesia were explained by the ERAS nurses. Reported benefits included reduction in length of hospital stay, reduced preoperative anxiety and reduced postoperative pain [102].

1.4.3.4 Development of Surgery School for Major Surgery

When designing the ERAS+ project in Manchester in 2013, we became increasingly aware as a clinical team that there was generally little thought given to patient and family involvement in the design of surgical preparation. Involving patients and families in the co-design and on-going iterative development of Surgery School in Manchester has assisted greatly in other developments such as the Greater Manchester Prehab4Cancer programme [94]. The UK development of Surgery School for major surgery is examined further during this MD.

1.4.3.5 Perioperative medicine's role in public health -Teachable moment

The evolution of perioperative medicine has encouraged healthcare professionals to look beyond the surgical episode and consider how they may improve a patient's lifestyle and future health. In 2010 Shi and colleagues [103] described the surgical pathway as a teachable moment in a patient's journey through healthcare, an unique time when they are actively listening to healthcare and advocate its role in permanent life style modifications including smoking cessation, alcohol consumption, increased physical activity and weight management. Research into this opportunity to facilitate behavioural change has shown that patients tend to favour interventions in the weeks leading up to their surgery as they are motivated by the risk in front of them [104], our challenge is maintaining lifestyle interventions in the long-term. The recovery element of prehabilitation programmes as we aim to support patients after their surgery gives us the opportunity to dovetail into community-based support to maintain confidence and foster better long-term health[105].

1.4.3.6 Patient reported outcomes

Understanding what matters to patients and their families and their wider support network is now increasingly recognised as essential to modern healthcare and feeds into shared decision making around surgery as I'll explain in the final section below. To understand a patient's response to treatment, standardised patient reported outcomes have been developed including symptom assessment, physical function, psychological health, nutritional status, and social function measures including employment and economic status. A Patient Reported Outcome (PRO) is defined as "any report of the status of a patient's health condition that comes directly from the patient, without interpretation for the patient's response by a clinician or anyone else" [106]. However, healthcare professionals are often reluctant to utilise PROMs outside of research setting as they report being concerned that it will only add to their work burden rather than acting as an efficient and useful measure of a patient's progress. Patients describe wanting their PROMs to be relevant to their care and the length of time to complete a multi-item PROM [Patient Reported Outcome Measure] can be appear a very onerous burden to a patient recovering from what may be a very significant procedure [107]**.** Electronic data capture systems offer an opportunity to gather relevant outcomes, without hopefully being burdensome to patients and healthcare. Relevant patient information can then be escalated for clinician action with agreed threshold and a better patient sense of control [108, 109]**.**

1.4.3.7 Shared decision making

Shared decision making is a process which aims to understand a patient's values and preferences married to the physician's expertise to determine the best bespoke care package that is possible for that individual [110]. Alongside developments in biopsychological models of health, the differentiation of illness from health and a focus on patient-centred outcomes, shared decision making is a further component of shift towards better 'patient-centred care' as we approach the 'pinnacle of patient centred healthcare'. This has particularly gathered momentum as we look to understand the health ethics and economics implications of operating on higher risk patients and for surgeries that may not offer longevity with high-risk of morbidity and potential suffering. Indeed, we should strive to achieve decisions that are 'supported by evidence, not duplicative, free from harm, truly necessary, and consistent with patients' values' [111].

Shared decision is a development of the more traditional consent process – with its primary focus on information giving - to a model that involves the family and their support network in a deliberative discussion about the best way forward. Anaesthesia alongside surgery has centred

this in the perioperative medicine space and can use several decision aid tools to support discussion and decisions made. From the patient and family perspective, MAGIC questions can be used to provide structured questions for healthcare providers such as do I really need this test, treatment, what are the risks, what are the possible side-effects, are there simpler safer options, what will happen if I do nothing [112]. Healthcare can use the SHARE approach to similarly reach a decision with the patient and evaluate what the implications mean for them [113]. Commonly shared decision-making processes require at least 2 meetings to support reflection and further consultation. It is becoming evident that there needs to be sufficient time resource allocated to such meetings to make the decisions valid and appropriate for patients.

1.5 Implementation science research

Improvement science and research is an emerging concept and is considered by the National Health Institute as "the scientific study of the use of strategies to adopt and integrate evidence-based health interventions into clinical and community settings in order to improve patient outcomes and benefit population health" [114].

Traditional effectiveness trials research focus on a particular clinical intervention such as a medication or therapy and uses randomization at the patient level. Random assignment within trials is intended to provide internal validity and aims to be able to attribute any effects on patient outcomes to the intervention. Implementation science is generally focussed on the extent to which an intervention was implemented, including its acceptability, fidelity and sustainability. However, it is possible to design implementation science studies where experimental design with randomisation can be used to examine the effectiveness of an intervention. Commonly the sites or hospital units where the intervention is planned to happen are used as the unit of randomisation rather than trying to randomise at a patient level. The risk of contamination at a site level is very high as providers would inadvertently begin introducing implementation interventions to those patients designed not to receive it and so patient randomisation in implementation is generally reported as inappropriate.

Implementation RCTs are often cluster-randomised trials where sites/hospital units are randomised to receive the intervention and this can be further refined where sequence of implementation strategies or elements of implementation bundle are examined using sequential, multiple-assigned randomised trail (SMART), where patients are randomised to receive different combination and timings of interventions.

Quasi-experimental designs are also used in implementation science where RCT design may be inappropriate and design types include pre-post design with a control group, interrupted time series and stepped wedge [115]. Pre-post design with control group uses a control group in the absence of randomisation with the control group matched by factors such as patient population, geographical and demographic features [116]. It remains less robust than a standard RCT. Interrupted time series rather than relying on a potentially non-equivalent control group, uses multiple time points before, during and after the intervention and the development of mathematical modelling to look for change in trends and so determine effect [117]. Stepped wedge design are trials where all patients receive the intervention but in a staggered method. All sites in a stepped wedge design traditionally have outcome measures at all time points, meaning

that sites that receive the intervention later in the trial can act as controls for early intervention sites [115].

1.6 Improving surgical outcomes in Greater Manchester – implementation science approach

This literature review provides a background to the development of the Greater Manchester ERAS+ (GM ERAS+) programme, and the perceived need for the implantation programme. GM ERAS+ is supported by Health Foundation Scaling up Improvement funding as the 'Improving surgical care for patients and their families in Greater Manchester – GM ERAS+ programme' [118].

From an implementation science perspective, it was planned to examine the implementation of ERAS+ pathway intervention across multiple hospital settings within GM ERAS+ using effectiveness-implementation hybrid methodology where there is a dual focus on the effectiveness of the intervention (ERAS+) being adopted at sites and also the success of implementation process itself across the GM health system. Mixed methods techniques were planned to be used to assess the adoption, as supported by the Institute of Implementation science in population health in quality improvement research (https://cunyisph.org/about). Mixed methods research combines quantitative and qualitative methodological components in the same study.

Quantitative measured outcome and process measures are used to look at the success of implementation and its effects. For quantitative evaluation, it was decided that ERAS+ would be offered to all patients at sites undergoing major colorectal surgery during the implementation period. There would thus be no randomisation and no site control group (patients not receiving the intervention), as all patients were designed to undergo the intervention. There would be an examination and comparison between those patients at the beginning and those at the end of the intervention in a 'before and after design'. Caution is required when interpreting the results of before and after studies where there is no control group, as any observed changes, may be due to other general trends being introduced or developed at the same time. To help overcome this it was planned to create a quasi-experimental cluster design [119], where sites would be grouped together into 2 cohorts, with later implementation sites acting as controls and also in a separate process to use data from 'non-ERAS+' GM surgical sites to provide 'control sites' where patients would be undergoing similar surgery but not receiving ERAS+.

Qualitative approaches tend to use semi-structured one-to-one or group interviews to generate meaning-oriented data. Methods are then brought together to answer a question or hypothesis.

The methodology and results of implementation will be examined through the following hypothesis.

Primary hypothesis:

Evaluate the success of the implementation of ERAS+ across multiple sites in Greater Manchester

Secondary hypothesis

What are the barriers and facilitators to the implementation of ERAS+?

For ERAS+ implementation using mixed method evaluation will allow us to answer the first hypothesis about the potential success of implementation of ERAS+ in our primary hypothesis question and will be measured through quantitative patient and process outcomes. The second hypothesis would be answered by qualitative analysis as we aim to understand from healthcare and patient participants in the ERAS+ programme what were the reasons for successful implementation or the barriers experience in implementation.

CHAPTER TWO

Methodology

The Greater Manchester ERAS+ (GM ERAS+) programme is supported by Health Foundation Scaling up Improvement funding as the 'Improving surgical care for patients and their families in Greater Manchester – GM ERAS+ programme' [114]. It was planned to examine the implementation of the ERAS+ pathway intervention using effectiveness-implementation hybrid methodology where there is a dual focus on the effectiveness of the intervention (ERAS+) being adopted at sites and also the success of implementation process itself across the GM health system. The following chapters describe the implementation methodology of GM ERAS+ and its mixed methods evaluation. They have been developed using the revised standards for Quality Improvement Reporting Excellent (SQUIRE 2.0) publication guidance [120].

2.1. Introduction

Postoperative complications (PPCs) are recognised as a significant problem for patients and healthcare professionals alike [29, 52, 53]. Post-operative pulmonary complications (PPC) normally affect 1-2% of patients after all surgeries and in major surgery particularly in open procedures, they are the most common complication affecting up to 30% of patients [52]. They are associated with increased hospital length of stay (LOS) and result in reduced life expectancy for up to 3 years after major surgery [30, 52, 53]. For colorectal procedures, despite the evolution in laparoscopic surgery which has reduced the incidence of pulmonary complications particularly in the elderly and those with background pulmonary disease, PPCs still affect up to 12% of patients having major colorectal laparoscopic surgery and remain a useful target for healthcare intervention [121]

In the post-pandemic world, ensuring institutions have structured, feasible and implementable pathways to reduce the burden of postoperative morbidity and mortality has never been more important. Current estimates are that, of the approximately 4 million operations normally undertaken each year in NHS institutions, approximately 1-2 million were postponed due to the COVID-19 pandemic [122]**.** As well as the inevitable backlog of cases, patients may also be deconditioned prior to surgery, through reduced activity during covid lockdowns and the effects of Covid 19 infection itself and as such more vulnerable to complications, longer lengths of stay and postoperative morbidity [123]. Prior to the pandemic enhanced recovery programmes were developed to improve patient experience, reduce healthcare-associated financial costs and enhance public health more generally [124]. Nevertheless, the principles of enhanced recovery have not been implemented universally across all organisations and there likely exists a gap between what is known and what is done [125].

Previous work from 2017 described the implementation of ERAS+ in a single tertiary surgical centre at Manchester Royal Infirmary between 2013-2016, with a reduction in the incidence of PPCs as well as hospital length of stay (LOS) [38]. The Greater Manchester Enhanced Recovery After Surgery programme (GM ERAS+) aimed to scale ERAS+ across Greater Manchester. Specifically the programme aimed to help better prepare patients for major surgery through: Surgery School; encouraging prehabilitation elements of increased aerobic activity and strengthening pre and post-operatively [74]; ICOUGH respiratory care bundle [54]; lifestyle medication with reducing/stopping smoking and reduction of alcohol consumption; psychological well-being; anaemia management; nutritional optimisation pre-op and initiation of early nutrition and mobilisation post-operatively in the form of a peri-operative bundle aimed at reducing PPCs.

2.2 Stakeholder engagement and GM ERAS+ development

During 2017, a series of listening events within the Greater Manchester Health and Social care Partnership (GMHSCP) [126] involving key stakeholders in the perioperative pathways for major surgery were conducted. From these learning events, 6 hospitals Trusts in GM agreed to undertake ERAS+ implementation for their major surgical population as the collaborative GM ERAS+. The six Trusts taking part in GM ERAS+ were Manchester University NHS Foundation Trust (Wythenshawe site), Stepping Hill Hospital, The Christie Hospital, Salford Royal Foundation Trust, The Royal Oldham Hospital and Royal Bolton Hospital. Their different locations would reflect diverse characteristics of NHS local sites to test scale up and spread. North Manchester joined the GM ERAS+ project in the early part of 2019, taking the eventual number of participating sites in Greater Manchester to seven.

With this agreement in place, a GM ERAS+ steering group was formed with peri-operative leadership and membership invited from each of the participating NHS Trusts alongside expertise from peri-operative multi-disciplinary team colleagues from Manchester Royal Infirmary who had undertaken the original ERAS+ implementation. Approval was sought from the medical directors for Greater Manchester acute NHS Trusts as well as Greater Manchester chief executives and board members to ensure system and hospital support.

To support the scaling and necessary implementation infrastructure required for GM ERAS+, it was recognised that operational and quality improvement partners would be required. These were identified:

- Project management support from the NHS Transformation Unit [127] would facilitate project and strategic support to implement the ERAS+ programme into host organisations. This operational role would provide overarching support to all participating sites.
- Improvement expertise to the project would be provided by the quality improvement team, Haelo [128], using in-programme rapid quality improvement cycling techniques. This technique provides 'in-implementation' regular feedback to project teams and stakeholders in order to help develop an intervention and address any implementation problems as they occur [129]. Haelo would also conduct a full-scale programme evaluation using a formative approach. The separate roles of implementation support and evaluation of the effectiveness of the project, would be achieved through separate improvement and evaluation teams. The evaluation aim would be to understand 'what worked, for whom and in what context?' for those patients participating in ERAS+. During the implementation period, in 2019 Haelo amalgamated with AQUA [130], another quality improvement NHS partner also based in Greater Manchester, which took over the quality improvement and evaluation team roles within the project. Improvement expertise was also provided to the programme by Rubis QI team [131] which provided high level support to the steering group and clinical leads of the programme.
- National Perioperative expertise – Working with national PQIP Perioperative Quality Improvement Project [132], provided peer support for the project and supported the development of a GM specific ERAS+ database. This was modelled on the standard Perioperative Quality Improvement dataset but would include ERAS+ elements and support additional data collection of PPC data up to day 7. There was a secondary aim to generate live dashboards of ERAS+ process and outcome metrics to generate real-time knowledge of success and barriers to implementation.
- Local Academic Health Science Network (AHSN) involvement from Health Innovation Manchester [133] was also sought to provide NHS system level learning, with the intention of developing an ERAS+ implementation toolbox to support scaling to other NHS Trusts through the AHSN.

With these partners in place, the GM ERAS+ project team applied for and were awarded Health Foundation Scale and Spread funding in October 2017 [114] through a competitive process. This funding supported the delivery of GM ERAS+ implementation over a 2-year period (2018-2020) across 6 NHS sites, and specifically supported funding of an ERAS+ data collector for each site, alongside operational (Transformation Unit) and evaluation (Haleo/Aqua) support to the

programme. A seventh site would join the programme in early 2019 and the data collector resource was shared between 2 sites to support their inclusion.

Aligning with Recommendations for Evaluation of Health Care Improvement Initiatives and Medical Research Council Guidance on developing and evaluating complex interventions [134, 135] it was planned to structure a two-phased roll out of ERAS+ (see Table 2.1). Three NHS Trusts from the south of Greater Manchester would take part in a Phase 1 Implementation between months four and nine, and three (later 4) NHS Trusts from the north of Greater Manchester would join as Phase 2 Implementation, 3 months later. It was also planned to look at data from comparator sites undertaking similar surgery but without ERAS+ implementation to act as control sites. Data collection was planned to start at sites during Phase 0: Baseline and run to completion of Phase 2. This approach aimed to create a quasi-experimental cluster design [119] where difference in difference comparisons of the key measures, would be made pre-post the phases, longitudinally and across sites.

NHS Trust	**Phase 0:** Baseline (Months 1-3)	**Phase 1:** South Greater Manchester Implementation (Months 4-9)	**Phase 2:** North & South Greater Manchester Implementation (Months 10-15)
Christies			
South Manchester	A0	A1	A2
Stepping Hill			
Salford			
Bolton	B0	B1	B2
Oldham			
Comparator A			
Comparator B	C0	C1	C2
Comparator C			

Table 2.1 Planned phase approach for GM ERAS+ implementation

The Greater Manchester ERAS+ (GM ERAS+) programme high level plan (Figure 2.1) was developed and set out pre-implementation planning stage (Nov-April 2018) including training of site teams and recruitment of data collectors, 2 phases of ERAS+ introduction (April 2018 and Sept 2018), following by 15 months of steady state operational ERAS+ delivery (Sept 2018-December 2019), followed by an evaluation stage (Jan-March 2020).

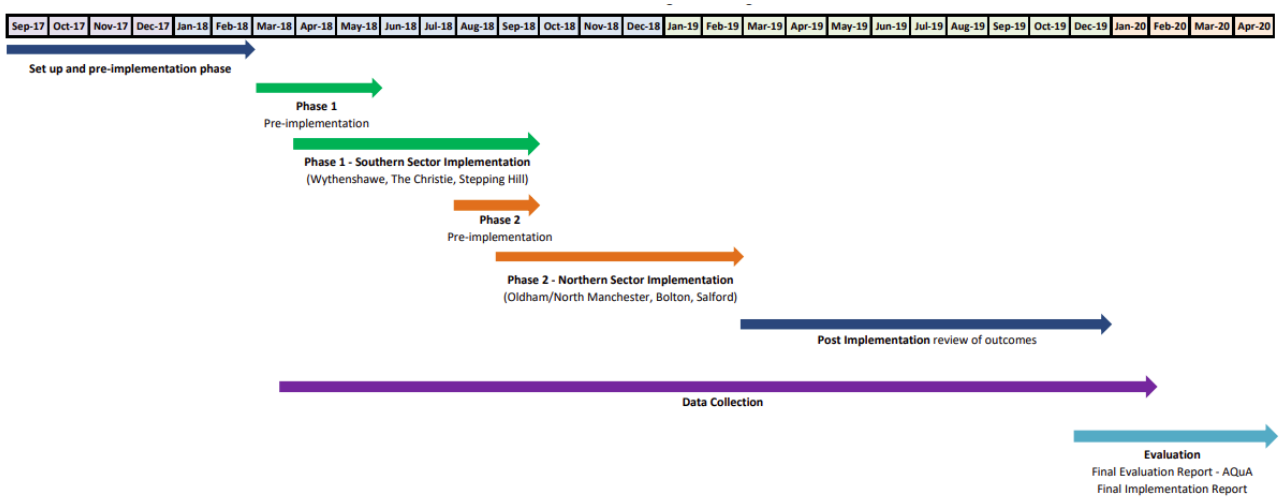

Figure 2.1 GM ERAS+ High Level Programme plan

2.2.1 GM ERAS+ Project Governance

Project governance for the programme was supported by the existing Greater Manchester Health and Social Care (GMHSC) partnership model already in place and used the General Surgery and Acute Emergency board (Theme 3) as a means of reporting into the GMHSC. An overview of the governance structure of the Greater Manchester ERAS+ implementation is shown in Figure 2.2 below.

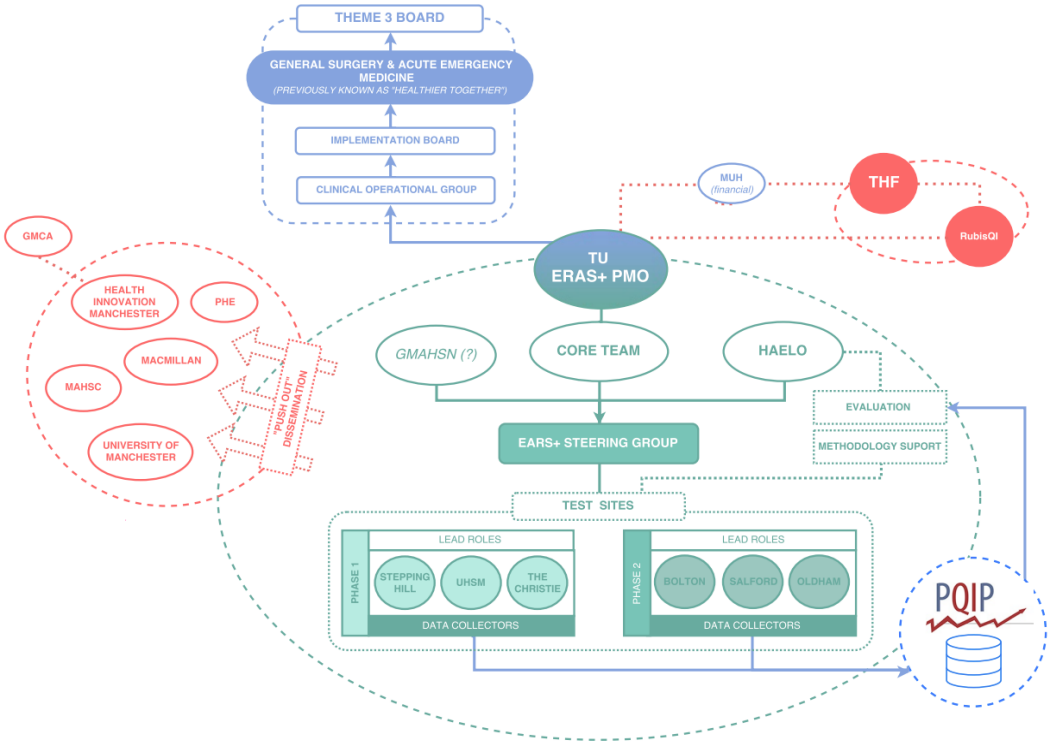

Figure 2.2 GM ERAS+ governance structure

In figure 2.2, the core implementation and evaluation partners are demonstrated in Green. The Transformation Unit appointed project management officer (PMO) and GM ERAS+ Clinical leads reported into Greater Manchester Health and Social care partnership (Blue pathway) through the General Surgery and Acute Medicine implementation board (Theme 3 board). The Health Foundation and Rubis QI support team liaised with the TU PMO and with the Haelo evaluation teams. The dissemination process (orange) of GM ERAS+ encompassed working with a number of regional partners including Health Innovation Manchester as local Academic Health Science Network partner, Greater Manchester Cancer (GMCA), Macmillan in Manchester, alongside research and health innovation partners at the University of Manchester and Manchester Academic Health Science Centre. The national Perioperative Quality Improvement (PQIP) team would provide advice to the project.

2.2.2 Cohort selection

A complete range of surgical services are offered by organisations across Greater Manchester, but it was decided for ease of comparisons between sites, that major colorectal surgery which is performed regularly and in large numbers (50-100/year) on each site undertaking the GM ERAS+ programme would be a suitable focus. The programme would be offered to all patients undergoing major colorectal surgery at each site once site implementation had commenced. It

was planned that this would generate at least 1000 patients undertaking the GM ERAS+ colorectal surgical pathway during the 2-year period of implementation.

2.2.3 Ethics

Reviewing the NHS Health Research Authority decision tool, it was greed that the GM ERAS+ implementation programme did not require NHS research ethics committee approval. All sites recorded ERAS+ as a local audit programme for the duration of the implementation and used internal quality and safety meetings to report the progression and findings of the GM ERAS+ at a site level.

2.3 Pre-implementation (Nov 2017 - April 2018)

Pre-implementation planning and the set-up phase of GM ERAS+ ran from November 2017 to April 2018. During this period a GM ERAS+ steering group was set-up with the introduction of monthly GM ERAS+ operational meetings. The membership of the steering group included representation from all partners, MRI ERAS+ experts and all site ERAS+ teams. These operational meetings provided quality improvement and operational expertise, implementation support, data quality monitoring and analysis and brought together the six, and then seven site ERAS delivery teams on a regular basis.

2.3.1 Components of GM ERAS+ Implementation

Through the GM ERAS+ steering group, the core components of ERAS+ implementation were agreed as:

1. **Each site would develop an ERAS+ team**. This would consist of an ERAS+ lead clinician 'champion', who was either an anaesthetist or surgeon, supported by a corresponding surgical or anaesthetic consultant, an ERAS+ nurse, an allied healthcare professional lead, a Health Foundation funded data collector and a local operational lead of directorate manager level (Band 7) or above. It was agreed as part of the project that there would be representation from each site team at the monthly GM ERAS+ steering group meetings.
2. **Surgery School** would be set-up by each site, acting as a preoperative education session for patients and their families discussing surgery and ERAS+ principles. Surgery School was initially envisaged as a patient and family face to face group educational event run by the core ERAS+ implementation teams alongside additional staff members including

physiotherapists, consultant surgeons and acute pain specialist nurses as required. Early innovation would see one of the sites developing a virtual and video recorded offer and another a one-to-one offer. The elements of what should be covered in Surgery School was agreed by the GM ERAS+ steering group and this would remain however the session was delivered. Surgery School would aim to provide information about preparing for major surgery, introduce goal setting techniques around exercise and other lifestyle modifications (smoking and alcohol), nutritional advice, physiotherapy led instruction in incentive spirometer and post-op breathing exercises, what to expect after surgery, pain management, medicines optimisation and steps of in-hospital and at home recovery. Attendance at Surgery School before admission was agreed as a core process measure for ERAS+ implementation, with sites aiming for 80% attendance.

3. **ICOUGH and DREAMING perioperative care bundle:** an updated perioperative care bundle to help prevent PPCs and other complications, was agreed by the steering group with the aim that it would be implemented within the first 24 hours of surgery. The ICOUGH bundle [54] utilised in the original ERAS+ implementation had focussed on the process measures of early mobilisation, use of incentive spirometer, teeth brushing twice a day and mouth washing twice a day. ERAS+ had been bolted onto existing ERAS pathways, which had included commencement of early diet (within 24 hours), this however was not explicitly specified as a process measure in the original ERAS+ implementation. In line with the DREAMing (drinking, eating and mobilising) approach initiated by Levy and colleagues [50] and demonstrated by Loftus to be a useful as a streamlined ERAS pathway [51] it was decided by the steering group to include commencement of diet at 24 hours as primary process measure in GM ERAS+ alongside the ICOUGH elements (mobilisation, incentive spirometer use, teeth brushing, use of mouth wash). It was agreed that achieving 4 of these 5 elements would make a patient's pathway compliant and the use of prescription charts including each of the elements was supported as part of the ERAS+ implementation.
4. **Development of digital resources** to support GM and national ERAS+ implementation. The MRI team secured innovation funding from Manchester University Foundation Trust to design an ERAS+ website [136] with patient and family resources and an ERAS+ downloadable APP [137] that provided daily prompts and reminders of the steps of ERAS+ and a particular focus on exercise, muscle strengthening, nutrition guidance and lifestyle modification in the days to weeks prior to surgery. This resource was co-developed with

previous surgical patients and their families. Video resources were also developed that included information about the programme, ERAS+ evidence base and signposting to local exercise and support resources in Greater Manchester.

With the components of GM ERAS+ agreed, development and training of ERAS+ site teams were undertaken through a series of workshops led by the expert team from Manchester Royal Infirmary. In consultation with local site surgical and anaesthetic teams, existing ERAS elements (anaesthesia and analgesia technique, surgical technique, use of pre-operative carbohydrate drinks) already in place for major colorectal surgery at participating sites were left unaltered and instead there was a focus on strengthening compliance with the elements contained within GM ERAS+. Sites were encouraged to convert the role of ERAS nurses to ERAS+ nurses and for medical leads to be given time in their job plan to support local ERAS+ implementation. To ensure integration and patient involvement, hospital, and cancer specialist patient participation groups (PPG), were involved in the establishment of ERAS+ alongside the GM Cancer colorectal pathway board which included patients affected by cancer.

During this pre-implementation planning period, an economic impact evaluation of the original single site ERAS+ implementation at MRI, was completed by the York Health Economic Consortium **(appendix 1)** suggested a net saving of £564 per patient for those undergoing ERAS+. A logic model was developed describing how the multi-site GM ERAS+ might impact on patient outcomes, with an aim to replicate the benefits of a 50% reduction in the development of PPC and a reduction in LOS of at least 1 day for participating sites.

The balancing measures for ERAS+ implementation would be readmission within 30 days of discharge and ERAS+ patient satisfaction scores, both captured by data collectors. An ERAS+ feedback form was developed to collect patient satisfaction using a 5-point Likert scale [138] represented by facial expressions, ranging from very unsatisfied to very satisfied, and a section created for free text comments and improvements.

2.4 Operationalisation of GM ERAS+ Implementation

Phase 1 of GM ERAS+ was launched in April 2019 and Phase 2 formally in September 2019. GM ERAS+ monthly steering group meetings continued through to completion of the project in Jan 2020. These meetings gave the opportunity to utilise rapid cycle quality improvement techniques, centred on providing regular feedback to project teams and stakeholders to help to develop the

ERAS+ intervention and address any implementation problems. Hosting at different sites on a rotational basis allowed an expanded team at each site to attend and engage in iterative QI learning, discuss barriers and facilitators to scale up and agree improvement actions for the on-site teams. (See **Appendix 2. Summary of learning from the monthly ERAS+ steering group meetings).**

Quarterly milestone meetings led by the evaluation team were designed to promote engagement across participating sites and for site leads to shape the intervention and adapt implementation. Meetings followed a structured format and focussed on identifying and understanding variation in progress across the six sites. Current progress was reviewed with successes, challenges, innovations and learning, and desired changes going forward. Formative learning from the milestone meetings was formally captured by the evaluation team and also reported to the local ERAS+ teams. (See **Appendix 3. Summary of learning from the ERAS+ milestone meetings).**

2.5 Evaluation of GM ERAS+ Implementation

As described earlier it was planned to use mixed methods (quantitative and qualitative) evaluation to examine the implementation of the GM ERAS+ programme. Quantitative patient outcome data and process measures were collected by the site data collectors, alongside patient feedback and Likert reporting. Healthcare workers involved in the implementation of GM ERAS+ participated in qualitative evaluation interviews undertaken by the Halo/AQUA teams.

2.5.1 Quantitative evaluation

The patient level quantitative data collected by the site data collectors are summarised in **Appendix 4** (**Patient level quantitative data collected by the site data collectors for the GM ERAS+ programme)** and included pre-operative, intra-operative and post-operative components including in-hospital follow-up on days 1, 7 and 15, and long-term survival follow-up to 1 year, where this was possible. The ARSICAT (Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT) Group Investigators developed a prediction tool for the development of PPCs and identified seven measures (baseline SaO2, age >80, presence of pre-op anaemia, urgency of surgery, location of surgery, duration of surgery), which helped determine patients as being at low, intermediate and high risk of developing PPCs [52]. This data was collected as part of the GM ERAS+ dataset and allowed the generation of ARSICAT scores for patients.

For determination of PPCs, the same methodology as in the original ERAS+ implementation was used and defined a PPC as either: clinician decision to commence antibiotics for suspected pulmonary infection; a requirement for escalation in respiratory support; CXRs demonstrating pathological changes (documented by the data collectors in discussion with the treating site medical teams). PPCs diagnosis were reviewed for quality assurance by the site ERAS+ clinical lead and also as part of the monthly GM ERAS+ meetings.

Length of stay median values over different time periods after ERAS+ implementation were compared using appropriate parametric (Student's T test with log transformation) and non-parametric (Mann-Whitney U) tests after tests for normality (Kolmogorov-Smirnov and skewness review). Incidence of post-operative pulmonary complications (PPCs) were compared over the different time periods using the Pearson's Chi-squared and Fisher exact tests. All statistics were performed using IBM SPSS Statistics version 25 [Armonk, NY, USA] and R version 3.1 [R Foundation for Statistical Computing, Vienna, Austria].

Process data measures agreed by the steering group were attendance at surgery school prior to surgery and compliance with the ICOUGH/Dreaming components of in-patient ERAS+ bundle. This information was collected by the site data collectors and used to generate local weekly ERAS+ compliance charts alongside the determination of monthly PPC, LOS and 30-day readmission data as balancing measures. This information was in turn used to generate local and GM ERAS+ dashboards, with quality improvement team facilitated statistical process control (SPC) run charts. Final balancing measure was the patient satisfaction score and the steering group agreed that a measure of success would be that 80% of patients gave a satisfaction score of great than 4 using the Likert scoring system as previously described. The steering group reviewed the dashboard on a monthly basis, issues were identified and investigated by the improvement analyst and local teams for triggers of Special Cause Variation (SCV); indicators of statistically significant change within the data. The 5 rules of SCV [139], were used to identify improvement and highlight where data points were outside of the normal variation expected in a system. For site-level dashboards, data was displayed on run charts using either weekly data for process measures or monthly data for outcome measures. Regularly monitoring process measures allowed each site to identify change within their systems and processes as they worked through the project.

The Haelo/AQUA team provided ad hoc advice and guidance for data interpretation and facilitated regular 'data meetings' to further support the data collection team and improve the data collection

process. The latter provided a valuable insight into the methodology of the data collectors and helped to standardise approaches and address inconsistencies in data collection. These co-operative and instructive efforts were possible due to the regular review of data at key milestone meetings.

Delays in data collection recruitment staff meant that plans to collect a period of pre-implementation data as baseline information was not possible. As such to understand the impact of ERAS+ implementation using a before and after approach, a historical dataset was required from sites. The surgical procedural codes for patients undergoing GM ERAS+ implementation (**Appendix 5. GM ERAS+ colorectal surgical codes),** were identified. Local hospital sites business teams were asked to provide LOS and readmission data for historical colorectal surgery patients prior to the implementation of ERAS+ using these same surgical codes. To further understand the impact of ERAS+ implementation in colorectal patients in the GM ERAS+ sites, control cohorts were developed using 2 non-ERAS+ colorectal hospital surgical sites in GM, Tameside and Wigan General. Using Secondary Use Hospital SUS data [140] (which the AQUA team had access to), the same surgical procedural codes were used to generate LOS data for Tameside and Wigan General for the period Jan 2016 to July 2019.

To understand how representative the data collected by the ERAS+ data collectors was of all patients having surgery during the ERAS+ implementation, it was deemed helpful to try and determine a total case denominator. Colorectal cancer patients have data collected and sent to a national bowel outcomes audit tool, NBOCA [141]. This data is then released after 2 years curation for local sites to analyse and improve practice. It was decided to examine the national bowel cancer surgery dataset covering the period of implementation and compare with the numbers of cancer patients collected in the ERAS+ dataset for applicable sites, to generate a plausible denominator.

Finally, to understand any relationship between the process measures of Surgery School and the ICOUGH-Dreaming respiratory bundle and LOS, it was planned that a factorial design analysis [142] would be used as part of the quantitative analysis. Factorial analysis uses combinations of process measures that patients receive and examines their relationship to patient level outcome of interest [142, 143].

2.5.2 Qualitative Evaluation

The National Centre for Social Research recommends one-to-one interviews for generating in depth personal accounts and understanding complex contexts, processes, motivations and decisions [144]. For this reason, one-to-one interviews were used as the primary method of qualitative data collection for GM ERAS+. The qualitative interviews were undertaken by members of Haelo evaluation team with Dr John Moore supporting the interpretation and generation of relevant themes and sub-themes, alongside providing reflection on the clinical implications.

A semi-structured design for the interviews was adopted; being partially pre-planned and replicable, but flexible enough for spontaneous questions to be asked. There were 2 main time points when qualitative interviews were undertaken by the evaluation team, the first was during the initial 6 months of implementation in 2018 and the second more broader analysis between August and December 2019. The initial interviews aimed to understand the barriers to initial ERAS+ implementation. The second series of qualitative interviews undertaken with staff between August and December 2019 aimed to more fully explore the question: 'What were the barriers and facilitators to implementation of ERAS+ across NHS Trusts?'.

2.6 My role in GM ERAS+

I am the medical lead for the ERAS+ surgery programme and led the design and development of the original ERAS+ programme at Manchester Royal Infirmary between 2013 and 2016. I was appointed as NHS Innovation fellow in 2016 by NHS England for the development of surgery innovation. In this role I led the design and implementation of the GM ERAS+ programme supported by Health Foundation funding.

In the GM ERAS+ programme

- I personally led the design and writing of the Health Foundation application and led the ERAS+ team in the interview processes undertaken as part of the successful application.
- During implementation of GM ERAS+ I chaired the monthly implementation steering group and worked with the Project Management Officer as the senior operational medical lead for the programme.
- I led site visits and supported site on-boarding with ERAS+.
- I acted as the senior medical ERAS+ expert supporting site implementation.
- I co-led the quarterly milestone meetings with the evaluation team.
- I was the clinical chair of the data group which reviewed and supported both the data generated by the site data collectors and its analysis.
- I presented at quarterly report meetings on GM ERAS+ with the Health Foundation.
- I met with the national PQIP team for quarterly overview and support of the project.
- I achieved innovation funding for ERAS+ App and ERAS+ website resources and then led the design and development of these resources with the digital developer.

For the evaluation and as part of my MD.

- I helped develop the figures in the quantitative results which were produced in collaboration with Simon Wickham, part of the Haleo/Aqua quality improvement team.
- The qualitative interviews were undertaken by members of Haelo evaluation team and I personally supported the interpretation and generation of relevant themes and sub-themes, alongside providing reflection on the clinical implications.

CHAPTER THREE

Quantitative Results

3.1 Quantitative Results

GM ERAS+ implementation began in April 2018 and ran until December 2019. In this chapter data is presented for the colorectal surgical cohort who took part in GM ERAS+. Seven NHS acute hospital sites took part in the Greater Manchester ERAS+ colorectal surgery implementation programme and they were Bolton, The Christie, North Manchester, Oldham, Salford, Stepping Hill, Wythenshawe (part of Manchester University Hospitals NHS Trust). The implementation programme was planned to offer ERAS+ to all patients undergoing major colorectal surgery at each site.

Demographic information will be presented for this population alongside ERAS+ process measures, length of stay (LOS) hospital data across sites and patient satisfaction measurements. There is then an expanded analysis of ERAS+ implementation at sites A and E, where the most consistent data collection took place. For the purpose of analysis hospitals are labelled as A, B, C, D, E and F. For the purpose of process measures site F is a composite of 2 hospital sites with a shared data collector and ERAS+ nurse.

As described in the methodology section, the colorectal surgical ERAS+ implementation had been planned to have 2 implementation phases with 3 hospitals sites in Phase 1 and 4 in Phase 2. Phase 0 was due to provide an opportunity for pre-implementation baseline data collection. To support a pseudo cluster analysis for ERAS+ implementation, Phase 1 sites were planned to commence implementation for 3 months followed by Phase 2 sites implementation 3 months later. Two of the Phase 1 hospitals went live with implementation and data collection from April 2018 as planned, however the 3rd site, although beginning ERAS+ implementation at the same time didn't have data collection in place till August 2018, through difficulty with data collection recruitment. The phase 2 hospitals were able to recruit data collectors more quickly and also requested to begin implementation sooner than September. With the delay in Phase 1 starting and the readiness of the teams to commence ERAS + implementation in the Phase 2 sites, a stringent phased approach wasn't possible and the opportunity to undertake a pseudo cluster analysis wasn't achieved.

The timing of hospital site implementation and data collection are shown in Table 3.1 below and stages of on-boarding are described numerically.

Stage	Site	Implementation begins
1	Site D	23/04/2018
2	Sites A and E	30/04/2018
3	Site C	16/07/2018
4	Site B	01/08/2018
5	Site F	22/09/2018

Table 3.1 Hospital site on-boarding

Overall, all 7 sites implemented ERAS+ and data was collected on 1472 colorectal surgical patients who took part in the scale up of GM ERAS+ between April 2018 and December 2019. Table 3.2 provides a breakdown of colorectal patients from each site.

Site	Total patients
Site A	246
Site B	352
Site C	182
Site D	180
Site E	235
Site F (two hospitals)	277
Total	**1472**

Table 3.2 Number of ERAS+ colorectal patients from each participating site

At site B, patients underwent more extensive colorectal resections than those at other sites because of the nature of their disease and the services provided at this site. The breakdown of colorectal surgical types from site B is shown in Table 3.2.

	Total patients
Major colorectal resection	177
Cytoreductive surgery and HIPEC	157
Total Pelvic clearance	18
Total	352

Table 3.3 Breakdown of colorectal procedure types at site B. (HIPEC - Hyperthermic intraperitoneal chemotherapy).

With these differences in colorectal surgical procedures, length of stay data will be considered separately for site B in comparison to the other sites (A, C, D, E and F). Data collection was absent from sites C, D for periods during mid implementation and likely explains why there are less patients from these sites. Site F is a composite of 2 hospital sites, and again data collection at these sites was delayed through issues with data collector recruitment.

The baseline characteristics of the patient cohorts are shown in table 3.3. The majority of patients were undergoing major colorectal surgery for cancer with on average 75.2% of procedures performed for cancer across hospital sites A, C, D, E and F. At Hospital site B almost all procedures were for cancer. The average age of patients at sites A, B, C, D, E and F was 64 (14.6), they were predominantly male, ASA 1-2 and the majority were having laparoscopic surgery. At site B the majority were having open cancer procedures and were ASA 3.

	Hospital A, C, D, E, F (n = 1120)	**Hospital B (n=352)**
Age; y	64 (14.6)	62 (12.3)
Sex; male	622 (55.6%)	201(57.1%)
ASA 1-2	722 (64.4%)	160 (45.4%)
ASA 3-4	398 (35.5%)	192 (54.5%)
Cancer Operation	842 (75.2%)	343 (97.4%)
Laparoscopic Procedure	728 (65.0%)	35(9.9%)

Table 3.4 Baseline characteristics of GM ERAS+ patients included in hospitals A-F during the study period April 2018-December 2019. Values are mean (SD), number (proportion).

To understand how representative the data during ERAS+ implementation was of patient population undergoing surgery in the sites, an examination was made of the NBOCA national bowel cancer surgery dataset [141] numerator for sites A, C, D, E, F for the time period of implementation and comparison made with the number of cancer cases collected by the ERAS+ data collectors. Not all Site B patients are collected or easily discernible in the NBOCA database and so this site was not able to be analysed. As there wasn't a data collector consistently in place for sites C, D and F throughout the implementation period, there is an estimate of total cancer patients from NBOCA based upon the months of data collection.

Site	**Site cancer patients from ERAS+ dataset**	**Estimated site cancer patients from NBOCA data (averaged based on months of data collection)**	**Denominator Percentage of NBOCA cancer patients captured in ERAS+ programme**
Site A	187	201	93.0%
Site C	135	158	85.4%
Site D	136	151	90.0%
Site E	175	192	91.1%
Site F (two hospitals)	208	244	85.2%

Table 3.5 Denominator – percentage of potential patients captured in ERAS+ programme

For sites A, C, D, E, F where dominator data could be calculated from the NBOCA dataset, between 85-93% of cancer patients having major colorectal resections appear to have their data captured in the ERAS+ dataset. This suggest that the ERAS+ programme captured the significant majority of potential patients at these sites and makes the outcomes representative of practice for these sites.

3.2 Quantitative – process measures

To measure the success of implementation and scale up of ERAS+ across the sites, two main process measures were established; the extent to which sites had implemented Surgery School and the degree of compliance with the ICOUGH and Dreaming perioperative care bundle. To support interpretation of the process measures the x axis of each chart has been labelled with a number to indicate the time when sites began submitting data as represented in Table 3.1.

The first process measure was the proportion of patients who attended Surgery School before their surgical admission date. It was agreed that the measure of success for this process measure would be 80%. The second process measure was compliance with the ICOUGH and DREAMing perioperative care bundle, and it was agreed that measure of process success would be 80% or greater compliance; defined as achieving four out of five components. The individual components were mobilisation within the first 24 hours post-surgery, starting an oral diet in first 24 hours post-surgery, use of incentive spirometry within first 24 hours post-surgery, teeth brushing twice a day and use of oral mouth wash twice a day.

3.2.1 Surgery school process measure

Figure 3.1 shows the aggregate data from all sites for the percentage of patients attending surgical school prior to surgery. At the beginning of implementation on average 17% of patients received surgery school prior to their surgery. The proportion steadily increases as implementation scale up progressed with on average 73% of patients receiving surgery school across all sites through 2019 (see Fig 3.1).

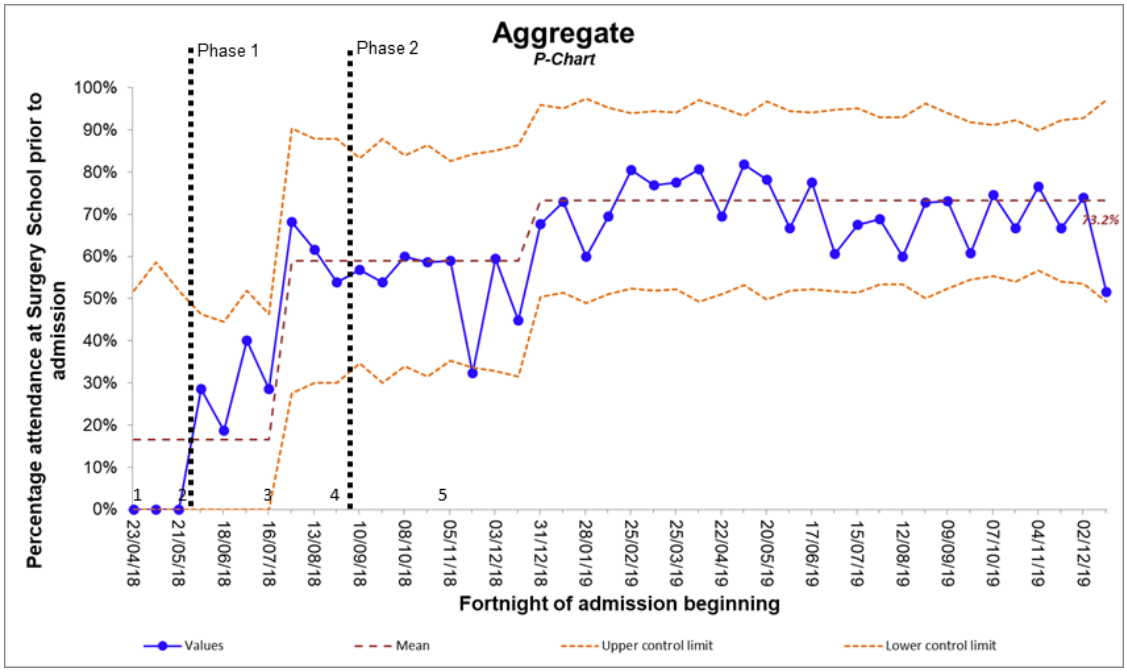

Figure 3.1 Percentage of patients attending Surgery School prior to admission (aggregate data)

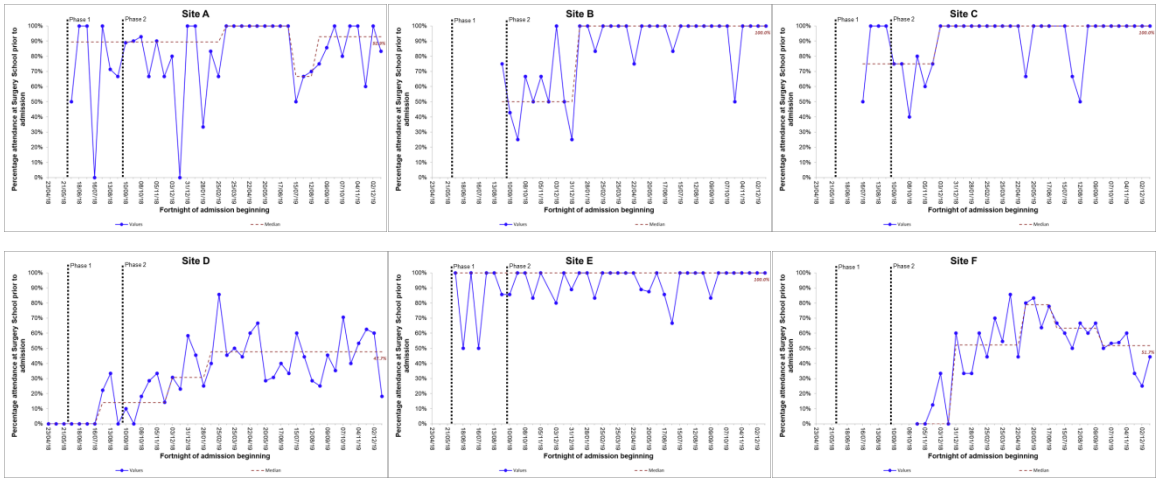

Figure 3.2 Percentage of patients attending Surgery School prior to admission (site data)

Overall, this falls below the target of 80% of patients receiving surgery school across the GM ERAS+ sites. On reviewing site specific data, (figure 3.2) four of the sites (A, B, C and E) achieved excellent rates of patient surgery school attendance with almost all patients receiving this intervention during later implementation. Contextual factors identified at sites D and F as inhibiting patient surgery school attendance were local staff resistance to surgery school (site D) and lack of support infrastructure including administration of surgery school at site F.

3.2.2 ICOUGH-DREAMing perioperative care process measure

Following initial implementation of the bundle, compliance stood at 12% of patients achieving at least 4 of 5 elements within the bundle. This improved to 42% by the completion of the programme (Figure 3.3).

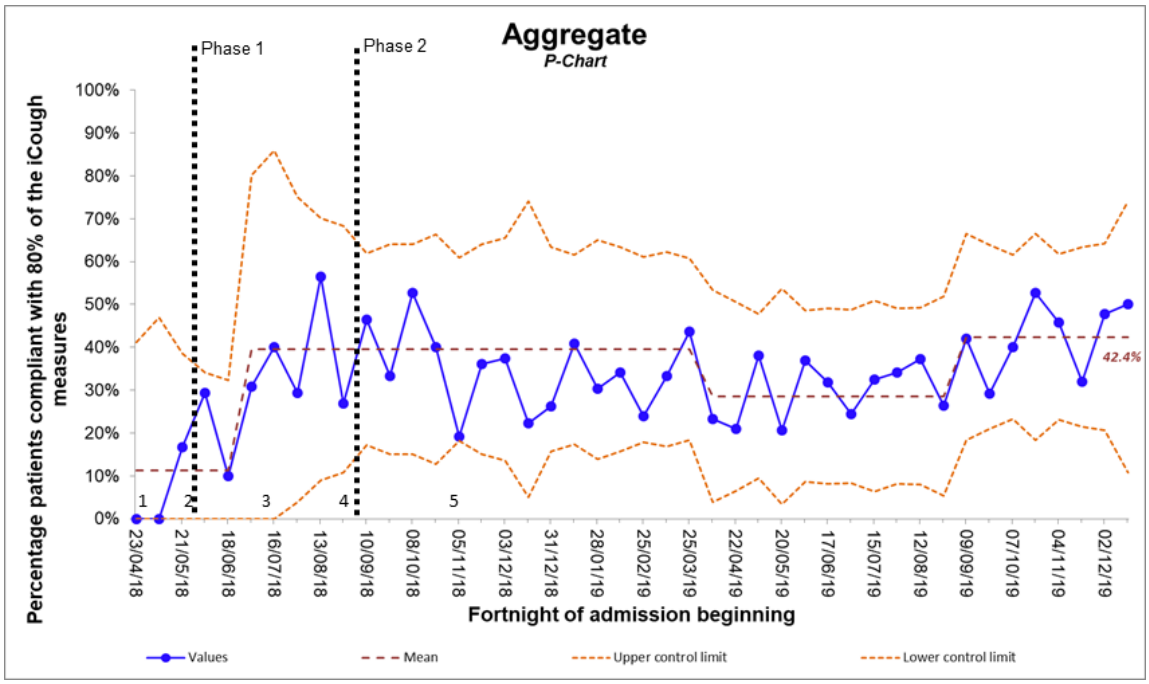

Fig 3.3 Percentage of patients who received 80% of perioperative bundle (aggregate data)

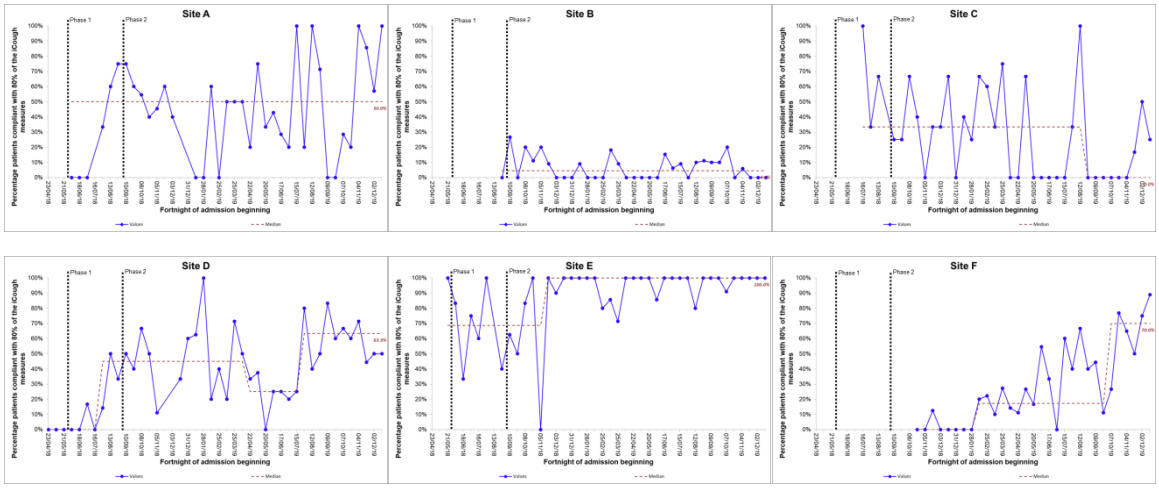

Fig 3.4 Percentage of patients who received 80% of perioperative bundle (site data)

Reviewing the site data (Figure 3.4), it is noted that site E performed well throughout ERAS+ implementation achieving excellence compliance with the perioperative bundle. Sites D and F

improved throughout implementation with rates of 60-70% bundle compliance towards the latter part of the programme. Site A had 50% median compliance throughout, and the performance of site C deteriorated during the programme. Site B had poor overall compliance for all elements. The achievement of 80% compliance with ICOUGH and DREAMING perioperative care process measures proved difficult for the majority of sites to achieve and to understand this better the five components of the perioperative bundle are examined individually next.

3.2.2.1 Teeth Brushing

Teeth brushing and mouth wash use are 2 of the elements of the respiratory bundle that are aimed at reducing the oral bacterial load which is involved in the pathogenesis of respiratory complications after major surgery. The baseline proportion of patients brushing their teeth twice within 24 hours of surgery was 46% (Fig 3.5). Compliance improved as the project scaled up; the mean increased to 68% in summer 2018 and stabilised until March 2019 when rates fell until some improvement in September 2019.

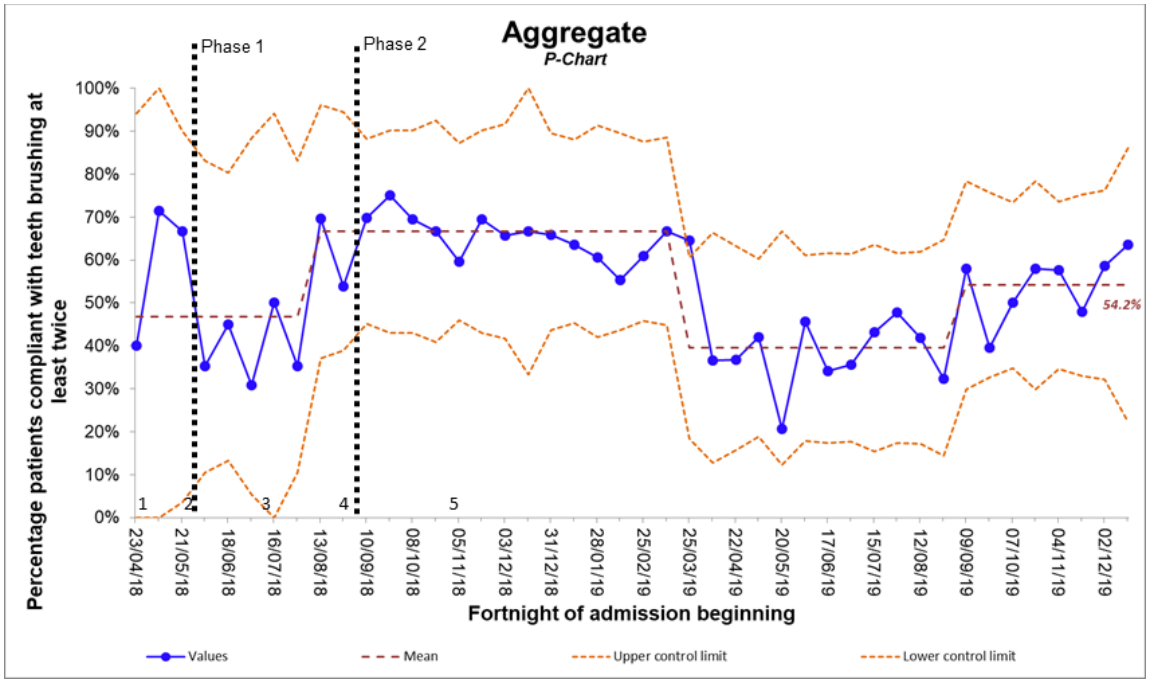

Figure 3.5 Percentage of patient compliant with teeth brushing (aggregate data)

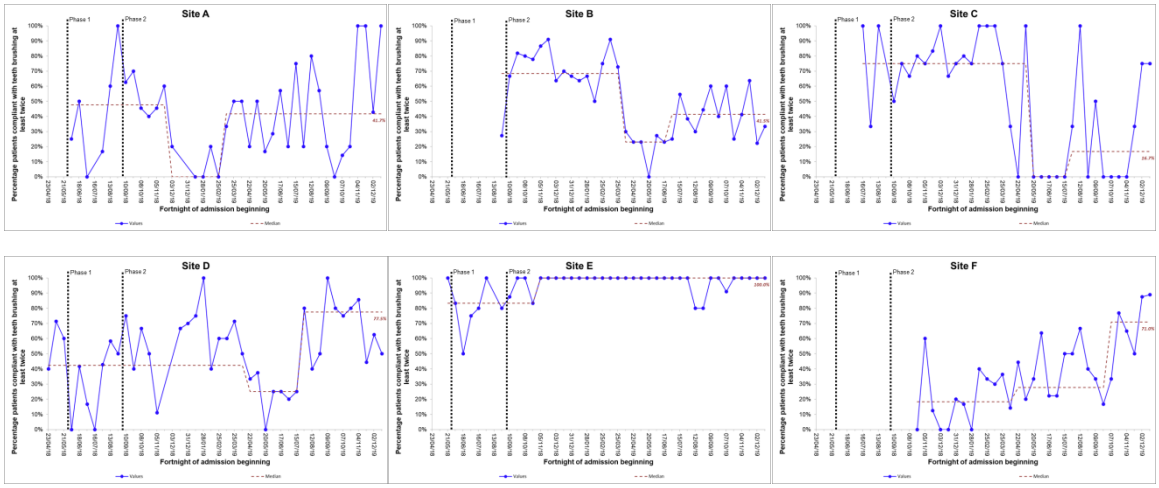

Figure 3.6 Percentage of patients compliant with teeth brushing (site data)

Site level analysis (Figure 3.6) shows that the decrease in overall GM compliance with teeth brushing was largely limited to Site B and Site C, which on closer discussions with these sites was related to change in ERAS+ nurse personnel. There was a small recovery in the latter part of 2019 and by the end of the project 54% of patients were compliant. Site A had intermittent improvement whereas sites D and F improved through the programme.

3.2.2.2 Mouth Wash use

The percentage of patients using mouthwash within 24 hours of surgery was on average only 31% throughout the duration of the project (Figure 3.7). The range between the upper and lower control limits decreased as the patient cohort grew with new sites adopting measures.

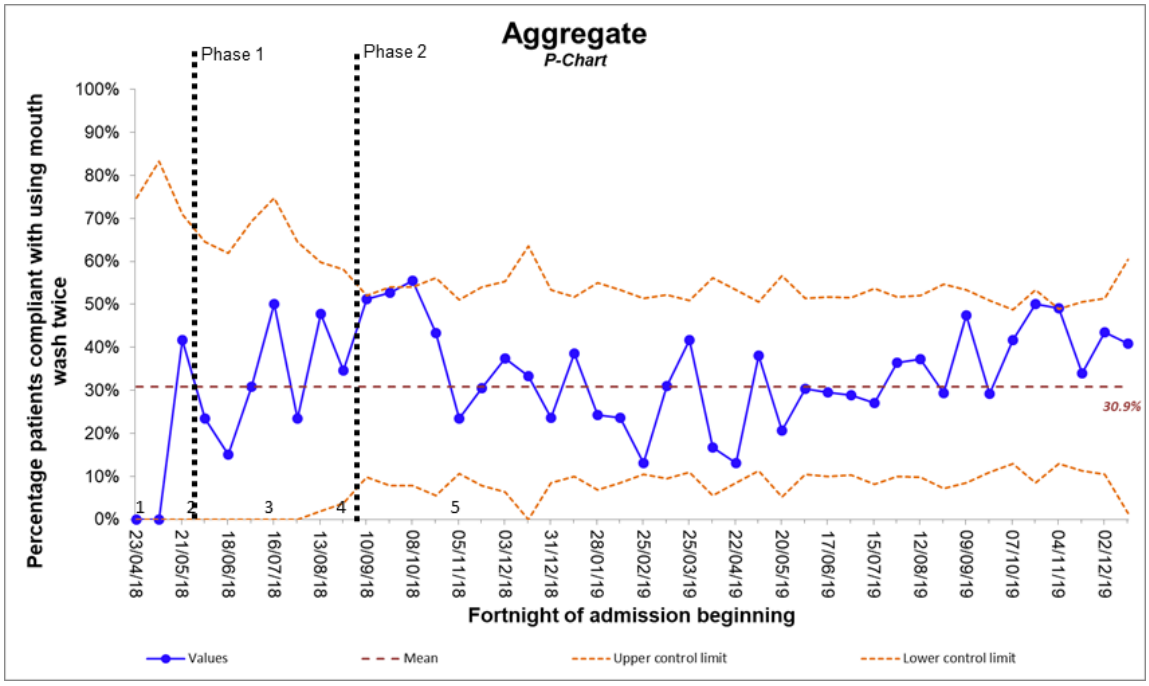

Figure 3.7 Percentage of patients receiving mouthwash at least twice a day post-surgery (aggregate data)

Only Site E (Figure 3.8) had any success with the implementation of this measure. Given the poor compliance for this measure across sites, the impact of excluding it from the measure of success was examined. The proportion of patients who received 3 in 4 of the iCOUGH-Dreaming measures (excluding mouthwash) was 60%.

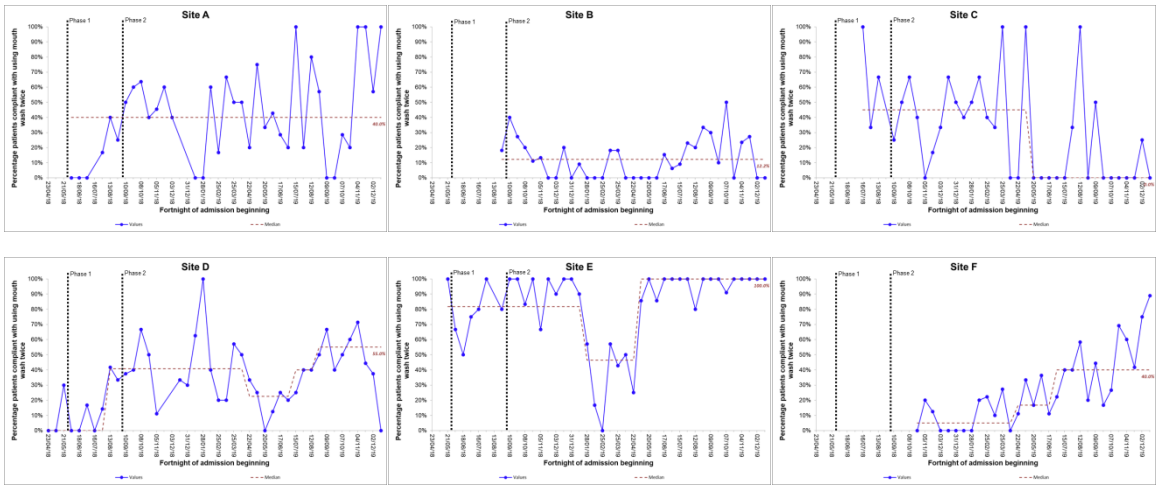

Figure 3.8 Percentage of patients receiving mouthwash at least twice a day post-surgery (site data)

3.2.2.3 Oral diet

At the outset a mean of 6% of patients were started on an **oral diet** within 24 hours after surgery. Following the addition of Site A and Site E, this increased to 69%, but decreased to 49% when the project was scaled up to all sites (Figure 3.9).

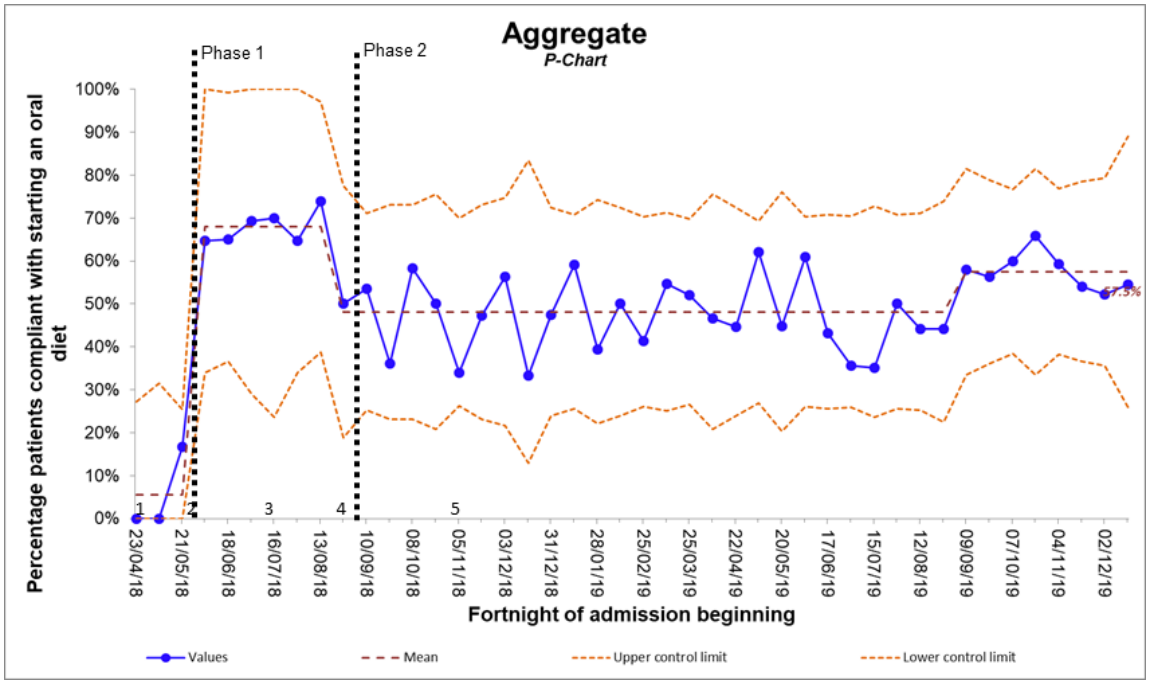

Figure 3.9 Percentage of patients starting an oral diet within 24 hours post-surgery (aggregate data)

Site B (Figure 3.10) particularly performed poorly with regards to commencement of diet within 24 hours. This is likely because of the different colorectal surgical patient group at Site B undertaking more complex surgery compared to the other sites. If Site B is excluded 79% of patients have commenced oral diet within 24 hours of surgery across GM by the completion of implementation.

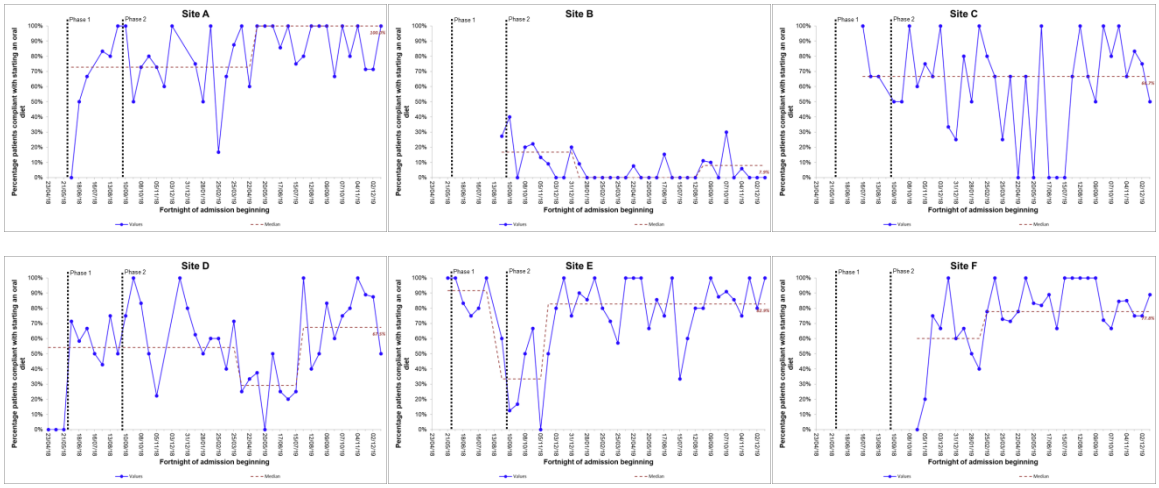

Figure 3.10 Percentage of patients starting an oral diet within 24 hours post-surgery (site date)

3.2.2.4 Mobilisation

The baseline for the proportion of patients mobilised within the first 24 hours after surgery was 58%. There was a shift in the data up to 72% just before the addition of data from the final site (sept 2018) and a narrowing of confidence limits as more patient data was available (Figure 3.11).

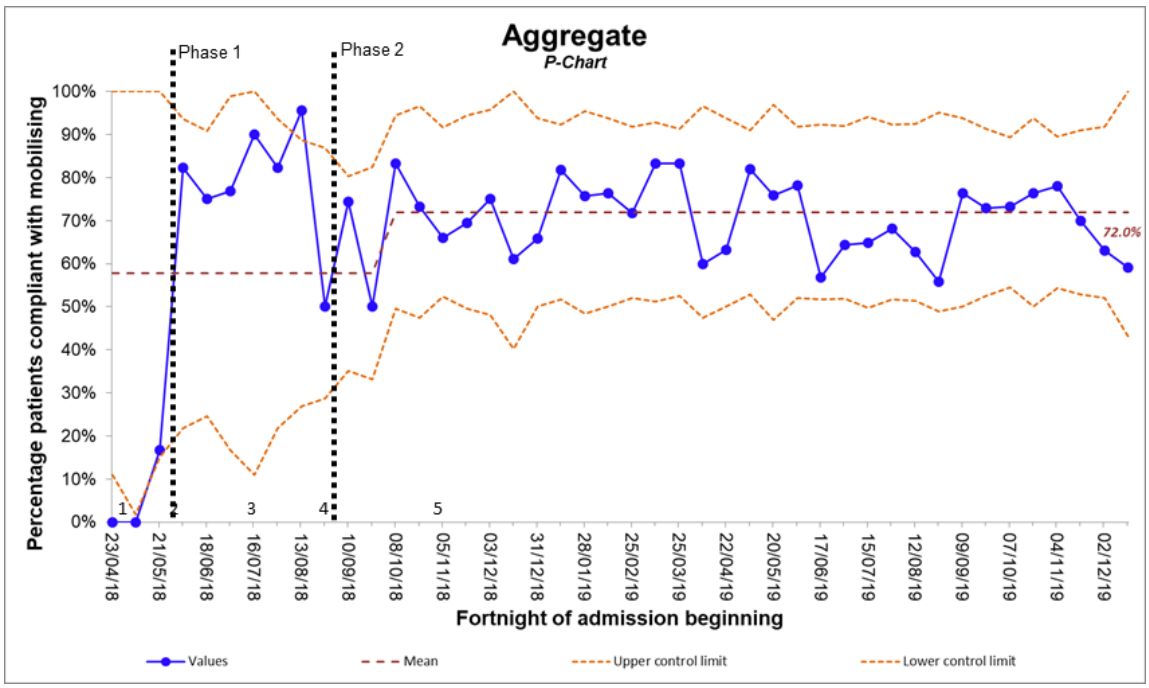

Figure 3.11 Percentage of patients mobilising within 24 hours post-surgery (aggregate data)

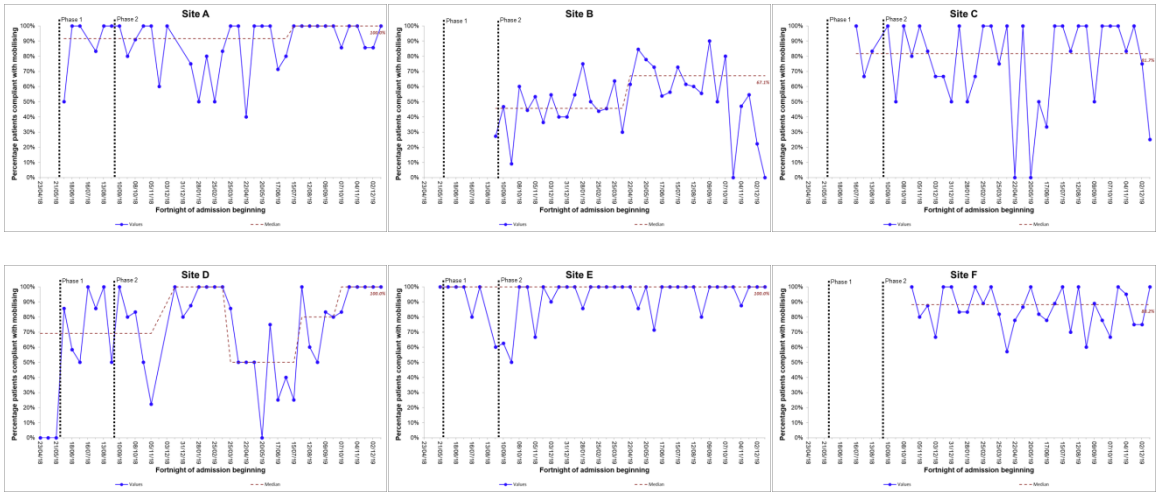

Figure 3.12 Percentage of patients mobilising within 24 hours post-surgery (site data)

By the completion of the implementation programme all sites (Figure 3.12) were performing well with regards to the standard of mobilising patients within 24 hours of surgery. Sites A, C, D, E and F had achieved compliance greater than 90% and site B with its more complex colorectal surgical population was achieving mobilisation rates of almost 67% from May 2019.

3.2.2.5 Incentive Spirometer

At the outset of the project there was an average 25% of patients using an incentive spirometer within 24 hours after surgery (Figure 3.13). By the end of implementation 68% of patients were using an incentive spirometer in the post-op period.

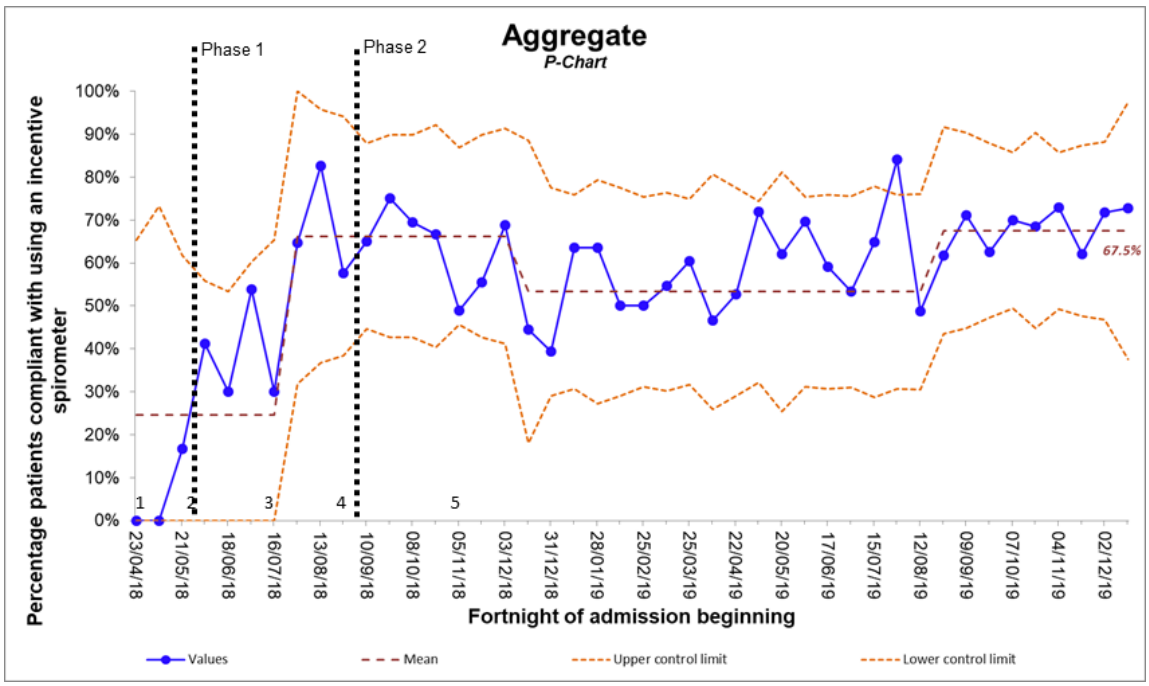

Figure 3.13 Percentage of patients using an incentive spirometer within 24 hours post-surgery (aggregate data)

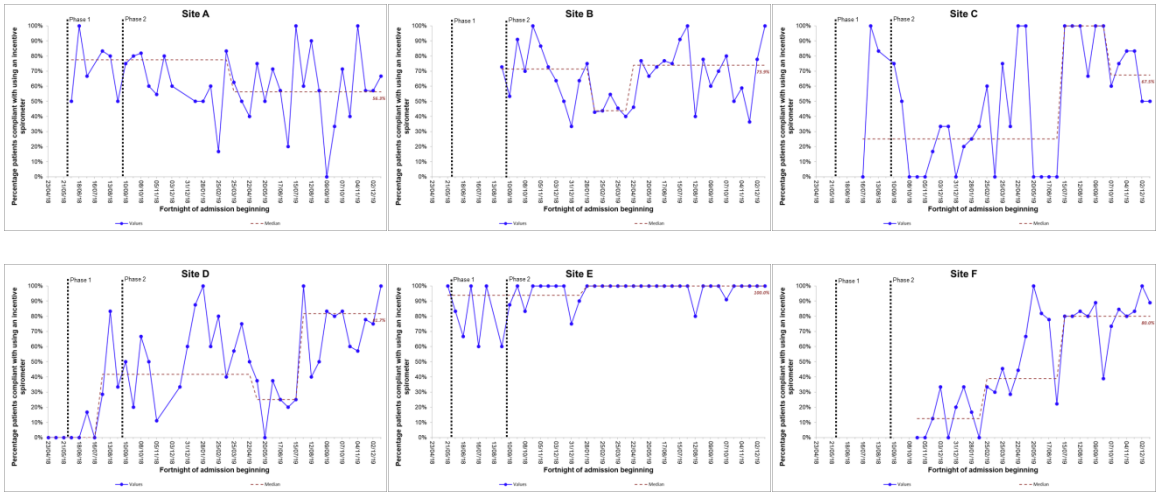

Figure 3.14 Percentage of patients using an incentive spirometer within 24 hours post-surgery (site data)

On reviewing ICOUGH and DREAMing perioperative care process measures, sites A, C, D, E and F, performed well with regards to mobilising, oral diet and the use of incentive spirometer in the first 24 hours after surgery. The threshold of 80% compliance for mobilisation and commencement of oral diet (DREAMING components) was achieved on these sites. Site B whose patients were generally undergoing more major colorectal population did demonstrate an improvement in mobilisation with 67% mobilising on day 1 after major surgery. Oral healthcare in the form of use of mouthwash by patients, was particularly difficult to implement across most sites and this will be examined further in the qualitative section of the results. The next section explores the impact of GM ERAS+ implementation on length of stay metrics.

3.3 Quantitative – outcomes

From the logic model, the pre-selected outcome measures from GM ERAS+ implementation for LOS was to reduce the average LOS by 1 day and PPC by 50% for colorectal patients by the end of GM ERAS+ implementation period.

3.3.1 Length of Stay

Historical LOS data for colorectal surgery was generated by sites A, C, D, E and F for the period Jan 2016 to Jan 2018. From aggregated data, at baseline the mean LOS was 12.1 days. By the completion of implementation in Nov 2019, there was an aggregate LOS reduction of over 3 days for these sites, with an average LOS of 8.8 days (Figure 3.15). Data for the final period had less variation which indicates a reliable system with lower LOS. There was LOS reduction for these 6 sites participating in GM ERAS+.

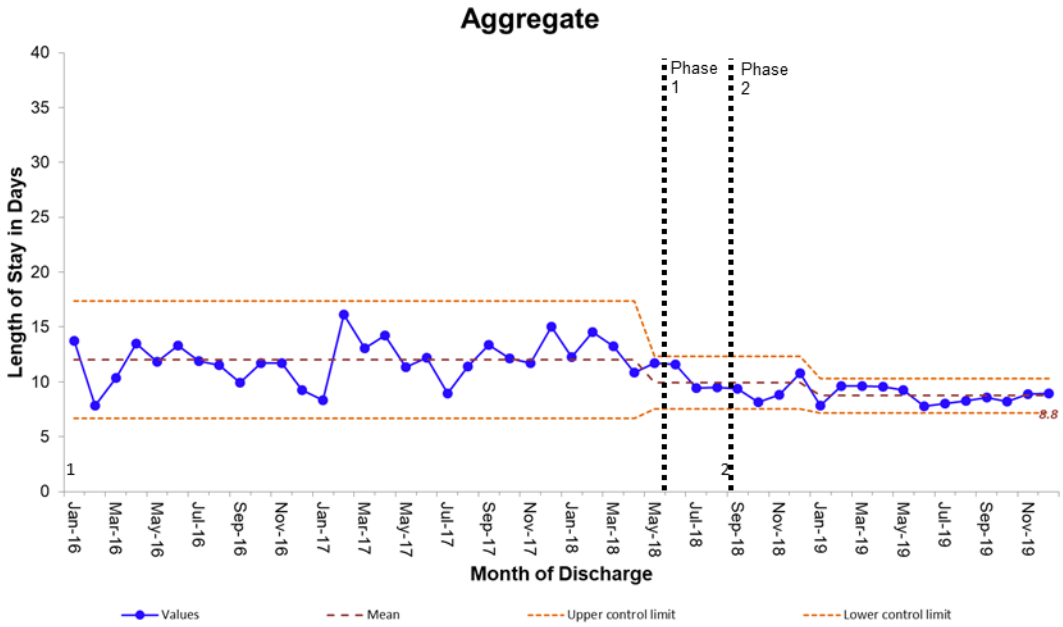

Figure 3.15 Length of stay for sites A, C, D, E and F (aggregate data) 2016-2019

Historical LOS data for colorectal surgery was not able to be generated for site B. For the period that data was collected for this site (Sept 2018 to Nov 2019) there was no improvement in overall hospital LOS following implementation of GM ERAS+ when the colorectal surgical group (major colorectal, pelvic clearance and cytoreductive surgery and HIPEC surgery) was considered as whole.

However, on more individual analysis, of major colorectal surgery patients (n=172) without pelvic clearance or HIPEC surgery, there was an improvement in mean LOS from 11 days at the beginning of ERAS+ site B implementation in August 2018 to 9.5 days LOS at the completion of the implementation programme in December 2019. The improvement in GM ERAS+ process measures at site B of early mobilisation, use of surgery school, incentive spirometer during the ERAS+ implementation may well have contributed to this improvement in LOS for this sub-group.

Comparison with 2 non-ERAS+ hospitals

LOS data was generated for 2 non-ERAS+ hospital surgical sites in Greater Manchester, sites G and H, delivering similar colorectal surgery to that in the GM ERAS+ sites. This allowed comparison between 2 sites not undertaking GM ERAS+ and 7 that were.

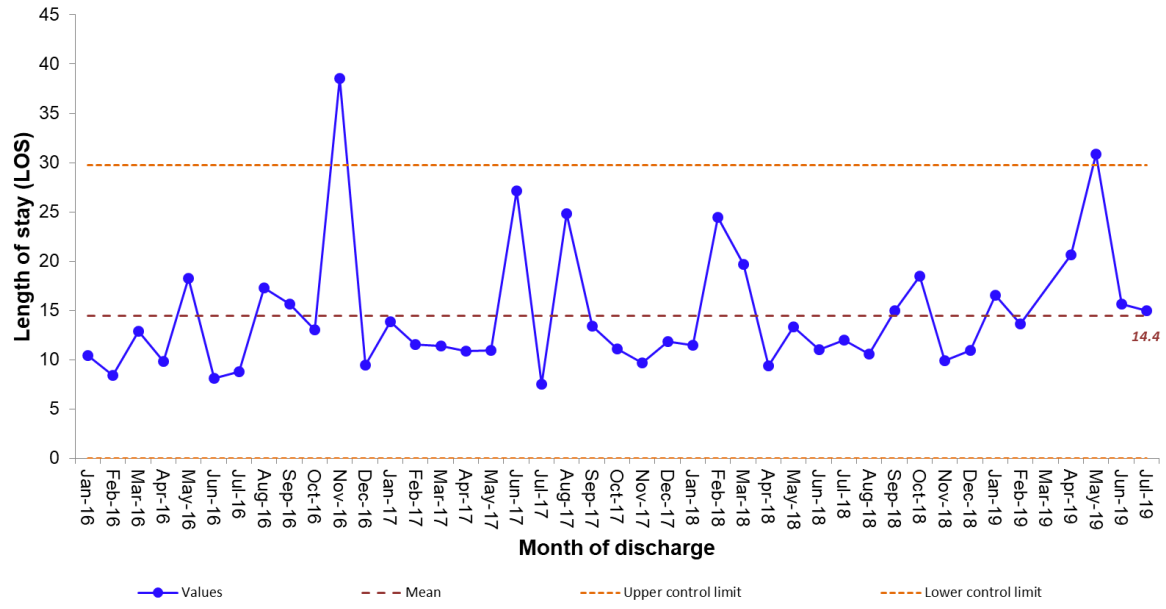

Figure 3.16 Hospital G colorectal LOS 2016-2019

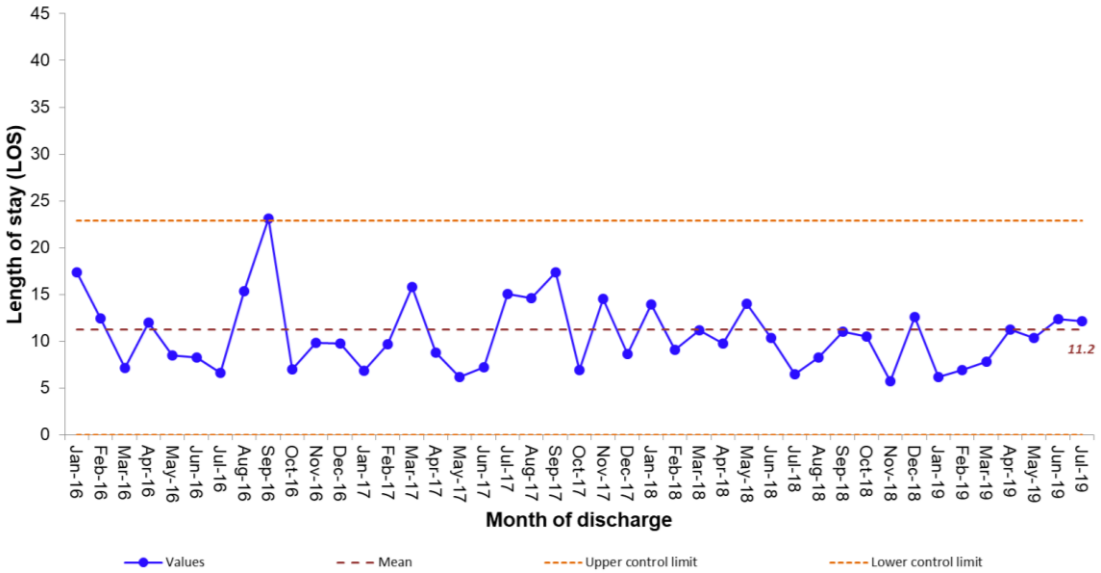

Figure 3.17 Hospital H colorectal LOS 2016-19

Both non-ERAS+ hospital sites G (Figure 3.17) and H (Figure 3.18) demonstrated no change in LOS during the GM ERAS+ implementation time period (2018-2019). This supports the suggestion that there were no external factors contributing to the improvement seen in hospitals A, C, D, E and F out with the GM ERAS+ implementation.

3.4 Interaction between process measures and outcomes (LOS) across all sites

To understand any relationship between the process measures of Surgery School and the ICOUGH-Dreaming respiratory bundle and LOS, a factorial design analysis [136] was performed on LOS against the combinations of process measures each patient received. Figure 3.19 shows the combinations of process measures received along the top and left side of the display. At the intersection of each combination is the average LOS in days for all patients across all sites that received those interventions. The cells highlighted in LIGHTEST green are where LOS is in the lowest 20% of the combinations (LOS 14.2 days).

Teeth Brushing	Incentive Spirometer	Mouthwash	Surgery School: YES / Diet: YES / Mobilisation: YES	Surgery School: YES / Diet: YES / Mobilisation: NO	Surgery School: YES / Diet: NO / Mobilisation: YES	Surgery School: YES / Diet: NO / Mobilisation: NO	Surgery School: NO / Diet: YES / Mobilisation: YES	Surgery School: NO / Diet: YES / Mobilisation: NO	Surgery School: NO / Diet: NO / Mobilisation: YES	Surgery School: NO / Diet: NO / Mobilisation: NO
NO	NO	NO	8.26	11.38	10.89	14.36	8.92	11.38	14.26	14.30
		YES	5.50			20.00	8.00			
	YES	NO	9.47	11.38	9.82	17.24	6.95	15.00	7.90	10.73
		YES	7.36		11.43	10.00	6.67			16.00
YES	NO	NO	8.05	7.00	14.05	11.62	6.57	10.50	25.22	17.50
		YES	8.67	6.67	11.75	13.86	9.17		9.29	15.20
	YES	NO	8.56	16.00	10.11	14.13	8.35	10.00	14.17	12.58
		YES	7.92	8.50	9.75	12.89	8.34	12.00	12.70	10.60

Quintile 1 (lowest LOS)
Quintile 2
Quintile 3
Quintile 4
Quintile 5 (Highest LOS)

Figure 3.18 Effectiveness of different combinations of process measures on Length of Stay

Most of the lower average LOS values were for patients who were mobilised and started an oral diet within the first 24 hours after surgery and conversely the higher LOS was associated with patients who didn't receive these interventions. These appear to be the interventions most strongly associated with improved LOS. While other interventions seem to have less impact on reducing LOS individually, a combination of all processes demonstrates one of the lowest average lengths of stay at 7.9 days (bottom left box of the visualisation). The analysis indicates that the less ERAS+ interventions that a patient achieves, the longer they are likely to remain in hospital following surgery, particularly if they don't start an oral diet or mobilise in the first 24 hours post operation.

3.5 LOS and Post-operative Pulmonary Complications (PPCs) in site A and E

Through issues with recruitment and retention of data collection personnel, only 2 hospitals A and E, had reliable data collection team in place for the duration of the GM ERAS+ implementation. These sites were used for more detailed evaluation of the impact of GM ERAS+ on PPC development.

Between them, these 2 hospitals A (n = 246) and E (n = 235) provided 32.7% (481/1472) of major colorectal resection patients of the total ERAS+ colorectal programme. Baseline characteristics for these 2 hospitals are detailed in Table 3.6 and show that the majority of patients (74-76%) were undergoing major cancer resection surgery, with an average age of 64 and were predominantly male. The risk of PPC for these cohorts was reasonably high on ARSICAT, with more than 30% scoring at least intermediate risk of PPC. ASA breakdown shows that the majority of patients were ASA 1-2 and had their procedure performed laparoscopically rather than open.

	Hospital A (n = 246)	**Hospital E (n=235)**
Age; y	63 (16.7)	65(13.2)
Sex; male	143(58.1%)	123(52.3%)
ASA 1-2	166 (67.4%)	167 (71%)
ASA 3-4	80 (32.5%)	68 (29%)
Cancer Operation	187 (76.0%)	175 (74.4%)
Laparoscopic Procedure	183(66.2%)	142(60.4%)

ARISCAT score		
Low	164(66.7%)	165 (70.2%)
Intermediate	67 (27.2%)	58 (24.7%)
High	15 (6.1%)	12 (5.1%)

Table 3.6 Baseline characteristics of patients included in hospitals A and E during the study period May 2018-December 2019. Values are number (proportion), mean (SD) or median (IQR [range]).

The outcomes for patients in hospitals A and E is described in table 3.7. The implementation period is for convenience divided into 3 different time periods (initial implementation May-Dec 2018, then Jan to June 2019 and then July to Dec 2019) to support analysis.

	May-December 2018	**January-June 2019**	**July-December 2019**
HOSPITAL A (n=246)	92	76	78
Hospital length of stay	8(6-11[3-53])	6(4-9[1-132])	6(4-9[2-36])
90-day mortality	0%	0%	0%
1 year mortality	3.3%	1.3%	1.3%
Postoperative pulmonary complications	11.9%	7.9%	6.4%
HOSPITAL E (n=235)	74	77	84
Hospital length of stay	9(6-13[3-33])	7(5-12[3-28])	6(4-9[3-29])
90-day mortality	0%	0%	0%
1 year mortality	5.4%	1.3%	1.2%
Postoperative pulmonary complications	12.1%	6.5%	5.9%

Table 3.7 Outcomes reported for patients undergoing elective colorectal surgery during three different stages of the ERAS+ implementation for patients in hospitals A and E. Values are number (proportion), mean (SD) or median (IQR [range]).

For hospital A cohort, there was a hospital LOS reduction post ERAS+ implementation from baseline (median 8 days) to a median LOS of 6 days for the period Jan-June 2019, and this is maintained through the completion of the GM ERAS+ project through to the end of 2019.

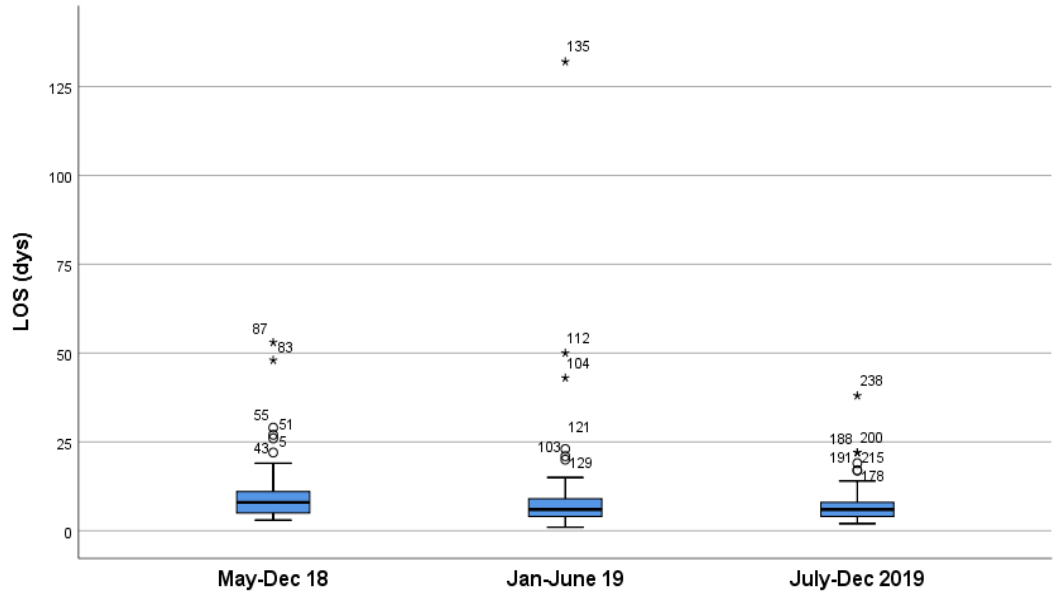

Figure 3.19 Hospital A cohort LOS

Comparing LOS May –Dec 18 **(8,3-53) (median, range)** to Jan-Jun 19, **(6,1-131) (median, range) p=.012** (Mann-Whitney U test). Comparing LOS May –Dec 18 **(8,3-53) (median, range)** to Jul-Dec 19 **(6,2-36) (median, range)**, **p=<.005** (Mann-Whitney U test). There is a significant reduction in LOS compared to baseline during ERAS+ implementation.

There is sequential reduction in PPC from 11.9% at baseline (May -Dec 18) to 7.9% and then 6.4% by the end of the implementation period Jul-Dec 19). This represents a 46.2% reduction in PPC compared to baseline. No significant association of time periods post ERAS+ and proportion of PPCs in Hospital A was found when comparing either 3-month intervals or 6-month intervals. (Pearson Chi-squared test or Fisher' s exact test).

There was an apparent improvement in mortality at 1 year compared to the baseline period, with mortality reduced from 3.3% to 1.3%. No statistical analysis was undertaken for this.

For hospital E, there is a similar LOS reduction from a median baseline of 9 days to 7 midway through the project and a further reduction to 6 days in the final period of the ERAS+ implementation.

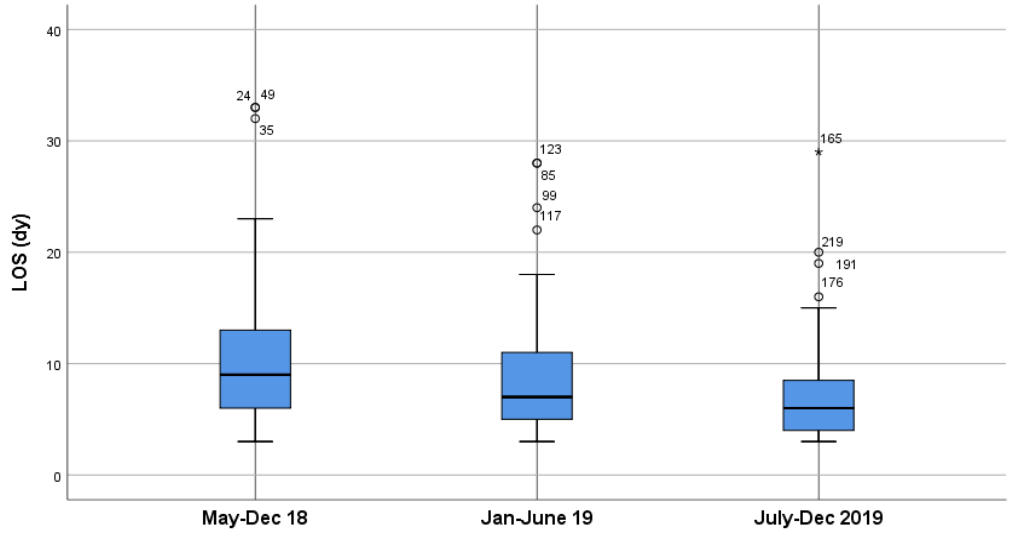

Figure 3.20 Hospital E cohort LOS

Comparing LOS May –Dec 18 **(9,3-33) (median, range)** to Jan-Jun 19, **(7,3-28) (median, range) p= .043** (Student's T test, log transformation). Comparing LOS May –Dec 18 **(9,3-33) (median, range)** to Jul-Dec 19 **(6,3-29) (median, range)**, **p=<.0005** (Student's T test, log transformation), there is a significant reduction in LOS.

The PPC rate drops from 12.1% (baseline – first few months of implementation) to 5.9% (latter period of implementation), a reduction of 51.2%, with a similar improvement in 1 year survival as seen in hospital A. No significant association of time periods post ERAS+ and proportion of PPCs in Hospital E when comparing either 3-month intervals or 6-month intervals. (Pearson Chi-squared test or Fisher' s exact test).

There was also an apparent improvement in mortality at 1 year in Hospital E compared to the baseline period, with mortality reduced from 5.4% to 1.2%. No statistical analysis was undertaken for this.

Historical average LOS are demonstrated in Figures 3.20 (Site A) and Figure 3.21 (Site E) and confirm a reduction in LOS following implementation of ERAS+ at both sites, compared to historical LOS.

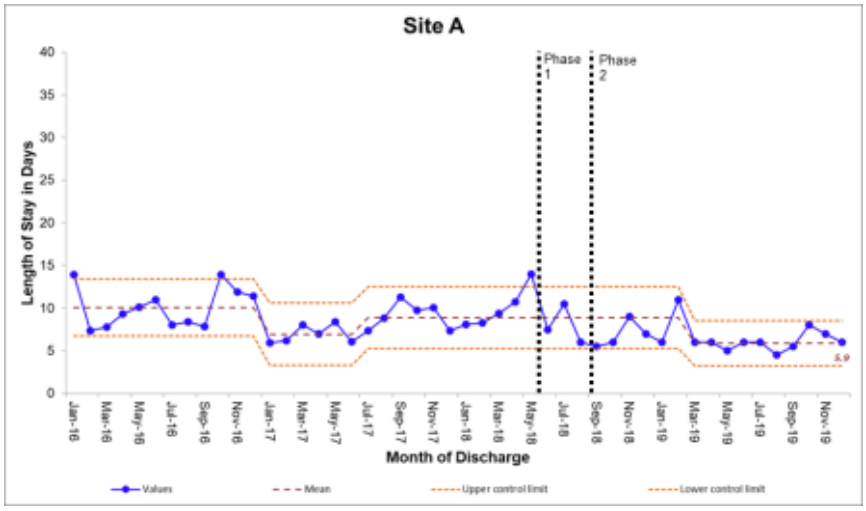

Figure 3.21 Average Length of stay following surgery over time for hospital A following implementation of ERAS+ from 2018 (phase 1) compared to historical length of stay data.

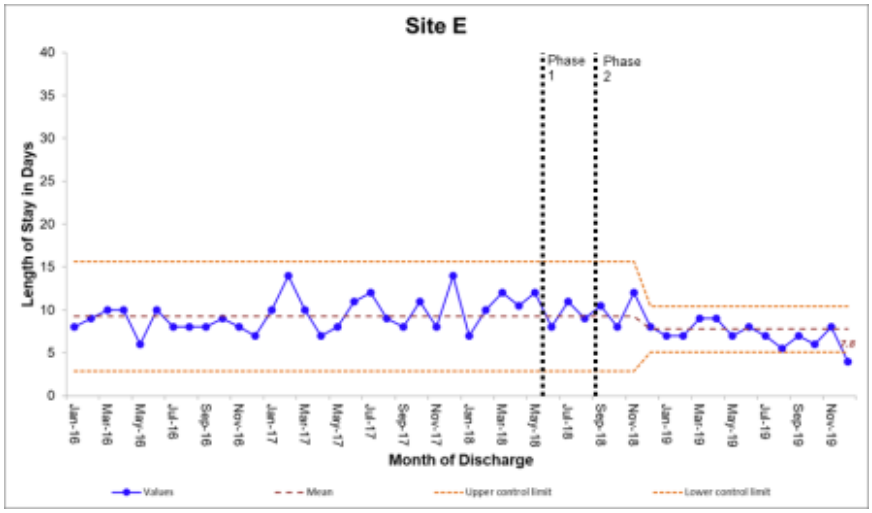

Figure 3.22 Average Length of stay following surgery over time for hospital E following implementation of ERAS+ from 2018 (phase 1) compared to historical length of stay data.

Hospital A achieved very good compliance in surgery school attendance, mobilization, nutrition and good use of incentive spirometer. However, less than 50% compliance with tooth brushing and mouthwash compliance, and so overall ICOUGH compliance (all elements) was less than the desired 80% for Hospital A (see figure 3.22). Hospital E (figure 3.23) had excellent compliance with all elements of ICOUGH and surgery school attendance as the project developed. However, both

hospitals saw significant benefit from ERAS+ implementation even without complete compliance to the ERAS+ bundle.

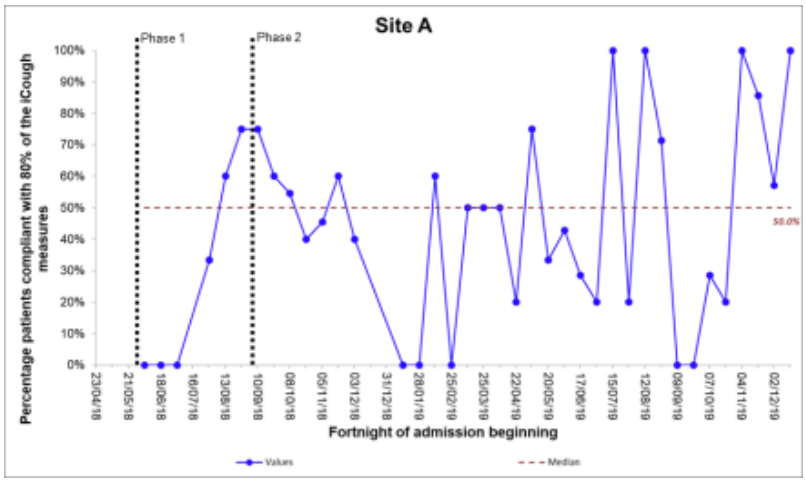

Figure 3.23 ICOUGH-Dreaming compliance for Site A

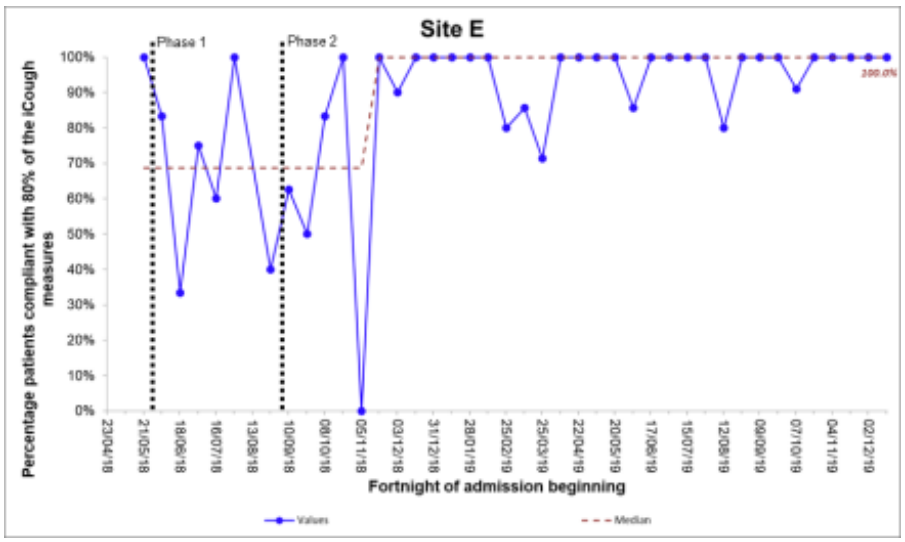

Figure 3.24 ICOUGH-Dreaming compliance for Site E

3.5.1 Factorial analysis of Hospitals A and E

Factorial design methodology was used to compare combinations of process measures against LOS for Hospitals A (Figure 3.24) and E (Figure 3.25). The figures below show the combinations of process measures received along the top and left side of the display. At the intersection of each combination is the average LOS in days for all patients across each site that received those

interventions. The cells highlighted in green are where LOS is in the lowest 20% of the combinations while those in red show those LOS in the highest 20%.

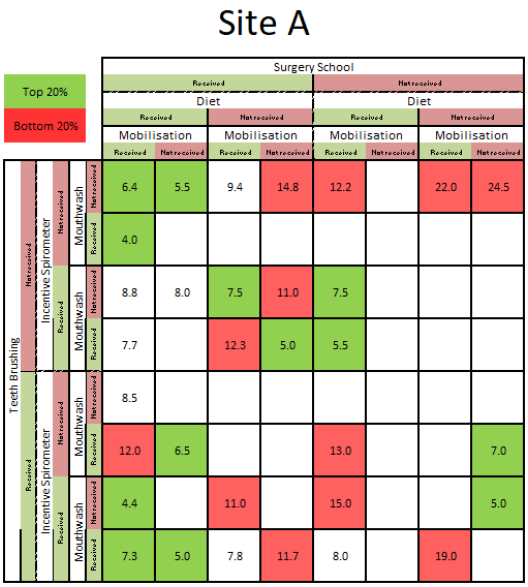

Figure 3.25 Effectiveness of different combinations of process measures on length of stay (Site A)

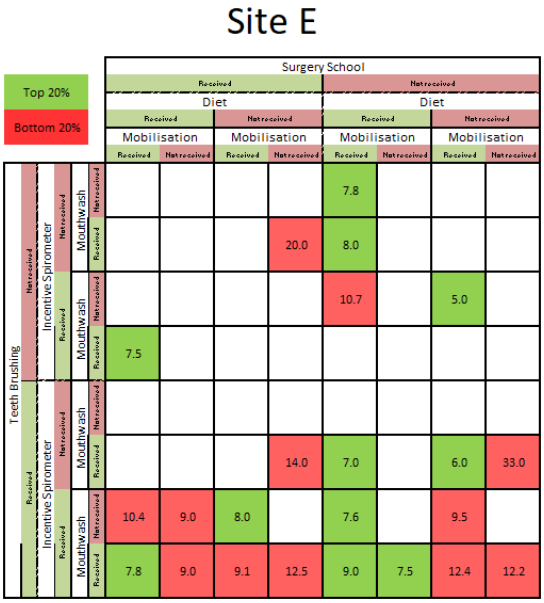

Figure 3.26 Effectiveness of different combinations of process measures on length of stay (Site E)

Generally, a lower average LOS occurred where patients (i) were mobilised within 24 hours post-surgery, (ii) started an oral diet within 24 hours after surgery and (iii) attended Surgery School before admission.

3.6 Balancing measures

3.6.1 Readmissions

Data is presented for all sites only as results were the same when the site without baseline data (Site B) was excluded. Readmissions were a balancing measure designed to ensure that the project didn't have an adverse effect where patients discharged sooner are more likely to be readmitted. The baseline readmission rate was 13% and there is no evidence of a shift in the data once the project started. There are two triggers for Special Cause Variation; an astronomical point in April 2018 and a downward trend running August to December 2018 (Figure 3.25). The results indicate there was no adverse impact on readmission rates for patients receiving the ERAS+ intervention.

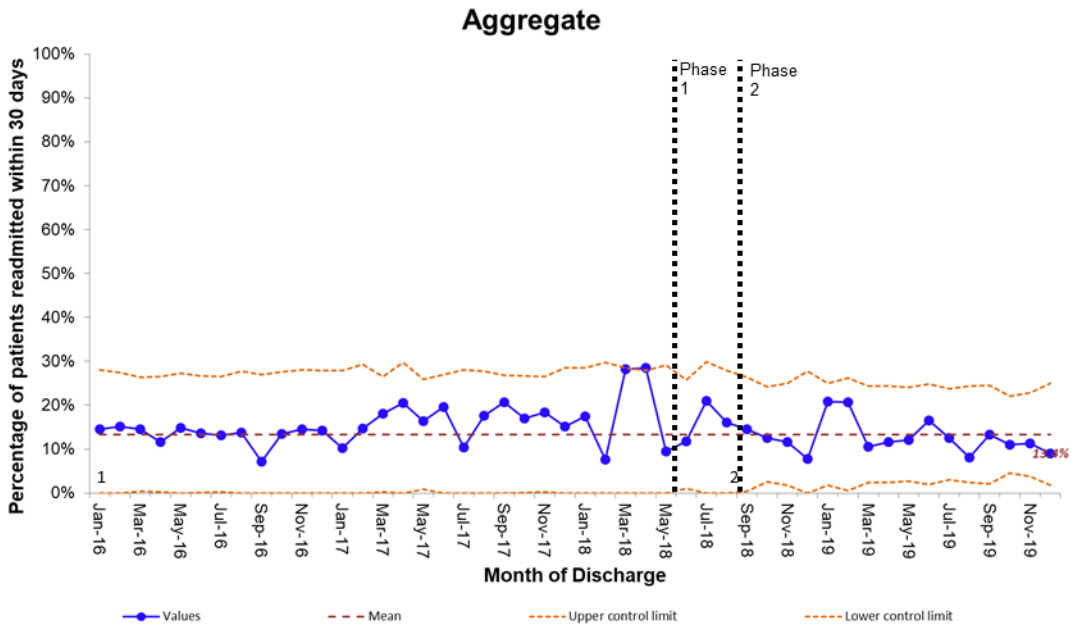

Figure 3.27 Percentage of patients readmitted within 30 days of discharge (aggregate data)

3.6.2 Patient Satisfaction

The scoring methodology for patient satisfaction were based on giving ERAS+ patients a choice of 5 options from the Likert scale; 1 being lowest/completely unsatisfied and 5 being highest/completely satisfied. The measure of success was for 80% of patients to score at 4 or above.

Patient satisfaction (Average score): At baseline patient satisfaction was 4.5; there was wide variation in patient satisfaction data as a result of the small number of patients responding (Figure 3.26). Variation reduced as more patient data became available. There was an increase shift in July 2019 to 4.7 which is an improvement in satisfaction. The balancing measure to maintain patient Patients on average feel positive about the care they received under pathways included in the ERAS+ programme.

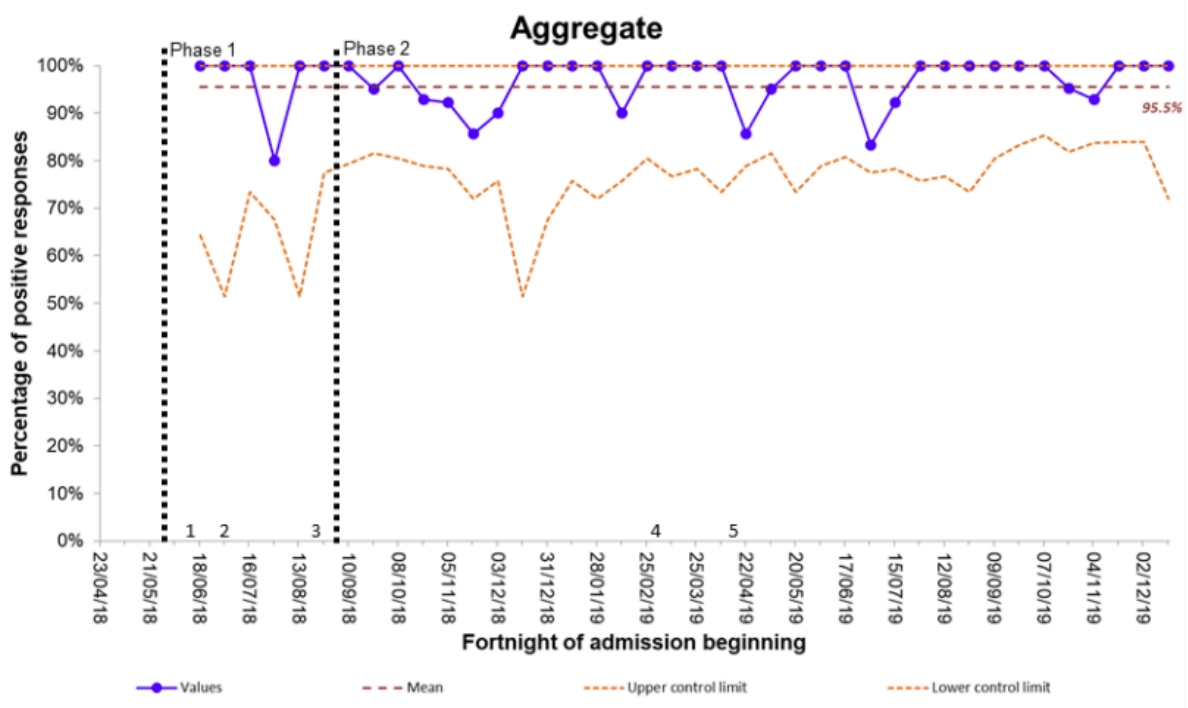

Figure 3.28 Percentage of patients with score >4 for satisfaction (aggregate data)

At baseline 96% of patients scored satisfaction of 4 or more and this didn't change throughout the project; with no triggers of Special Cause Variation. As a balancing measure, the aim was for patient satisfaction not to deteriorate as the ERAS+ project scaled up. Patient satisfaction data was collected to make sure that improvements to the pathway didn't result in a negative patient experience. The data shows that patient experience remains consistent throughout the project, indicating that the improvements made by the implementation team have not had an adverse effect on patient experience of their surgical pathway. Further patient analysis of experience with ERAS+ is undertaken in Chapter 4 - qualitative results section.

3.7 Use of digital resources

As part of the preoperative patient questions undertaken by the ERAS+ data team, we asked patients about their use of ERAS+ digital resources that had been developed as part of the programme. For hospitals A and E, on average 65% of patients reported that they had viewed on-line ERAS+ resources before their surgery and 20% had downloaded the APP onto their smartphone.

CHAPTER FOUR

Qualitative Results

In this chapter there is exploration of barriers and facilitators to the implementation of ERAS+ from a staff and patient perspective using qualitative methodology,

4.1 Exploring staff perspectives about the scale-up of ERAS+ over time

The interview schedule for GM ERAS+ was based on the Institute for Health Innovation (IHI) 'Readiness for Scale Up Assessment Tool' [145] and learning from Normalisation Process Theory [146]. The Readiness for Scale Up Assessment Tool was developed by the IHI to help health system leaders and staff assess their hospital's capability in three key areas: 1) Phase of Scale Up, 2) Adoption Mechanisms and 3) Support Systems. The evaluation team employed the tool as a guide for the interview schedule to ensure that questions fully explored perceived areas of strength and weakness of ERAS+ and assessed progress towards improvement goals. Normalisation Process Theory (NPT) is a theory of healthcare implementation which offers a structure for understanding practices that enable or constrain the integration of an intervention into routine care. The theory identifies four determinants of embedding complex interventions in practice: coherence, engagement, collective action and reflexive monitoring. These concepts were used to inform the structure of the interview schedule. The evaluation team piloted the interview schedule and added questions for the interim evaluation. In the final interview schedule the evaluation team added questions to explore how effective data collection was, use of data collection guidelines, use of PQIP and learning from group data reviews.

The evaluations team's formative approach meant the interview schedule evolved in response to learning from the interviews, the steering groups and the milestone meetings. The broad topic areas for the initial schedule and for the final evaluation interviews are outlined in Table 4.1.

Initial Interview schedule topic areas	Final interview schedule topic areas
• ERAS+ role • Understanding of ERAS+ • Engagement with ERAS+ • Scale up so far and readiness for further scaling • Reviewing ERAS+	• ERAS+ role • Engagement with ERAS+ • Data collection • Scaling of ERAS+ • Reviewing ERAS+

Table 4.1 Topic areas covered by the interview schedule for initial and final review

4.2 Exploring staff perspectives about early implementation of ERAS+

The qualitative interview data from the first round of staff interviews identified the following four broad themes:

1. Limited time available for implementation

2. Awareness of the intervention

3. Culture shift

4. Development of the Data Collector Role.

Table 4.2 summarises these themes in the context of NPT.

The evaluation team conducted a survey which showed wide variation in the remit of the Data Collector role at the different sites; some data collectors were involved in the organisation of Surgery School, staff education of ERAS+, promotional activities as well as data collection and input for ERAS+ and other projects. The initial implementation qualitative findings also suggested that the data collector and ERAS+ Nurse roles were seen as fundamental to evidence the effectiveness of the programme, as well as contributing to programme implementation, promotion and engagement of hospital staff with ERAS+.

Normalisation Process Theory Construct	Main Descriptive Theme/subthemes	Definition
Coherence Understanding and awareness of ERAS+	Awareness of the intervention (staff)	Staff awareness of the ERAS+ programme and ERAS+ patients
	Awareness of the intervention (patients)	Patient awareness of the ERAS+ programme and their surgical pathway (including surgery school)
Cognitive Participation: Engagement with ERAS + and its data, and associated barriers	Time availability	Time availibity to implement the ERAS+ in relation to targets and funding
	Staff availability	Availability of different staff members to be involved in ERAS+
	Patient availability	Patient ability to attend ERAS+ related appointments/surgery school
	Culture shift	Existing ways of thinking and working and degree to which these are changing
Collective actions: Promotional activities undertaken to normalise and increase awareness of ERAS+	Promotional activities	Local site meetings Steering group meetings Milestone meetings ERAS+ learning events
Reflective monitoring: Reviewing and developing ERAS+ elements	Development of the data collector role	How roles have changed over time

Table 4.2 Results of the qualitative findings from staff interview during initial implementation of ERAS+ mapped against Normalisation Process Theory

4.3 Steering group and milestone meetings to support the dispersal of early qualitative evaluation

The monthly ERAS+ steering groups were identified as an important forum to share learning and support the dispersal of information from the initial qualitative interviews. Barriers and facilitators to scale up were discussed and attendees were able to take away improvement actions to their on-site teams. A variety of problems, successes and solutions were reported and proposed by various stakeholders from all seven participating Trusts over the implementation of ERAS+. The evaluation team captured key learning from the meetings (See **Appendix 1. Summary of learning from the monthly ERAS+ steering group meetings**).

Another important opportunity for understanding and reflection of the qualitative and quantitative data were the quarterly milestone meetings. These took place in September 2018, December 2018, April 2019, October 2019 and December 2019. These meetings provided a deeper dive into the data and the barriers and facilitators that were been identified in the programme implementation. Recommendations from these meetings were synthesised to help inform the rapid-cycle approach to the evaluation. (See **Appendix 2. Summary of learning from the ERAS+ milestone meetings).**

4.3.1 Later exploration of staff perspectives about the barriers and facilitators to implementation of ERAS+

A second series of qualitative interviews were undertaken with staff between August and December 2019; the aim was to further explore the question: 'What were the barriers and facilitators to implementation of ERAS+ across NHS Trusts?'.

The qualitative interviews adopted a purposeful sampling strategy, aiming to achieve a diverse and representative range of perspectives from staff working on ERAS+ in different roles across sites. This was in order to gather important contextual information which was unique to a particular site or particular role. Staff in the core ERAS+ roles of clinical lead, data collector, nurse and physiotherapist in each of the sites, were approached for interview. In total 38 people were invited to participate. Constraints on staff availability and turnover meant that of the 38 invited, 15 responded and 12 interviews were conducted. The 12 interviews conducted did not cover each of the key roles for each of the sites. However, participants were interviewed across all sites and for all key roles. Six staff members were interviewed for both the interim and final evaluation.

In relation to answering the question 'what were the barriers and facilitators to implementation of ERAS+ across NHS Trusts?' four key themes (Table 4.3) emerged from the qualitative interview

data; ability to implement key elements of ERAS+, engagement with ERAS+, dedicated ERAS+ roles and visible champions, flexibility to review and adaption of the intervention. In many cases, the themes were reported as both a barrier and facilitator. For example, staff engagement could be viewed as a continuum with low engagement reported as a barrier in some sites, and high engagement as a facilitator in others. There were also reports of this continuum within sites, where participants reported high engagement of one group (or individual) but low engagement of another group (or individual), in the same site.

Table 4.3 Themes from staff interviews

Theme	Subtheme	Evidence
1.Ability to implement key components of ERAS+	a) Establishing Surgery School b) Availability of patient belongings and adherence with ICOUGH bundles	P8: "we're still having some problems with the referrals system into Surgery School […] we've moved it to a bigger room because we were having so many people going "oh well I was just told turn up today" so we've had to make those changes" P1: "The problem that we are having is that if they've not been to the Surgery School, then, we're having to provide [equipment] on the wards… In regards to teeth brushing, obviously patients are quite good at brushing their teeth but the issue is around mouthwash. People don't bring it in"
2.Engagement with ERAS+	c) Promotional activity d) staff engagement and participation e) culture and ways of working f) Patient engagement and participation	P2: I think Trust wide we have done quite a lot of work to try and raise the profile of the enhanced recovery plus. So there's been articles in Trust newsletters and things like that, photographs on the enhanced recovery plus team. I think we've struggled to get staff to engage but a lot of that's probably been down to staff education which is improving and has improved a lot since [data collector] started… I can't say there's anybody, any particular person, who's been a barrier or any team that's been a barrier, I think everybody gets it and sees that there are benefits to it and want a piece of it [patients] only have the physio input once a day in the morning, it would be a lot better if it was twice, so then they get up in the afternoon. But the nursing staff can do that with them…it doesn't have to be the physios I think the patients have been pretty facilitating as well because they've come in so prepared for it and so motivated to do it that a lot of them have got on with the ICOUGH principles even without nursing support
3.Dedicated ERAS+ roles and visible champions	ERAS+ nurse ERAS+ data collector Staffing recruitment, retention and time constraints	P4:"I don't think it does work without people being in post. It just- it's a protocol that needs to have that visual and that constant…. there's certain things protocol wise that will work regardless isn't there? There's you know if somebody is diabetic there will be certain protocols that will work because that's standard practice but with something like ERAS I think you do need to have 'a' person or people in post to be able to keep the momentum going.
4.Flexibilty to review and adaption of the intervention	Learning from others Implementing ERAS+ alongside other hospital processes	P12:I think in terms of Surgery School, like things that people do and talk about in Surgery School, I think that's kind of helped us to evolve and create our Surgery Schools. I think there's probably been some initiatives that other people have done that we've kind of taken and ran with ourselves or altered and implemented P11: I guess that's a little bit why I've tried to keep hold of the one to one [pre op information] because I feel that I need that relationship with my patient because I get them out of bed the next day

4.4 Themes from staff interviews

4.4.1 Theme 1: Ability to implement of key components of ERAS+

A key theme in the data was participants' (staff) ability to influence the implementation of key components of Surgery School and the ICOUGH-DREAMING perioperative care bundle in their hospital site. The quantitative data indicates that Surgery School and ICOUGH were implemented to varying degrees across the seven sites.

a) Establishing Surgery School

Barriers to implementation of Surgery School identified were the organisational aspects of setting up and running of the school, ensuring that the ERAS+ team members (ERAS+ nurse, anaesthetist, allied health professional) attended and determining whose responsibility it was to manage the administration of how people and their families were invited and supporting their attendance.

In most cases, staff were willing to participate and help to deliver Surgery School, but this relied on a dedicated individual in each site to plan and organise the sessions. At sites A and E, where surgery school attendance worked best, the data collector took over responsibility for organising Surgery School and a large part of the administration duties so that the Surgery School could be established. This perception supports the view that Surgery School needed a dedicated individual to organise and coordinate it:

P6: So you've got consultants who are prepared to turn up and deliver Surgery School, you know, every other week and give an hour of their time to do it but if it doesn't happen or the room is not booked or they don't get an invite or the patients aren't organised then they haven't got the energy to then fix the problem themselves. So all the supporting cast are all there but if you haven't got the main- the main people driving it then is hasn't happened.

Overall, Surgery School and the pre-hospital education element of the ERAS+ intervention was perceived by interviewees as highly effective in educating and engaging patients in the ICOUGH elements of the pathway post operatively, as well as preparing patients for surgery both physically and psychologically. One of the sites recognised that the site pain team alongside the ERAS+ nurse might prove useful in managing and alleviating patient concerns about pain:

P8: […] pain is people's main fear about it. They're not frightened that they won't get mobile again because they know it will happen at some point. What they're frightened about is that it's gonna be really painful so we have been in contact with the pain team and they are really keen to be involved. So they're

going to be coming and presenting around pain management. So we have been looking to adapt Surgery School.

As Surgery School became more part of normal care across all sites and viewed as valuable, it was recognised that better administration was required alongside funding of the time required by the ERAS+ team members to attend. This was supported from an operational point, by the creation of a Surgery School business case by the GM ERAS+ steering group.

b) **Availability of Patient Belongings and adherence with ICOUGH principles**

A reported barrier at four sites (sites B, C, E and F) was patients not having access to the equipment needed for ERAS+, such as their incentive spirometer and other personal belongings (e.g. glasses, slippers, toothbrush, toothpaste, mouthwash and in some cases, dentures).

Three of these sites (sites B, C and F) did not meet the pre-determined 80% adherence target for ICOUGH-DREAMING implementation, so the availability of equipment and patient belongings may have been a contextual barrier to implementation at these sites.

In some cases, equipment and belongings were not available because hospital procedures and lack of storage resulted in belongings being sent home with relatives or not immediately available following surgery. Some sites relied on patients bringing in the incentive spirometer they had been given pre-op, others would give a new incentive spirometer to patients after their surgery. The impact of this was that some patients were not able to use their incentive spirometer or access belongings that they needed to mobilise within 24 hours, leading to an impact on meeting the 80% adherence with the ICOUGH bundle.

At site F, it was reported that patients sometimes did not bring the necessary belongings with them when they went into hospital. This was particularly the case if they had not attended Surgery School, and therefore may not have been aware of what they needed to bring and they would not have received an incentive spirometer:

P1: I think if they've been to Surgery School most of them are reasonably good at bringing them in. The problem that we are having is that if they've not been to the Surgery School, then, we're having to provide them on the wards

The lack of availability of belongings was overcome at sites B and C by introducing a small bag, branded with the ERAS+ logo, which followed the patient from surgery to the ward. These sites were looking into the effect of this on their adherence data at the time of interviewing:

P13: Yeah, we've introduced things like ERAS+ bags that we have on the ward so patients that go to HDU from theatre so they pack the spirometer and the mouth care and stuff in that bag and we drop it off at critical care so it's there ready for them so they are using that stuff then from the get go after their… so rather than not having it for two days and going back to the ward and then starting to use it 'cause they didn't have it in critical care…

At site F, an interviewee reported how they were trying to ensure a supply of toothpaste would be available to patients, and that they were putting together a hospital stay checklist to remind patients about what to bring with them. A site B participant described how they have introduced a 'teeth trolley' at night-time to encourage teeth brushing on wards:

P12: [Name] created a little tea trolley so in the evenings they have a little tea trolley that goes round and offers everyone a warm drink before they go to bed and then that's now followed up by a 'teeth trolley' so everyone can brush their teeth and that sort of stuff afterwards. So just little things like that, just trying to get it embedded into practice really.

This interviewee reported a perceived change in routine work at ward level and staff being more aware of the importance of patients brushing their teeth. However, they also reported that it may not have been possible to show the impact of this on the adherence data for this element of ICOUGH because of changes in how they were recording data at this site around the same time.

At other sites lower adherence with teeth brushing was not attributed to the availability of belongings. For example, an interviewee at site F suggested that both patient behaviour and hospital culture may have been a barrier to implementing this element of ICOUGH at that site:

P8: I'm not particularly surprised that the mouthwash and tooth brushing has been more of a struggle. I think that's the nature of the population around here.. They maybe don't see the benefit of that so much. Erm, I also think that that's probably hampered by the fact that there doesn't seem to be a massive push on the wards to bring people a bowl and some cold water so that they can brush their teeth.

4.4.2 Theme 2: Engagement with ERAS+

ERAS+ implementation strategies for sites included planned training of staff (nurses, surgeons, anaesthetists, allied health professionals) directly involved in the care delivery of the pre and post-op elements of the ERAS+ pathway. Alongside this was a request to promote the ERAS+ pathways in their hospitals to other staff within the hospital.

Hospital site staff engagement with ERAS+ was identified by interview participants as both an important facilitator (when engagement was high) and a barrier (when engagement was low) to scale up. At four sites (A, D, E and F), low engagement was reported to be concentrated in certain areas of the hospital, or to groups of staff. Common themes relating to staff engagement included:

- Promotional activity was noted as important in the early stages in supporting initial implementation. Perceived lower engagement from critical care, HDU and some surgical ward level staff at some sites;
- The role of clinicians/surgeons in supporting ERAS+ and the decisions they made which related to adherence with ICOUGH-DREAMING principles;
- The importance of colleagues in supporting roles in implementing an MDT approach and carrying out ERAS+ tasks;
- Hospital culture and ways of working as a barrier to implementation;
- Patient engagement and participation as a perceived facilitator to ICOUGH.

c) Promotional activity

The extent to which participating sites trained staff in ERAS+ and promoted the pathway in their hospital sites varied. In most cases ERAS+ training and advertisement was deemed to have helped to raise awareness but may not have been enough in itself to sustain staff engagement. At sites which reported limited promotion of ERAS+, in one case, this was because there was a reported local staff perception that promotion was unnecessary as this site already had a well-established enhanced recovery service.

Three sites (B, D and E) reported a significant amount of promotional activity to try to raise and support awareness of ERAS+. Common activities included: displaying ERAS+ data on wards and having ERAS+ posters and leaflets on wards. One participant reported promoting ERAS+ in an internal newsletter and a participant at another site reported having a promotional stand in the hospital foyer to support hospital staff interest and engagement in the programme. In some cases,

these additional promotion strategies were deemed to have helped raise awareness of ERAS+ within the hospital. Additionally, it was reported that site B had perceived a difference in the level of engagement when they began to hold staff training sessions on ERAS+, delivered by a new data collector:

P13: I'd say there is more [awareness] now, I don't think [...] the rest of the hospital would be particularly, know what is it... But I'd say on our surgical ward and critical care I think since I started there is a lot more awareness of it at least know what it is a lot more know 'cause I've trained them all and been through everything with them.

However, one interviewee acknowledged that information in itself, did not necessarily result in staff engaging with the intervention and that more work was needed to engage staff at all levels:

P2: [things] that have gone out in the Trust newsletter so that people are aware of what we're doing. So I think it would be very difficult to be a member of staff on a surgical ward and not know about ERAS+. I think the challenge is people knowing about it but also being interested and engaged in it. I'm not sure that we've quite done enough work around that bit yet.

At two other sites (A and F), interviewees reported that there had been plans to promote ERAS+ but less promotional activity had actually taken place than had been hoped for, possibly because it ran out of momentum, or it was not clear who's responsibility this was. An interviewee at site F reported that they personally promoted elements of ERAS+ which were most closely linked to their profession, for example, mobilisation and using incentive spirometers. Additionally, an interviewee at site A reported how promotional activity seemed to lose traction and then stop and a site F participant reported that the type of promotional activity at this site was not enough to educate staff about ERAS+:

P1: We do have on entering the surgical ward, a banner made, promoting ICOUGH, but it doesn't really go into the details of what ICOUGH is, erm, so, I think that is something that we could improve, and we do plan to, alongside more leaflets to give out and information booklets and stuff like that

At site C, where there was already a well-established enhanced recovery service, an interviewee reported that they did not deem it necessary to promote ERAS+. They explained that ERAS+ terminology was not used at their site. Instead, elements of ERAS+ which were different to their existing programme were simply added into their current practice:

P11: yeah I suppose I don't say "this is an ERAS+ programme" I just say it's an ERAS programme, cos to me it's all part of the same thing. Yes we have added these other things in so, you know, if you said to

somebody, do you know what ERAS+ is they'd probably say I've heard of it, erm, but if you then said do you use a spirometer? Are you having a Surgery School? And they'd all go, oh yeah we're doing all of that. So it's just terminology I think isn't it?

When asked about the level of staff awareness of ERAS+ at site C, another interviewee reported that this was good, supporting the view of participant 11 that staff were aware of ERAS+ without the need for promotional material.

Participant's accounts indicate that whilst there were no perceived negative consequences of promoting ERAS+, simply providing information about the ERAS+ intervention may not, in itself, be enough to facilitate implementation of ERAS+ or generate the engagement and support from hospital staff which was needed to help implement the pathway (staff engagement is discussed in more detail in the next section).

Other contextual factors may have been more important than the promotion component of the ERAS+ package in some sites. For example, of the three sites that saw reductions in length of stay during the project, two sites reported promotional activity (sites D and E), whereas one (site A) did not, yet data in this site still indicates reductions in length of stay and readmissions. It may be that promotional activity occurred that this respondent was not involved with, or it was not as important as other components, such as Surgery School. This highlights some of the complexities involved in understanding the relative contribution of different elements of the ERAS+ package.

Site E, which reported various methods of promoting ERAS+ did meet the pre-determined criteria for scale up of both Surgery School and ICOUGH-DREAMING and achieved a reduced length of stay. However, there were other contextual factors at this site which may have been important, which are highlighted in the sections that follow.

d) **Staff engagement and participation**

Staff engagement with ERAS+ was identified by interview participants as both an important facilitator of scale up (when engagement was high) and a barrier (when engagement was low). At four sites (A, D, E and F), low engagement was reported to be concentrated in certain areas of the hospital, or to groups of staff. For example, some interviewees at site E perceived lower levels of engagement at a senior clinical level and in HDU, which they perceived as having an impact on the mobilisation of patients after surgery:

P2: I think there is a core of people who are very, very engaged, there is a core of people who are, erm, I think there are some people who haven't engaged well with enhanced recovery and there's a minority

perhaps who are quite resistant still…there is also, a smaller element that is lack of engagement from people who you would think should support the process, so the more senior leadership perhaps are not engaged as well as we would like, so they are not disseminating that down the ladder, if that makes sense?

However, an interviewee at site D explained that in some cases, patients were deemed too unwell to engage with ICOUGH after their surgery and that this could be misinterpreted as a lack of engagement with ERAS+. This interviewee explained that they were signed up to the principles of ERAS+ but that they were not always suitable for the patient:

P7: Erm, I think mostly- I think sometimes what is interpreted as lack of engagement, isn't quite correct […] for some patients, they are very high risk going into these operations and they- some of the kind of set "this should happen on this day, this should happen on this day" it doesn't always happen. Not because people are not educated about it but more because it's just not appropriate for that individual patient

The role of clinicians was also highlighted by an interviewee at site C, who had strong views about the need to have support from surgeons to effectively implement any new initiative and that this had been a key facilitator to implementation at this site:

P11: So I know ERAS is all about prehabilitation and Surgery School but actually for me, you need the surgeons on board because they are the ones that drive the pathway, when the patient's in hospital […]. And I have to say that mine have always been on board with that

At sites A and F, interviewees reported attempts to engage colleagues in particular elements of ERAS+ had proved unfruitful. For example, a staff member at site A described how they had tried unsuccessfully to engage some surgical nurse colleagues to support ERAS+ in their discussions with patients. And at site F, a similar issue was encountered with ward managers, who were offered training about how to use certain pieces of equipment, but this was not taken up. This individual went on to explain that lower engagement at this site may have been partly due to the late involvement of this site in the project due to wider contextual factors. However, they reported a positive shift in engagement when the dedicated ERAS+ nurse started in post.

Conversely, some sites reported good levels of engagement from colleagues across a range of disciplines, evidencing a multidisciplinary approach to implementing ERAS+. For example sites A, B, C, and E reported the involvement of a wider group of staff (e.g. pain nurses, anaesthetists, advanced practitioners and physiotherapists), supporting Surgery School and the implementation

of ICOUGH-DREAMING at ward level. This was often alongside pockets of disengagement from certain groups of staff or individuals.

Of these, sites A and E had a reduced length of stay. Sites A and E also achieved 100% scale up of Surgery School. One interviewee at site E attributed reduced length of stay outcome to higher referral of patients to Surgery School because more referrals were being made by nurses, indicating increasing engagement with ERAS+:

P4: the attendance at Surgery School is better now. I think the colorectal nurses, erm, probably say, or recommend more Surgery School so, you get more numbers through of people that are going along to that or are engaged with it. So, I do think it's a combination.

However, interviewees at sites B and C did not report staff engagement as being a barrier to ERAS+. Despite achieving 100% scale up of Surgery School, these sites data did not see improvement in targeted outcome measures. At site D, it was reported that although the majority of staff were willing to be involved in ERAS+ and the delivery of Surgery School they had not successfully implemented Surgery School, due to lack of dedicated person responsible for planning and organising it. This participant noted some inactivity at site D, which may have hampered progress. Interestingly, sites A, B, C and D all had an established enhanced recovery programme in place prior to implementation of ERAS+ and none of these sites met the 80% adherence target for scale up of ICOUGH. The reason for this is less clear.

An interviewee at site B described the challenges they had experienced in educating staff about the benefits of ERAS+ and how the data collector had started to improve this by holding education sessions with staff, but that they did not see staff engagement as a barrier. There were also reports of backfill support being provided to maintain the momentum of specific ERAS+ duties, for example other staff supporting data collection where there was high volume, or when data collectors were on holiday, both within the core ERAS+ team and also support from colleagues in other roles:

P3: You see you've just reminded me actually … the nurses there collect the ERAS data for us, 'cause they get a lot of patients, so they actually do the ERAS data collection now

Interviews indicate staff engagement with ERAS+ was varied both across and within sites. Some sites have improved this with staff education while others have noticed a difference when a vacant ERAS+ role was filled. Engagement and support from staff outside of the core ERAS+ team has been reported as being a facilitator at all six sites in improving adherence with ICOUGH on wards, delivering Surgery School and maintaining momentum with activities such as data collection.

e) Hospital culture and ways of working

It was felt by some interviewees that existing practice and culture within hospitals was a barrier to implementing ERAS+ at some sites and that there was a need to shift this before elements of ERAS+ would become business as usual. Interviewees at site E reflected on how ways of working at this site were not aligned with the aspects of ERAS+ which are time sensitive, such as mobilising within 24 hours after surgery and that this is not viewed as the collective responsibility of staff on wards. An interviewee at site F reported other initiatives being slow to embed at this site, suggesting that challenges at this site were not unique to ERAS+:

P8: It's not just ERAS+ that has taken a long time to actually get embedded on the wards. Things like, we do safer board rounds and it has taken a long time (too long really) to get it up and actually happening every day and it's still occasionally a bit hit and miss

f) Patient engagement and participation

Patient engagement and participation with ERAS+ was highlighted by interviewees at three sites as a potential facilitator to ERAS+ scale up. The main reported benefit was patients who had attended Surgery School (regardless of the style of delivery of Surgery School) were both more aware of what they needed to do to help their recovery and were proactively engaging with it. This starts to evidence some of the key goals of ERAS+ being achieved, for instance, educating patients in preparation for surgery. Several interviewees commented on the behaviour of patients after surgery and compared this to what they experienced before implementing ERAS+, in particular, Surgery School:

F8: The ones that come to Surgery School you get to them and they're like "I've already started my incentive spirometry, I've been out of bed already" erm you know, " I've been trying to do my breathing exercises" and those are things that just wouldn't have happened and you know, they would have laid in bed until we got to them and then they would have got up and moving so that's been really positive I think

P2: to think of that happening two years ago, pre ERAS, or pre Surgery School particularly, yeah, it wouldn't have happened.

However, staff at site E still perceived hospital ways of working to be barrier to this at times:

P4: we say to them what our ideal is in Surgery School and then they come here [HDU] and it doesn't quite work. And then they get back up onto the surgical ward and actually it does work again then because they're encouraged to be independent, they're to go off and do their own- brush their teeth and

all that sort of thing, so, yeah it is just more, it's more here [HDU] is the main barrier, to it working as well as- you know it works fine but it could be better.

4.4.3 Theme 3: Dedicated ERAS+ Roles and Visible Champions

Another reported key facilitator to implementation of ERAS+ was the presence of dedicated individuals to both implement and promote the pathway. The visibility of these individuals at ward level was reported by four sites as particularly important in facilitating adherence with ICOUGH. Often this was the ERAS+ nurse (at two sites) or data collector (at three sites) but in some cases, others took on this role in the absence of an ERAS+ colleague, for example physiotherapists. Other challenges which were identified included staff recruitment, retention and time constraints.

g) ERAS+ Nurse role

An interviewee at site F noted the positive impact of an ERAS+ nurse on the wards in relation to promotion, training and enthusiasm following a period of this role being vacant:

P8: So, the nursing staff on the wards are starting to get on board with it because [ERAS+ Nurse] is really, they are quite inspiring because she's really excited by it and she's really good at selling it to them (patients) and she's done a load of training for the incentive spirometers, which I offered 8 months ago but they didn't take up

Positive impact of the ERAS+ nurse in driving progress was reported at site E:

P2: I think the initial progress was quite limited because we didn't have an enhanced recovery nurse and I think that was a big turning point in terms of what input I needed potentially once the enhanced recovery nurse came into post, erm, actually, I think she took a lot of the momentum forward

An interviewee at site D reported that potential benefits of this role had not been realised at their site, because of perceived lack of visibility of the enhanced recovery nurse on the wards. These accounts support the conclusion that the ERAS+ nurse is essential in generating support from a wider team of hospital staff.

h) ERAS+ Data Collector role

The ERAS+ data collector was also reported by three sites as being a key facilitator of implementation of ERAS+. In addition to the collection and reporting of data to monitor process and outcomes measures, some data collector roles developed to include elements of project management and improvement of implementation of ICOUGH-DREAMING on wards. In some cases, development of the role happened over time (e.g. site B and D) and included more clinical

duties and in others, data collectors took on additional responsibilities from the beginning of implementation (e.g. site E).

The potential value of the clinical element of this role was also recognised by interviewees at sites A and B. The data collector at site A commented on how they thought the role would benefit from having more influence with nurses in order to support implementation of ICOUGH when their data was indicating certain elements were not being done. However, they also noted the tension and uncertainty when the clinical element was not an explicit part of their role.

Similarly, to site D, site B changed their data collector role to include clinical aspects which would support implementation of ICOUGH on wards. Both data collectors also took on the role of educating staff about ERAS+ which they perceived had increased awareness of ERAS+. Learning from the steering group and milestone meetings also supports this finding. For example, difficulties mobilising patients at site B were reported to have improved since the data collector role was adapted. The ERAS+ data collector role appears important in the successful implementation of ERAS+ and there appears significant value in the expansion of their role to encompass the running of surgery school, the education of staff including the local feedback of ERAS+ audit and outcome data.

There was consensus among five interviewees about individuals in dedicated ERAS+ roles who are visible on wards being an important aspect of successful ERAS+ implementation. At site E, continuity of core ERAS+ staff, who were reported to be highly engaged with and committed to ERAS+ was identified as important for maintaining momentum. Site E achieved the highest levels of adherence with ICOUGH-DREAMING and had a reduction in length of stay. This site is the only site where there has been continuity of staff in dedicated ERAS+ roles for the full time period of the project, suggesting the importance of these roles for the implementation of ERAS+.

i) Staffing recruitment, retention and time constraints

Interviewees from three sites reported challenges with recruitment and retention of ERAS+ staff. For example, delays in recruiting data collectors at three sites meant that there were gaps in data for periods of several months, which impacted on the ability of these sites to collect process and outcome data.

To overcome retention issues with fixed term contracts, one site identified secondment as a recruitment strategy for the data collector role and after this idea was shared with other sites, it was supported by an interviewee at another site:

P3: And we were saying we think that [secondment] would be a better option because people are less likely to leave if … they don't have to worry about finding a new job at the end of it as they can just go back to their old job

Where there have been no reported issues of staff continuity, such as at site E, process measures and some outcome measures (reduced length of stay) were achieved, which may indicate the role of stable key staff and team play in facilitating the implementation ERAS+. An interviewee at site F described how delays with funding resulted in it taking a long time to recruit the ERAS+ nurse at this site:

P8: But she came in quite late. She's only been in post about 6 to 9 months, because it took so long to get funding and things

Time constraints were also identified as a barrier to implementation by interviewees at four sites. In some cases this was the availability of staff to support the implementation of ERAS+ due to competing priorities and high workload, at sites B, D, E and F.

Theme 4: Flexibility to review and adapt the intervention

Many of the interviewees said that they had adapted certain elements of the ERAS+ package to make it work better at their site.

Examples of these included:

- the style of delivery of Surgery School (two sites);
- bringing different people in to support Surgery School delivery;
- adding more information for patients e.g., pain nurses (one site);
- evolution of the data collector role (two sites);
- coming up with initiatives to improve access to patient belongings and teeth brushing, to improve adherence with ICOUGH-DREAMING (three sites)

Participants reported that the ability to learn from each other was a facilitator to implementation and that the main mechanism for this were the regular steering group and milestone meetings. A couple of interviewees reported that they would have liked to have been able to do more of this. In some cases, participants reported having more specific help from others in implementing elements of ERAS+, for example, sites that were later to implement Surgery School learnt from those who had already done so. Reported differences in how ERAS+ was implemented were also dependent on the degree to which enhanced recovery was already embedded at the site. Finally,

there were two examples of participants sharing learning from ERAS+ beyond Greater Manchester at national meetings.

j) Surgery School Method of Delivery

Adaption of Surgery School to fit the local context was reported in varying degrees at five sites. One site initially implemented classroom style delivery but reverted back to the one-to-one pre-op patient education with a nurse, one implemented a classroom-based style of delivery alongside the one-to-one session for some patients and one used an online delivery style. The three other sites used a classroom style Surgery School to varying levels of success. These sites reported adapting their classroom-based Surgery School by involving more colleagues in the multidisciplinary team who delivered Surgery School, for example pain nurses and physiotherapists.

At site B, an online Surgery School was implemented, to address the geographical dispersion of their patient population, and reduce the need for patients to make additional journeys to attend a classroom session. An interviewee at this site explained that they thought that this had improved the uptake to Surgery School at this site and that this suited the cohort of patients from this site as it meant less travel and the ability to re-watch the Surgery School. At site C, a tour of High Dependency Units where [patients would be cared for in the immediate postop period was included in Surgery School. Patients could see the environment in advance and as already mentioned, and this was reported as extremely positive by both patients and staff. Site F decided to involve pain nurses in Surgery School to try to alleviate patient concerns about pain.

The extent to which different models of Surgery School influenced successful scaling up, based on meeting the 80% adherence target, can be seen at four sites (A, B, C and E). Some of these sites implemented different modes of Surgery School, suggesting that this can be flexible in scale up. Learning from the milestone meeting also shows that while sites were delivering Surgery School in different ways, the same core educational content was being delivered across all formats.

k) Learning from others

Many of the ERAS+ interviewees noted the benefits of shared learning across sites during the course of the project. This included how Surgery School was implemented and ideas for improving adherence with ICOUGH-DREAMING. The main vehicle for this was the monthly steering group meetings where interviewees found learning from others as the most useful part of these meetings. Some interviewees said that they would have liked more opportunities for this:

P12: we've been able to talk amongst ourselves about what's working and have you tried this and we're really struggling with that, have you tried that, that's been really beneficial, I think more of that would have been probably great for us

In some cases, ERAS+ staff visited other sites to share learning, outside of the formal steering group meetings, expanding their networks and supporting cross pollination of initiatives beyond ERAS+:

P7: I have had communication with other Trusts like one of the Trust's that's doing really well with it, erm, the ERAS nurse over there put me in touch with one of the anaesthetists who is doing particular work … I find it easy to, to contact people or to know who to contact if I need- if I want to get some information

Additionally, two interviewees from sites explained how they had shared learning from their involvement with ERAS+ with other enhanced recovery staff from services outside of GM, via other networks that they are involved in. Awareness of ERAS+ therefore reached beyond the cohort of sites in this scale up project. For example, one site's online Surgery School has had interest from Trusts nationally:

P12: we kind of hear from a lot of people from all over the country wanting to know what we do as part of our enhanced recovery programme and ERAS + always comes up and I think people are keen on starting their Surgery Schools and things we are doing including prehabilitation, so I think people are keen to know what works

An interviewee from site C reported inviting a colleague from outside of GM to a monthly steering group, because they felt strongly that their colleague would benefit from ERAS+ and wanted directly to involve them.

l) ERAS+ vs enhanced recovery

Four of the sites involved in the scale up of ERAS+ had pre-existing, well established enhanced recovery surgical services. These sites also had ERAS nurses who were involved in implementing ERAS+ alongside their ERAS pathways. At two of these sites (site C and D), interviewees reported some degree of reluctance (both personal and amongst colleagues) towards ERAS+, particularly in relation to implementing Surgery School. For example, a nurse at site C explained how they felt that a classroom-based pre-op education programme would have a negative impact on their ability to build personal relationships with patients which they relied on to engage patients in the pathway after their surgery:

P11: I guess that's a little bit why I've tried to keep hold of the one to one because I feel that I need that relationship with my patient because I get them out of bed the next day

As a result of this, the nurse adapted the information provided to patients in their one-to-one sessions to ensure that they received all of the necessary information, thus providing them with a one-to-one Surgery School. The nurse explained that she had learnt a lot from implementing ERAS+ and adapting their practice and did not see any barriers to implementation of ERAS+. Mainly this involved some amendments to business as usual. This site scaled up ERAS+ to all patients, so despite some self-reported initial reluctance, this site still delivered Surgery School but in a different way. A similar story emerged at site D. One interviewee explained that they had initially tried to switch to a classroom-based Surgery School as per the ERAS+ model, but reverted to keeping the established one to one with the nurse, with relevant elements of ERAS+ added in. However, unlike at site C, this did not get off the ground, and as a result, they intended to return to the classroom-based approach to ensure consistency. This was also reflected in the data from this site which showed that they did not scale up Surgery School as well as any of the other sites in the project.

Interviewees' accounts indicate variation in implementation of ERAS+ across sites even when they had a similar starting position e.g. already having an enhanced recovery service in place. Site C did not use ERAS+ terminology and integrated ERAS+ directly into the existing service by introducing a classroom-based Surgery School for some patients (with other patients receiving the information in adapted a one-to-one meeting with the nurse). This site implemented ICOUGH-DREAMING alongside their enhanced recovery programme, without reporting any significant barriers. In contrast, at Site E where there had been no enhanced recovery service for a significant period, the scale up of Surgery School and ICOUGH was more successful than any of the other sites. This suggests that starting from a position of having no recognised ERAS service, implementation of the ERAS+ model is possible.

4.5 Qualitative data - Exploring patient perspectives about ERAS+

At the outset of the project the Steering Group developed a patient feedback form to standardise the capture of overall ERAS+ patient satisfaction. The form used a 5-point Likert scale represented by facial expressions (five faces form), ranging from very unsatisfied to very satisfied. A free text comment box was included for patients to provide qualitative feedback on their experience. A

summary of the methods implemented by sites to gather patient satisfaction comments and experience of ERAS+ are included in **Appendix 5**.

126 comments were received across the six hospital sites, from a total number of 1523 patients who received ERAS+ across GM (representing feedback from just over 8% of patients). These ranged from comments on patients' experience of ERAS+, experience of enhanced recovery and Surgery School.

Patient feedback comments were reviewed and then analysed by site and sorted into three categories: positive, negative and neutral. The most common themes across all sites are summarised in Table 4.4. The highest number of positive comments were about the hospital staff and the support and care that patients had received. Second was the number of general positive comments about the experience and third was patient perceptions of feeling well informed and prepared for their surgery. Some patients also reported feeling fitter and having a faster recovery compared to other surgery they had undergone in the past. Surgery School was the element of ERAS+ that was referenced most often.

Neutral comments included suggestions for additional information (e.g. mental health, anaesthetic, complications) and awareness of ERAS+. Two comments in this category related to patients not being aware of ERAS+ or Surgery School. In one case, the patient did not perceive this to be an issue and in the other, they explained that they were not aware of Surgery School but were told about it by the ERAS+ nurse after surgery.

Negative comments mostly related to the amount of information that patients were given. Some reported that too much information was provided; whereas others reported that they would have liked more. Other negative comments concentrated around timing, for example, one patient explained that they had forgotten certain elements of Surgery School by the time it came to their operation; whereas another reported that they would have liked it sooner. Other negative feedback included patients feeling that they were being asked to do too much and that the targets were hard to achieve, as well as the impact that this had on them. There were also perceptions from patients that they would have liked more support from staff and that at times, there were no staff available to help them with certain elements of ICOUGH-DREAMING, such as mobilising.

	Positive Comments	Total	Negative comments	Total
Themes common to all sites	Staff, support and care	43	Amount of information (too much or too little)	7
	General positive comments about the experience (good, excellent)	27	Timing – too soon or too late	4
	Feeling informed and prepared	24	Availibity of staff to support the patient	3
	Feeling engaged and motivated to recover	4	Hard to achieve the steps in ERAS+	2
	Felt recovered better/more quickly	4		
	Surgery School	4		

Table 4.4 Themes from patient satisfaction feedback comments

CHAPTER FIVE

‘Implementability’ of ERAS+

In Chapter 2, an overview of the setting up and implementation of the Greater Manchester ERAS+ surgical programme across 7 hospital sites was presented. There was then a mixed methods evaluation with chapter 3 examining the impact of the ERAS+ from a quantitative perspective and chapter 4 presenting a qualitative overview. In this chapter, there will be a further exploration of the implementation process from an implementation science perspective including the rationale for GM ERAS+ implementation and why we did it what we did. There will be a further exploration of the context of the intervention and an examination of the effectiveness of GM ERAS+ implementation using quantitative and qualitative data, examining barriers and facilitators to its introduction and sustained use.

5.1 Implementation of healthcare Interventions

To help understand how implementation of interventions work, the field of implementation science has developed. Within implementation science, quality improvement and quality assurance have been recognised as separate but inclusive entities. Quality assurance (QA) is a "set of activities that monitor a product or service provided, providing confidence that it fulfils its requirement for quality" [147]**.** This is commonly framed in healthcare by the Donabedian triad of structure, processes and outcome [148]. Quality improvement (QI) aims to solve a problem, and generate new knowledge through quality-based research, using iterative processes and a 'plan, do, study, act' framework in an effort to improve healthcare, rather than simply ensuring that good quality care happens. Both quality assurance and improvement activities commonly use a 'before and after or during' auditing processes through data collection to understand if benefit has occurred.

Implementation evaluation usually uses three approaches to examine change and the impact of a healthcare intervention. The first is the driver or processes that are in place to generate change and what problem is trying to be changed. This maybe a top-down approach through national or regional guidance to change healthcare or a more organic bottom-up approach, where local healthcare workers examine and generate a change solution for a healthcare problem. The second approach is examination of the healthcare context where the healthcare and implementation changes are occurring. The third aspect is understanding the 'implementability' of the intervention defined by Klaic as "the likelihood that an intervention will be adopted into routine practice and into health consumer behaviours across setting and over time", thus how likely an intervention is to be effectively introduced and sustained [149]**.** These three aspects will be used to explore the implementation of GM ERAS+.

5.1.1 What problem are we trying to solve?

Implementation science through quality improvement requires a healthcare problem that needs to be solved. The primary problem that Greater Manchester ERAS+ is trying to solve or rather improve is the morbidity suffered by patients undergoing major surgery. Post-operative pulmonary complications (PPC) normally affect 1-2% of patients after all surgeries and in major surgery they are the most common complication affecting up to 30% of patients [52]. They are associated with increased hospital length of stay (LOS) and result in reduced life expectancy for up to 3 years after major surgery [30, 52, 53]. There are circa 340 million surgical procedures globally each year and with the impact of PPC, it has been suggested that their prevention should be viewed as global measure of health care quality [150].

Preventing PPCs and improving survival aligns with domains 1, 3, 4 and 5 of the NHS Outcomes Framework [151]:

1.Improving five-year survival from cancer

3.Improved outcomes from planned treatments

4.Improving hospitals' responsiveness to personals needs to patients and families

5.Reducing the incidence of avoidable harm

It thus appears that the magnitude of PPCs in patients undergoing major surgery and their social economic consequences makes their reduction an appropriate aim for implementation of a healthcare intervention across the GM healthcare system.

5.1.2 What should the intervention look like?

At the commencement of planning for GM ERAS+ in 2017, there was no specific UK or international guidance in place for reducing perioperative respiratory complications following major surgery. Evidence that ERAS+ was the right intervention for scaling to help improve outcomes for patients in Greater Manchester came from its previous successful implementation in a single tertiary centre in Greater Manchester (2013-2016). Following implementation there was reduction in PPC from 18.7% to 8.7%, which was associated with length of stay reduction from 12 to 9 days for major surgical patients [38].

ERAS+ is an evidence based surgical pathway that encompasses pre-surgery, in-hospital and post-op elements. It encourages prehabilitation elements of increased aerobic activity and

strengthening preoperatively and post-operatively [74]; the ICOUGH respiratory bundle to reduce the risk pf pulmonary complications Cassidy [54]; lifestyle modification through reducing/stopping smoking and reduction of alcohol consumption; psychological well-being; anaemia management; nutritional optimisation pre-op and initiation of early nutrition and mobilisation post-operatively. It is supported through a Surgery School patient and family pre-op education training event.

During pre-implementation planning for GM ERAS+ in 2017, the steering group reviewed the evidence from the ERAS+ intervention and reaffirmed the value in retaining the various elements in the hospital perioperative care; early mobilisation, use of incentive spirometer, teeth brushing twice a day and mouth washing twice a day. The partial difficulty with bundles of care is understanding which part is important in affecting change. The plan for factorial analysis in GM ERAS+ would give the opportunity to understand the importance of the elements within the ERAS+ bundle. An updated review of the perioperative literature suggested that commencement of diet should be included as an additional process measure in the GM ERAS+ perioperative care bundle [50, 51]. Although previously encouraged in the original ERAS+ implementation it had not been explicitly recorded as a process measure. The ability of a patient to be able to mobilise and eat and so be 'functional' after colorectal surgery also provides a surrogate quality assurance measure of good surgical and anaesthetic practice**.**

5.2 Context of Healthcare Intervention

To understand the success of QI implementation in healthcare we need to understand not only the intervention but the context or the environment we are trying to deliver the intervention in. This requires a shift in focus from trying to understand whether interventions work to aiming to understand why, when and where they work most effectively. Context includes characteristics of the organisational setting, the environment, the team, individual members and their role in the organisation and in the QI project. Contextual features of the QI team members include resourcing, training, motivation and QI skills.

With the aim to better understand the role of context in the evaluation and implementation of QI several models have been developed. The Promoting Action on Research Implementation in Health Service (PARiHS) model offers leadership, team working, decision making process, QI skills, team attributes as prominent features of contextual model [152]. The EPIS framework consists of key implementation factors, associated with an outer system context, an inner organisational context and bridging factors (2 directional influencers between the outer and inner contexts)

[153]. In the Model for Understanding Success in Quality (MUSIQ) framework [154] (Figure 5.1), 25 contextual factors are organised on the levels of the healthcare system in which they are operating. They are described in regard to the QI team delivering the intervention, microsystem QI aspects as part of an "inner system", organisational or macrosystem "outer system", and environmental levels.

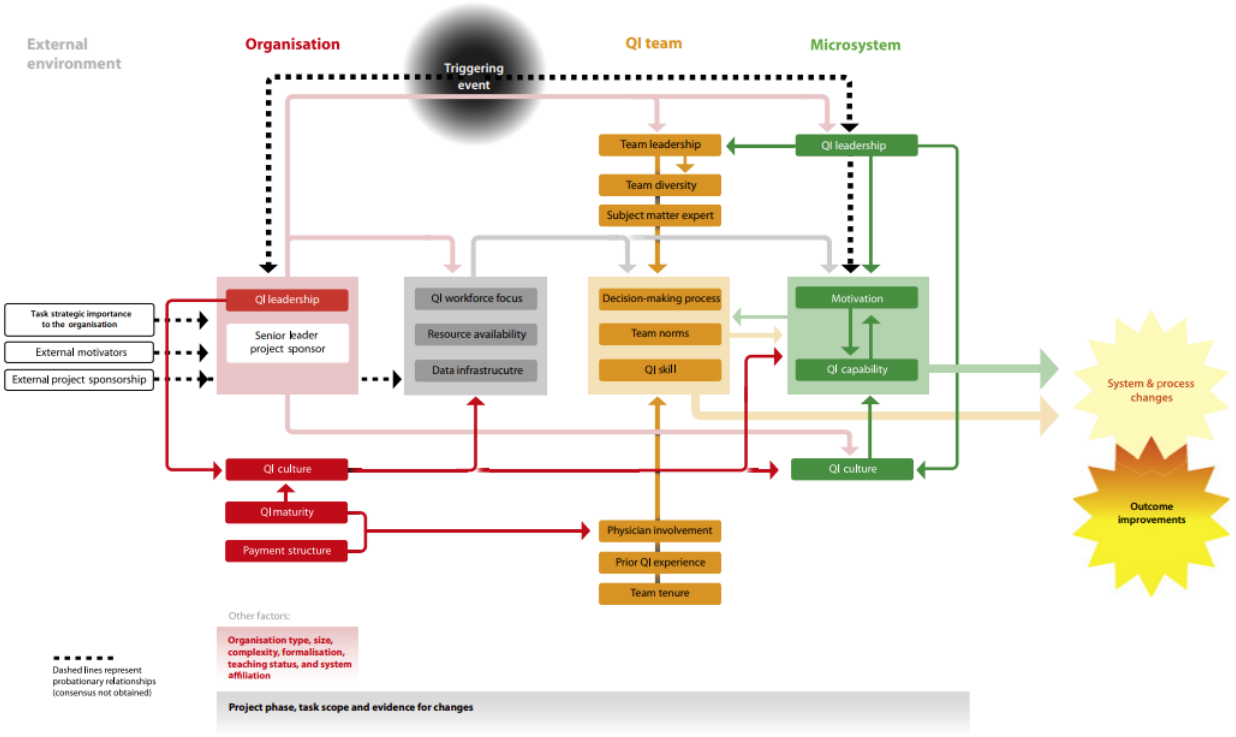

Figure 5.1 MUSIQ: Model for Understanding Success in Quality. Contextual factors are organised with regard to the QI team (in orange), microsystem QI aspects (green) as part of an "inner system", organisational or macrosystem (red) "outer system", and environmental levels (white) (*Kaplan* et al.) [147].

The MUSIQ model is a useful means of examining the contextual elements of GM ERAS+, focussing on the micro and macrosystem, external environment, using the quantitative and qualitative analysis developed in chapters 3 and 4.

5.2.1 Microsystem – Inner system context

The local microsystem delivers the QI intervention. The team's attributes and motivation are core to the success of implementation. Through the design of GM ERAS+, it was agreed and understood that each site needed to develop a core ERAS+ implementation team to lead on the implementation. This team would need to be diverse with respect to professional discipline to

ensure all stakeholders involved in the surgical pathway felt involved in the implementation. Through the steering group the generic traits of good teamwork, good communication and freedom to alter the intervention to meet local needs and a commitment to improve were all encouraged and monitored during the implementation process. It was recognised that site teams needed to share the desire to improve performance and again this was supported through the monthly steering and quarterly milestone GM ERAS+ meetings.

The role of physician leadership is recognised by the MUSIQ model and also was integral to the planning and delivery of the GM ERAS+ programme. All ERAS+ site leads were consultant anaesthetists who were encouraged to become personally involved in supporting the implementation programme effort. As part of the GMHSC support for the implementation, time was given to these consultants within their job plan to support their leadership of the programme and for attendance at steering group meetings. Attendance recorded from the minutes for monthly and quarterly meetings from the programme confirms excellent attendance from site leads. In the appointment of site leads it was recognised as important that they also considered the clinical rationale for GM ERAS+ appropriate and an important interventional goal for their hospital, and so could genuinely act as ERAS+ champions. They were encouraged to work closely with other clinician colleagues particularly surgeons and other anaesthetists involved in the delivery of colorectal surgical care on their sites. As part of the on-boarding of sites on to GM ERAS+, all surgical and anaesthetic colleagues as well as other AHP and nurse colleagues were invited to attend site introductory meetings to understand the rationale and goals of improvement.

It was recognised that each site team would require QI support and through the funded role of Haleo/Aqua as part of the Health Foundation support of the programme, there was excellent QI support for sites. More than 250 healthcare workers took part in GM ERAS+ specific QI workshops during the lifetime of the implementation programme. Core team members from each site had individual team sessions to support them in becoming subject matter experts and also to understand how to use QI methodology and data analysis as part of the delivery of the programme.

Support for data collection and analysis was fundamental to the success of the GM ERAS+ implementation. It was recognised when the implementation programme was being designed and pitched to the Health Foundation that the addition of specific funded site data collectors would be fundamental to collecting data to support implementation delivery as well as understanding the system level impact of GM ERAS+. Relying on current team members to collect data in a new QI

project is recognised as being fraught with challenge as these team members are often already too busy doing their own tasks and the lack of data collection resource is often cited as a reason for failure of a QI implementation. A further challenge for any QI programme is the continued collection of data to ensure quality assurance when it moves from implementation to the sustainability phase. For the GM teams implementing ERAS+, 4 of the sites were able to move to recurrent funding of a data collector to support this process and further embedding of ERAS+ during the initial implementation of ERAS+.

Local hospital organisational QI leadership and support was also recognised as important in the planning and delivery of GM ERAS+. Senior level commitment to the project was generated through GMHSC Medical Director and CEO support of ERAS+ as a GM strategy project which was transferred locally to site bases as a hospital site strategy goal to deliver ERAS+ implementation. To help accomplish this there were local CEOs agreements to support the time required for ERAS+ team members to deliver implementation, alongside operational site support.

Project manager officer resource from the Transformation Unit provided specific operational support to the GM ERAS+ implementation site teams and again were inherent in supported the scaling of the programme. Specific PMO roles including GM organisation of teams and meetings, generation of operational targets, Gant chart generation, maintenance of action and risk logs, regular governance reports which supported executive and GMHSC oversight.

5.2.2 External environment – outer system context

Outer contextual factors are those external to the implementing organisation and aim to simulate and support the organisation to improve the performance and delivery of the QI project. These contextual factors include the wider healthcare system, funding bodies, research networks, charities and also the target of the population that are receiving the QI innovation.

With GM ERAS+, the project sponsorship offered by the Health Foundation was unique in providing access to both national Health Foundation expertise as well as to peer support through other teams undertaking other large Health Foundation supported scale up programmes across the UK. At Health Foundation sponsored and facilitated learning events, scaling teams shared their programme development, progress, challenges, and lessons learnt. This was very useful in the early stages of scaling and also as the programmes moved toward sustainability planning. Representatives from each of the GM ERAS+ site teams were able to attend these events which again supported a culture of QI learning within the GM ERAS+ programme and acted as a bridging factor [146] for the programme implementation and further innovation.

Organisational

At a Greater Manchester system level, senior leadership support within the GMHSC, was very important to generating hospital level support for implementation of the ERAS+ programme. This was made easier through an ability to articulate the programme aims through a simple logic model of improving outcomes and reducing healthcare costs. Thus supporting its adoption as a GM healthcare organisational goal. With the need for the new Integrated Care Systems to deliver the elective surgical recovery programme following the Covid pandemic, programmes such as ERAS+ which provide better healthcare outcomes with good return on investment should prove attractive [155, 156].

5.2.3.1 When contextual factors worked well in GM ERAS+

Microsystem team leadership and motivation

Reviewing the quantitative and qualitative results, site E is an excellent example of where contextual factors of microsystem team leadership and motivation appeared to work particularly well to support the delivery of ERAS+. The site generated excellent process measure (surgery school and perioperative care bundle delivery) compliance in the implementation of ERAS+, generating improvement in patient LOS and PPC rates. The microsystem that developed at the site appears very important in this regard. Features evident were the broad-based nature of the implementation team with an extremely positive culture and shared vision of making ERAS+ work on the site. Although nominally clinical led by an anaesthetic consultant, the ERAS+ nurse and allied health professionals were strongly engaged in leadership of site implementation, capability for improvement and adjusting the programme to their local needs. This was greatly enhanced by the recruitment of a data collector who remained with the programme through its duration. There was also development in the role of the data collector at site E, as they took on more of the organisational aspects of ERAS+, with mentorship from the ERAS+ project manager officer. All these factors appeared to support their retention. The site E team members would become the subject matter experts for the GM ERAS+ programme, which would them lead to presenting GM ERAS+ at national ERAS meetings.

5.2.3.2 When contextual factors didn't work well in GM ERAS+

Microsystem team culture

At site D, there was already a well-established ERAS programme. Introducing ERAS+ to this site was seen by some individuals on the site as superfluous and unnecessary. This cultural response was evident through site interactions, during steering group meeting and indeed through the qualitative interviews. The surgical and anaesthetic leadership for Site D who were very supportive of ERAS+ implementation was very challenged to resolve this and despite high level support from the hospital senior leadership team, there remained a culture of negativity towards the introduction of ERAS+ from some key professionals involved in the care of surgical patients at this site. From review of the qualitative analysis and the in-programme steering group meetings, site D was the only site that explicitly had this cultural issue with ERAS+ implementation. However, because of the difficulties experienced on this site, there was a review of how ERAS+ was introduced to sites to ensure ERAS+ was promoted as adjutant to existing ERAS site practices rather than a replacement. ERAS+ would focus on maintaining the core fidelity of surgery school and delivery of perioperative respiratory bundle alongside the existing ERAS surgical care package.

Organisational Data recruitment

The recruitment of data collectors was an important contextual factor for the implementation of GM ERAS+. It was very much understood that the funding and recruitment of data collectors for each site would be essential to ensuring data was collected to support implementation delivery as well as understanding its impact. The inability to recruit data collectors in a timely fashion meant that some sites were unable to commence data collection as planned which prevented a phased introduction of ERAS+. When data collectors left the programme as was the case for 3 of the sites during the timescale of implementation of GM ERAS+, there were subsequent unintentional gaps in data which meant that more granular data analysis wasn't possible for all sites for the duration of the programme. Only sites A and E had data collection in place for the duration of the programme and these were the sites that allowed the evaluation of PPC as explored in the quantitative results section. One of the main reasons cited for why data collection recruitment and retention for the programme was challenging was reported as the fixed duration of funding of the post (18-20 months) and the banding offered to the post (band 3). Healthcare colleagues undertaking new positions which are not substantive, particularly when they may already be in a role in healthcare can be challenging, particularly when the pay banding is perceived to be low. During implementation it was agreed with the Health Foundation that there could be an adjustment in banding using underutilised funds, to make this position easier to recruit to and all data collectors banding was moved and recognised as band 4. The value attached to the role through the data collected meant that 4 sites moved their data collectors to being fixed members

of staff during the implementation of the programme, encompassing organisational aspects of surgery school and making future recruitment more attractive.

5.3 The 'Implementability' of GM ERAS+

The Diffusion of Innovation model developed by Rogers and Burdge in 1962 [157], suggested six features of innovation that made the adoption of interventions more or less likely. These were, relative advantage, compatibility with existing system, complexity of the intervention, trialability, potential for reinvention and observed effects. This was further defined by Greenhalgh and colleagues to include risk from the intervention and they developed a feasibility tool using 'Greenhalgh measures' to understand the potential success of healthcare intervention implementation **151 [158]**.

Using Greenhalgh measures in Table 5.1, we can see that ERAS+ appears to score well with regards to feasibility of scaling as the GM ERAS+ programme.

Greenhalgh Measure	**Components of ERAS+ that support scaling**
Relative advantage	clear effectiveness with evidence base which has been published
Compatibility	compatible with intended perioperative healthcare and patient audience
Complexity	viewed in original implementation as simple to follow and a common-sense approach to improve pre-operative fitness, nutritional and well-being, improve patient and family education and so more likely to be adopted
Observability	benefits are likely to be realised quite quickly and should be easily visible
Reinvention	potential adopting sites can refine ERAS+ to suit their hospital needs
Risk from intervention	low risk to the NHS with ERAS+ intervention

Table 5.1 ERAS+ assessed for scalability using Greenhalgh measures

Damschroder developed the Consolidated Framework of Implementation Research (CFIR) which expanded the attributes to seven to support intervention implementation [159]**.** These were intervention source, evidence strength and quality, relative advantage, adaptability, trialability, complexity and design quality and packaging, referring to how the intervention is presented and healthcare usability. Klaci and colleagues have recently developed a conceptual framework to understand the 'implementability' of an intervention using the domains: acceptability, fidelity, feasibility, sustainability, and scalability [142]. This appears a useful tool to explore the 'implementability' of GM ERAS+.

5.3.1 Acceptability of ERAS+ implementation

Appropriateness and adoption

As observed in the quantitative results section, 1427 patients took part in the ERAS+ implementation across Greater Manchester between 2018 and 2019, and 85-93% (sites A, C, D, E, F) of cancer patients having major colorectal resections appear to have their data captured in the ERAS+ dataset. This suggest that the ERAS+ programme had a high engagement measure of acceptability and patient recruitment as well as data completeness. Perceptions of high acceptability, appropriateness and adoption align with reports from the qualitative interviews of healthcare professionals involved in the implementation of the programme and from patients receiving the programme. From a healthcare staff perspective, ERAS+ is viewed as simple to follow and a common-sense approach to prepare and recover for major surgery. The benefits of the intervention appeared clear to staff and they perceived its implementation as helpful to patient care. Reflection of patient and carers experience with ERAS+ is also very positive from the healthcare interviews and also from the patient satisfaction quantitative and qualitative feedback. Improving compliance with ERAS+ process measures, particularly surgery school attendance, nutritional commencement and early mobilisation with progressive implementation of the programme supports the acceptability of ERAS+. There were no steering group reports of patients experiencing side-effects or adverse events through participation in ERAS+. This is important particularly in regard to potential problems with early mobilisation such as patient collapse. Early steering group actions had been to advise sites that during the initial early mobilisation processes at Manchester Royal Infirmary, the original hospital development site, had been complicated by collapse episodes in patients with epidurals for pain relief. Epidurals commonly cause a lowering of blood pressure through blocking sympathetic outflow [160] and often require blood pressure

support medications such as noradrenaline to maintain an adequate blood pressure and allow mobilisation. Standard operating procedures developed at MRI to support early mobilisation had been shared through the steering group with participating sites to advise staff on how to safely undertake mobilisation. These instructions included advice on gradual mobilisation techniques, use of vasopressor blood pressure support medications where necessary and the avoidance of blood pressure control medication which may have precipitated low blood pressure after surgery. This all appears to support ERAS+ as being highly acceptable and a safe intervention.

Within surgery school, the explanation of major surgery as a major body stressor to patients, is reported as helpful by staff and allows patients to see surgery as something that they can prepare for as one might prepare for a major race such as a marathon. This promotes natural conversations before surgery about how to improve pre-operative fitness, nutrition and well-being as well as goal setting around smoking and alcohol cessation. It also allows a conversation about preparation for the in-hospital elements of recovery, and better understanding of the need for early mobilisation, early nutrition, incentive spirometer use. Using surgery school supports the recognition of surgery as a teachable moment when patients are actively listening to healthcare and supports the idea of patients as partners in their own recovery [103].

To explore the experience of patients undergoing colorectal surgery within an ERAS pathway, Gillis and colleagues undertook qualitative interviews with 27 patients who had undergone colorectal surgery [161]. They determined themes from these patient interviews which support the usefulness of a pre-operative surgical education event such as surgery school: develop opportunity to explain to patients the ERAS protocol you want them to follow, so that patients become knowledgeable about their own treatment and allow them to act as partners; extend ERAS guidelines to include the pre-surgery phase, so that patients can be prepared physically and emotionally; consider using experienced patients to act as peer support; by beginning the ERAS partnership early, patients have more time to prepare and are more likely to feel confident to leave hospital earlier and continue their recovery at home; one size does not fit all and local and patient adaptions will be useful. Supporting patients to be knowledgeable about their surgery and supporting them to appreciate the importance of their role in their own recovery is an important aspect of surgical care and helps mitigate potential patient barriers to surgical innovations such as ERAS+.

5.3.2 Fidelity of ERAS+ implementation

Fidelity from a QI perspective is generally taken to mean, was the intervention delivered as intended, with adherence to the protocol and did all the patients receive the same intervention [142]. It does however allow for local context variation where this is thought to be helpful. Similar process of implementation was utilized in all 7 sites and there was site agreement about what the components of GM ERAS+ should be. This consistency was maintained throughout the programme's implementation period, with the aim that every patient in ERAS+ should benefit from the processes involved. Monthly rotation of the ERAS+ steering group between the different participating sites supported direct access to the teams delivering ERAS at each site and provided reassurance and oversight of intervention fidelity. There was variation in the delivery mode of surgery school however, with one-to-one face-to-face, group face-to-face and virtual models all successfully used throughout the different sites. Indeed 3 of the sites used all three modalities to enable as many patients as possible to benefit from surgery school.

5.3.3 Feasibility of ERAS+ implementation

Feasibility is taken to mean the ease of delivery of an intervention [142]. The implementation of the ERAS+ perioperative surgical programme was feasible across multiple sites in Greater Manchester. Data is presented in this MD for 1477 major colorectal surgical patients who participated across the seven sites of the GM ERAS+ programme. ERAS+ was also introduced for lung cancer, upper GI and gynaecological cancer surgical patients alongside colorectal surgical patients across multiple sites during the same period however through issues with data retrieval they are not presented here.

Implementation of surgery school at new sites was readily easy to deliver, with 4 of the sites achieving excellent compliance with this process measure and overall attendance at Surgery school for all patients being 73% by the completion of the programme. For the perioperative respiratory bundle, only one site achieved high compliance for all elements. Implementing the regular use of oral mouthwash was particularly difficult and likely reflects widespread contextual cultural reluctance, hesitance in its role in the prevention of PPC and the fact that oral healthcare is generally done very poorly in hospitals [162]**.** The ERAS+ elements of oral nutrition, mobilisation and the use of oral incentive spirometers were achieved much more readily and in many more patients. From factorial analysis oral nutrition, mobilisation and attendance at surgery school were associated with LOS and reduction in PPCs.

Feasibility and fidelity align with the extent which ERAS+ was adapted to suit the local context versus the original model e.g. variation in the delivery of Surgery School. Overall, the penetration [163] or integration of GM ERAS+ practice into the hospital service setting seems very fair and reflects a good level of spread of the intervention.

5.3.4 Sustainability of ERAS+ implementation

All interviewees reported that ERAS+ was something they were planning to continue at their site. Examples of how they intended to sustain ERAS+ in the longer term included:

- Recruitment of ERAS+ Data Collector and ERAS+ Nurses on permanent contracts (with some having already secured funding for this and supported by GM ERAS+ steering group ERAS+ business case (**See Appendix 6).**

- Financing solutions to challenges they have experienced (e.g. procuring branded bags for patient belongings and incentive spirometers)

- Setting up Surgery School as an outpatient multidisciplinary appointment, in agreement with commissioners. This would provide income stream for the provision of surgery school and support investment for the site ERAS+ programme

- Data collection being amalgamated with other surgical data collection.

- Continuously updating Surgery School to ensure the latest information is provided.

One participant raised the risk of Trust's not being as enthusiastic about ERAS+ if the data did not show an improvement after almost two years. A similar view was shared by another participant who explained that they could justify their roles because they have achieved a reduction in length of stay.

5.5.5 Scalability of ERAS+ implementation

We have demonstrated with the GM ERAS+ implementation programme that a peri-operative pathway based on Surgery School and a postoperative respiratory care bundle is scalable and can improve patient outcomes. Two NHS hospitals, where data collection was consistently in place for the duration of the programme, were able to demonstrate a reduction in PPC of 40-50% alongside

a statistically significant reduction in hospital LOS, replicating the results of the original ERAS+ implementation (38).

Importantly, we are also able to demonstrate that ERAS+ implementation was associated with a 1-year survival advantage at 1 year follow-up. The pathway was associated with high levels of patient satisfaction and no increase in 30-day readmissions. The population captured in these 2 hospitals is reflective of patients having major cancer resection nationally [141] and the implementation of ERAS+ provides an opportunity alongside other initiatives such as prehabilitation [164] to improve care for patients undergoing major surgery and to help improve outcomes as we look to clear the Covid surgical backlog [165].

CHAPTER SIX

Discussion

6.1 Primary hypothesis:

Is ERAS+ surgical pathway implementable across multiple sites in Greater Manchester?

ERAS+ is a lean perioperative surgical pathway that encompasses patient preparation and recovery stages encapsulating an in-hospital stepped recovery programme. It focuses on achieving a 'functional recovery' with a patient able to mobilise and eat within 24 hours of major surgery, alongside achieving good oral healthcare and the use of incentive spirometry to reduce post-operative respiratory complications.

The successful implementation of ERAS+ across seven hospitals in the GM healthcare system as the GM ERAS+ programme has demonstrated that ERAS+ can be introduced across a system with differing hospital contexts generating similar benefits to those observed in the original single site implementation.

The implementation of GM ERAS+ generated benefits to patients, hospitals and the wider healthcare system. The patient satisfaction levels achieved during implementation were excellent and support the belief that ERAS+ is considered by patients as a beneficial partnership with clinicians. Placing patients as partners in their care aligns with the NHS long term plan and global perioperative initiatives across the world [57, 58]. Recent evidence confirms persistent on-going functional disadvantage in older patients following major colorectal cancer resection [166]**.** When faced with major surgery, older, more frail people, are less likely to place as much importance on length of survival but instead on quality of life (QOL) and functional independence [167]. The ERAS+ pathway by supporting patient preparation and particularly prehabilitation alongside minimising complications associated with surgery aims to facilitate this return to functional QOL.

Surgery School supports a patient-centred approach involving both patients and family members by offering a framework of target setting for short-term, as well as long-term goals in relation to their surgery. It is well recognised that patients' network commonly suffers from anxiety morbidity with concerns about their loved one's surgery and opportunity for long-time survival in the case of cancer resection surgery [168]. Families that are able to act openly and solve problems for their relatives will be less anxious and have lower levels of depression [169]. In the ERAS+ programme, families and patient's friends are actively encouraged to participate in the ERAS+ programme and given a role to support patients in their efforts to improve their fitness, nutritional and well-being status.

At a hospital level during baseline implementation, some of the participating sites had what were reflective of what has happened across the UK to ERAS programmes, following their original

introduction in 2011 [46]. With the implementation of ERAS+ there was the opportunity to update enhanced recovery surgical practice across the 7 hospital sites in the project and bring all practice up to a higher standard in a collaborative setting. This was particularly the case with the Health Foundation supported data collector role which offered each site an explicit resource to produce its own data and support local surgical pathway improvement. The data collectors were noted to undertake a more project administrator role as the project advanced and supported the creation or rejuvenation of the ERAS/ERAS+ multi-disciplinary team with medical, nursing, pharmacy, allied health professional and managerial participation. All sites reported the need to sustain the role of ERAS+ administrator to support data collection as well as undertaking the organisational aspects of surgery school.

The important evolution of peri-operative medicine as a multidisciplinary team endeavour is being increasingly recognised [170]. Allied health professionals, pharmacy and surgical pathway data provision are now seen as fundamental to providing quality care for surgical patients. Collaborative working and peer support were seen as extremely positive steps in GM ERAS+ to improving care and there are many examples of where this is proving useful in improving surgical care using national benchmarking tools such as the UK PQIP [126] and GIRFT [69] programmes. There was considerable opportunity for collaborative working and through taking part in the 2-year project more than 250 NHS employees from the various participating sites benefited from learning in quality improvement techniques and rapid cycling evaluation from our quality improvement partner, with attendance at learning events.

The ERAS+ programme in Greater Manchester is the first UK example of system or regional ERAS implementation to be carried out across multiple hospitals as an implementation programme. Outside of the UK, the Alberta healthcare system in Canada is one of the only systems that has undertaken a similar approach to system ERAS implementation. Across a healthcare system of around 3 million patients, Alberta has undertaken a series of ERAS pathway implementations across 5 surgical specialties (colorectal, liver, gynaecologic oncology and radical cystectomy) across 9 hospital sites between 2014 and 2018 [171]. A review of this collective process was undertaken in 2021 with a review of 7757 patients that had participated in this series of implementations. In the total cohort there was an improved adherence to ERAS from 52% to 75% which was associated with a reduction in LOS from a mean of 9.4 to 7.8 days. Similar to GM ERAS+, the Alberta team focussed on clinical and operational leadership, and the development of intersite relationships through steering group meetings. From an economic perspective, the Alberta ERAS programmes,

had a return on investment as high as 7.3, meaning every dollar spent brought a $7.3 return allowing the authors to conclude that ERAS implementation was cost-saving in Alberta [172]. From the results presented here for GM ERAS+, although no formal health economic analysis was undertaken, the LOS reduction would be expected to produce a financial benefit for commissioners and the GM integrated health system.

It is important for future scaling to consider which elements of ERAS+ may be most beneficial for patients. Factorial analysis [137] allows 2 or more variables to be compared in their relationship to an outcome. Using this type of analysis, we identified that surgery school, early mobilisation and oral nutrition appear to be the components of ERAS+ that were most associated with reduction in LOS. The likely importance of these 3 measures in terms of LOS reduction, is seen in how Hospital A which was very complaint in these measures, but not so much in others (oral healthcare) and was still reporting a similar reduction in LOS to Hospital E which was very compliant in all. The role of surgery school in supporting behavioural change and life-style modification is now gathering momentum and is viewed by many hospitals as a vital step in re-engineered major surgical pathways [173]. The pre-operative environment provides a unique teaching opportunity when patients are switched on to their health and are listening. This supports acute behavioural change and hopefully longer-term lifestyle modification [103, 105]. Alongside the role of Surgery School, the GM ERAS+ programme was very successful in achieving DREAMing (drinking, eating and mobilisation) [50]. Indeed, for all sites that took part in the GM ERAS+ programme early mobilisation and oral nutrition were elements that could be achieved readily. Being able to get patients mobilised suggests that anaesthetic and surgical techniques that were employed as part of the programme were supportive of good functional recovery. Early mobilisation supports patient rehabilitation and reduces complications[174]. Early nutrition is supported alongside early mobilisation in improving patients' recovery following lower GI surgery [175]. Alongside the GM ERAS+ programme, Loftus has previously demonstrated that a focus on DREAMing in a streamlined ERAS pathway was successful in reducing complications and LOS [51].

It is interesting that Hospital A alongside some of the other hospitals in the GM ERAS+ programme reported difficulties with the embedding of oral healthcare measures of twice daily toothbrushing and use of mouthwash. Oral healthcare is generally not well done by NHS institutions and by healthcare workers it is often seen as a low priority [176]. Oral healthcare as a health intervention is extremely low cost and has increasingly been seen as a public health priority for good long-term health [177]. Evidence is accumulating about its potential role in preventing ward-based hospital

acquired pneumonia through the use of ward based oral healthcare staff training in the Mouth Care Matters programme [178] and other surgical specific cohorts [179]. With this in mind we would still aim to support its role in Surgery School patient education and hospital healthcare professionals utilising ERAS+ programme.

ERAS+ includes incentive spirometer (IS) as part of its pathway in an effort to reduce the incidence of atelectasis after major surgery. This follows on from the original ICOUGH bundle which demonstrated the use of IS as part of the respiratory bundle helped reduce the incidence of PPCs. Despite the widespread use of IS in post-surgical practice, particularly in the USA, there is a lack of evidence for its use, and it may be viewed as costly [180]. Many of the previous trials however tended to present patients with IS only after surgery rather than training patients in their use beforehand, as we do with Surgery School. Physiotherapy directed IS training alongside explanation and training in breathing techniques to be used in the post-op period is we consider a fundamental step in supporting patients [181]. In the ERAS+ programme, IS are given out during surgery school and appear to act as a useful adjunct for patient engagement. In the post-operative period IS are prescribed and this supported utilisation in the ERAS+ implementation as well as MDT training in supporting patient compliance alongside early mobilisation. They also act as a bedside reminder for patients to undertake breathing exercises in the post-operative period. Using IS in a more regulated way is also supported by a recent RCT study in patients undergoing cardiac surgery where patients were randomised to reminded with regular hourly prompts to undertake IS exercises, with a consequent reduction in respiratory complications [182].

6.2 Secondary hypothesis

What are the barriers and facilitators to the implementation of ERAS+?

The most recent guidelines for perioperative care in elective colorectal surgery from the ERAS society has 24 items that form part of pathway compliance [183]**.** Although it is recognised that not all items need to be achieved for successful ERAS delivery, the pathway remains onerous. ERAS+ is a lean perioperative surgical pathway that encompasses patient preparation surgery with a pre-op surgery school to help educate the patient about expectations of surgery and encourage their role as partner in their own care. This simplification of standard ERAS peri-op pathway considered to be good existing functional enhanced recovery programmes, others however had suffered from chronic under resourcing and were limited in their scope and effectiveness, this is

facilitates ERAS+ implementation, with a focus on achieving a functional patient from an anaesthetic and surgical perspective and because of fewer elements, measurement of compliance is much more straightforward.

Surgery school is an excellent facilitator to good preparation and recovery for major surgery and was a significant success in the implementation of GM ERAS+. By aiming to make the patient a partner in their own recovery, the pathway becomes automatically more patient centred. Patients are actively being approached to more active in their own healthcare particularly in a chronic health setting [184]. Surgery is a unique motivator and viewed as a teachable moment in a person's life when they are actively listening to healthcare, which can support significant lifestyle modification [103]. By also educating patients about what is expected from them to support their own recovery, Surgery School aims to prevent patients being an unintentional barrier to the implementation of ERAS/ERAS+. It is important that patient experience from pathways such as ERAS+ is used to improve the experience for future patients. To support this more formally, previous patients can be approached to undertake expert user involvement and support co-development of new pathways as was the case with the GM ERAS+ development.

Cohen and Gooberman [185] in their review of staff experience with ERAS implementation in different surgical cohorts, highlighted five main staff facing themes which supported implementation of ERAS protocols; communication and collaboration, resistance to chance, role and significance of protocol based care, knowledge and expectations. The implementation and scalability of ERAS+ is consistent with addressing these themes and aimed to ensure effective multidisciplinary team collaboration and communication, education of staff involved in the delivery of ERAS+ with a particular focus on the rationale for why it was being implemented, recruitment of local dedicated clinical champions with time to support and direct implementation

The make-up of the site ERAS+ teams and their role in the microsystem context was fundamental to successful implementation. It is recognised that clinical anaesthesia and surgical champions support the introduction of new innovations in surgical ERAS pathways and are crucial to their success [186]. However, the majority of ERAS+ and other ERAS interventions are delivered outside of the theatre environment by nurses and allied health professionals, and they should be viewed as pathway 'champions' also. The significance of their role was recognised in GM ERAS+ and those sites that achieved the best results following ERAS+ had excellent AHP and nurse leadership, indeed in some cases these individuals increasingly became the 'leading champions' of ERAS+ as implementation progressed. A combination of multiple speciality clinical champions appears a strong element in supporting successful implementation at a microsystem level. From these site

teams, nurse and AHP peer to peer support to other sites, should be encouraged as was the case with GM ERAS+. This is one of the benefits of undertaking collaborative implementation taken across multiple sites.

Although ERAS+ implementation was successful across GM, not all sites had the same readiness or willingness for implementation of ERAS+. There were certainly cultural barriers to implementation at different sites where ERAS+ was seen as a 'threat' by some of the healthcare providers to what was already being delivered on the site. Organisational readiness is described by Weiner et al [187] as the 'extent to which organizational members are psychologically and behaviourally prepared to implement organizational change'. This is likely reflected at multiple levels in an organisation with individual, group and organisational aspects [188]. Implementation of ERAS+ at future sites could utilise pre-implementation readiness for change evaluation tools such as The Organizational Readiness for Implementing Change or ORIC, to understand what aspects or level of organizational readiness is necessary for an optimal implementation process [189]. The analysis of GM ERAS+ using the MUSIQ model [147] was a useful means of examining the contextual elements of GM ERAS+, focussing on the micro and macrosystem, external environment facilitators and barriers. Alongside the use of an Organizational readiness tool, a checklist of GM ERAS+ contextual factors based on the MUSIQ model would be useful aid in supporting future implementation of ERAS+.

For successful large-scale implementation of a healthcare innovation such as ERAS+, explicit data collection resource was essential to provide reliable data to measure both its implementation success at site level and to evaluate its usefulness and healthcare value at a system level. This was made possible for GM ERAS+ because of funding secured from the Health Foundation. On-going funding of data collectors at 5 of the 7 sites was achieved largely because of the positive results of the project and the expanded role of the data collector to an ERAS+ administrator incorporating data collection, surgical school and other administrator management tasks. For future implementation of ERAS+ in other sites, exploration of other methods of data collection will likely be necessary as specific funds for data collectors may not be possible. As most hospitals now use electronic health records, the process measures within ERAS+, such as attendance at surgical school, mobilisation and nutrition within 24 hours of surgery, should prove useful time stamps to measure ERAS+ process compliance, which could then be combined with hospital LOS and readmission as outcome data. Improvement data collection tools such as Web improvement Support in Healthcare (WISH) using open-source coding have been developed to provide cost effective means of undertaking QI. They provide QI evaluation and analysis by incorporating

Statistical Process Control charts for use with both community and hospital electronic data captured [190].

Details of the ERAS+ programme including implementation tools are freely available as downloadable resources @www.erasplus.co.uk [131]. Further learning from the implementation of ERAS+ in Greater Manchester is being developed, which will detail the facilitators and barriers to implementation. These will be shared through the eras+ website as well as through future publications.

Summary

We have successfully implemented the ERAS+ colorectal surgical pathway into seven other GM institutions as part of the GM ERAS+ programme. This system level implementation has delivered excellent patient outcomes and confirms that the pathway is transferable out of a single centre.

ERAS+ supports the triple aim of improving patient experience of care; improving population health by reducing complications and reducing the per capita cost of healthcare [27]. It offers NHS hospitals a low-cost bolt on for existing ERAS programmes. Quantitative and qualitative analysis of the findings of GM ERAS+ implementation identify facilitators and barriers for future implementation. The delivery of a fully engaged and functional patient in the immediate post-operative period who is able to mobilise and eat, appears a very reasonable and achievable target for colorectal surgical pathways.
and recovery stages encapsulating an in-hospital stepped recovery programme. It focuses on achieving a 'functional recovery' with a patient able to mobilise and eat within 24 hours of major

CHAPTER SEVEN

Limitations and Conclusions

7.1 Limitations

This MD has strength and limitations. One significant strength is the size of the GM ERAS+ colorectal surgical cohort (1427 patients) involved in the implementation of GM ERAS+ over an 18-month period. This surpasses the 1333 patients in the Alberta regional colorectal ERAS programme [191]. The second strength is the ability of the programme to scale across multiple teams and across multiple sites, within 1 health care system, with similar outcome improvements to the original single site implementation. The high number of cancer patients included in this study also support the suitability of the ERAS+ pathway in colorectal cancer patients alongside major benign colorectal surgeries. Although the data for ERAS+ in other surgical cohorts in GM was not available for this MD report, following the success of Alberta programme in similar cohorts, it is likely that we would have seen an advantage for lung, gynae and upper GI patients with the utilisation of ERAS+ in those cohorts in Greater Manchester.

Limitations of this project include the pre post design and the lack of randomised assignment mean that unmeasured variables could account for the association between the implementation and improved outcomes. To help overcome this it was planned to create a quasi-experimental cluster design, where sites would be grouped together into 2 cohorts. Unfortunately, with the operational delay in recruitment of data collectors this was not possible for the project. Control groups were developed for patients undergoing similar surgery at non-ERAS+ GM sites. Quality improvement projects such as GM ERAS+, particularly those with a care bundle approach will often carry a significant number of limitations and they may struggle to confer causation following successful implementation [192]. It is quite possible that other factors outside the implementation of ERAS+ were responsible for the improvement in PPC and LOS. This is complicated further by the issues experienced with data collection recruitment and retention during ERAS+ implementation which reduced the number of sites where PPC prevention could be analysed. However, where there was robust data collection, we have shown similar benefit in two separate institutions and there was no other significant alteration in anaesthetic or surgical practice during the implementation of ERAS+ that we are aware of. It is also reassuring that the introduction of ERAS+ into 2 new hospital sites was able to generate similar results to the original ERAS+ implementation. The benefits of ERAS+ implementation are supported by the absence of LOS improvement at the control sites during the implementation period.

The finding of an improved survival at 1 year is interesting and supports reports from other ERAS protocols in colorectal cancer surgery programmes which have demonstrated that high levels of ERAS compliance were associated with lower rates of complications and better 3-5 year survival

[193, 194]. However, when the Alberta team corrected for confounding factors in their system ERAS implementation, although LOS improvement and reducing in post-op complications remained, an apparent positive affect upon mortality was no longer seen [171]. Going forward we will have the opportunity to look at the impact of the ERAS+ on cancer patients 2 year survival in Greater Manchester using the NBOCA dataset.

To support national scaling of ERAS+, a cost-effectiveness analysis of the GM ERAS+ implementation within this MD, would have added to a clearer understanding of the health economic and social impact of the programme. I would aim to achieve this as a near future element of the GM ERAS+ programme, which will support its wider scaling and spread by the new generation of ICBs. However, for the purpose of this MD, based upon similar costing models to the original ERAS+ York evaluation in Appendix 1, there appears financial savings evidence to support its use.

7.2 Future research

In other ERAS models, it has been established that increasing the compliance within ERAS there is inverse dose-response association between ERAS adherence and clinical outcome improvements. There is however an ever-reducing return on effort and investment. Within the factorial design of this programme, it appears that surgery school, and the establishment of nutrition and mobilisation within the first 24 hours of surgery have the greatest impact. This supports the recent success of the promotion of DREAMING within the national PQIP programme with its focus on functional recovery as demonstrated by early eating and mobilising. These pathways are deliberately designed to be lean and with the minimum number of elements that improve outcomes. Thus, an iterative development of ERAS+ would look to study a Surgery School-Dreaming bundle in other non-colorectal surgical cohorts. This could be supported by using sequential, multiple assigned randomisation trail (SMART) technique [195] where adaptive sequence of implementation strategies can examine the various components influence upon outcomes and well as understanding how best to efficiently and effectively support implement strategies with sites that struggle with implementation.

The implementation of system wide prehabilitation and recovery programme Prehab4Cancer for colorectal patients within Greater Manchester began in late 2019 and is now substantially funded. Prehab4Cancer directly builds upon GM ERAS+ implementation outlined in this MD and future

work will include an evaluation of the first UK regional model that combines system level ERAS and prehabilitation.

7.3 Conclusions

- ERAS+ is a lean perioperative surgical pathway that encompasses patient preparation and recovery stages encapsulating an in-hospital stepped recovery programme. It focuses on achieving a 'functional recovery' with a patient able to mobilise and eat within 24 hours of major surgery, alongside achieving good oral healthcare and the use of incentive spirometry to reduce post-operative respiratory complications.

- The successful implementation of ERAS+ across seven hospitals in the GM healthcare system as the GM ERAS+ programme has demonstrated that ERAS+ can be introduced across a system with differing hospital contexts generating similar benefits to those observed in the original single site implementation.

- Patient friendly education about surgery through the Surgery School model within ERAS+, opens a significant opportunity for lifestyle interventions, explanation of surgical and anaesthesia processes prior to surgery alongside the introduction of prehabilitation to help optimise physical, nutritional and psychological well-being. Following its development in Manchester, Surgery School is now delivered across many NHS institutions. Flexibility in the delivery of 'surgery school' patient education during the course of GM ERAS+ implementation with both face-to-face as well as virtual delivery supported a Covid-19 ready solution to support patients' preparation for major surgery.

- Within the ICOUGH-Dreaming respiratory bundle utilised in GM ERAS+, it was possible to identify through factorial analysis that the initiation of early mobilisation and early nutrition within the first 24 hours after surgery, alongside surgery school attendance pre-op had the strongest link to a reduction in post-op complications and length of stay reduction. These elements should be prioritised in future ERAS pathways.

- Pathways such as ERAS+ which deliver surgical care particularly for patients with cancer should be patient centred. To support this more formally, previous patients and relatives of previous surgical patients should be approached to undertake expert user involvement

and support co-design and development of future pathways. It is important that patient experience from pathways such pathways is used to improve the experience for future patients.

- The make-up of the site ERAS+ teams and their role in the microsystem context was fundamental to successful implementation. It is recognised that clinical anaesthesia and surgical champions support the introduction of new innovations in surgical ERAS pathways and are crucial to their success. However, the majority of ERAS+ and other ERAS interventions are delivered outside of the theatre environment by nurses and allied health professionals. The significance of their role was recognised in GM ERAS+ and those sites that achieved the best results following ERAS+ had excellent AHP and nurse leadership, indeed in some cases increasingly becoming the 'leaders' of ERAS+ as implementation progressed. A combination of multiple speciality clinical champions appears a strong element in supporting successful implementation at a microsystem level.

- For successful large-scale implementation of a healthcare innovation such as ERAS+, data collection resource was fundamental to both measure its establishment and also to evaluate its usefulness and potential healthcare value. Future site ERAS+ implementation will be able to utilise the growing prevalence of hospital electronic health records to support data collection.

- Although ERAS+ implementation was successful across GM, not all sites had the same readiness or willingness for implementation and implementation of ERAS+. Future sites would benefit from a pre-implementation site assessment and other quality improvement tools such as MUSIC to help understand the interplay between the process intervention and the hospital context that ERAS+ is being planned to be delivered in.

- A toolkit of ERAS+ tools to support implementation and learning from GM ERAS+ including data analysis approaches has been gathered to support future implementation.

References

1. Beecher, H.K. and D.P. Todd, *A study of the deaths associated with anesthesia and surgery: based on a study of 599,548 anesthesias in ten institutions 1948-1952, inclusive.* Annals of surgery, 1954. **140**(1): p. 2.
2. Craft, T. and P. Upton, *History of Anaesthesia*, in *Key Topics In Anaesthesia*. 2021, Routledge. p. 129-130.
3. Johnstone, M., *The human cardiovascular response to fluothane anaesthesia.* British Journal of Anaesthesia, 1956. **28**(9): p. 392-410.
4. Lundy, J.S., *The usefulness of anaesthetic agents.* Canadian Medical Association Journal, 1935. **33**(5): p. 490.
5. Brain, A., *The development of the Laryngeal Mask--a brief history of the invention, early clinical studies and experimental work from which the Laryngeal Mask evolved.* European journal of anaesthesiology. Supplement, 1991. **4**: p. 5-17.
6. Van Zundert, A., *The green footprint of anaesthesia.* Anaesthesia, Critical Care & Pain Medicine, 2021. **40**(4): p. 100872-100872.
7. Buschmann, D., et al., *Propofol and sevoflurane differentially impact microRNAs in circulating extracellular vesicles during colorectal cancer resection: a pilot study.* Anesthesiology, 2020. **132**(1): p. 107-120.
8. Wu, Z.-F., et al., *Propofol-based total intravenous anesthesia is associated with better survival than desflurane anesthesia in colon cancer surgery.* Anesthesiology, 2018. **129**(5): p. 932-941.
9. Xu, Y., et al., *Effects of propofol on the development of cancer in humans.* Cell Proliferation, 2020. **53**(8): p. e12867.
10. Griffith, H.R., *The use of curare in an aesthesia and for other clinical purposes.* Canadian Medical Association Journal, 1944. **50**(2): p. 144.
11. Berg, H., et al., *Residual neuromuscular block is a risk factor for postoperative pulmonary complications A prospective, randomised, and blinded study of postoperative pulmonary complications after atracurium, vecuronium and pancuronium.* Acta Anaesthesiologica Scandinavica, 1997. **41**(9): p. 1095-1103.
12. Gray, T.C., *d-Tubocurarine chloride*. 1948, SAGE Publications.
13. Shafer, S., *From d-tubocurarine to sugammadex: the contributions of T. Cecil Gray to modern anaesthetic practice.* British journal of anaesthesia, 2011. **107**(1): p. 97-102.
14. Kumar, K., et al., *A review of opioid-sparing modalities in perioperative pain management: methods to decrease opioid use postoperatively.* Anesthesia & Analgesia, 2017. **125**(5): p. 1749-1760.
15. Bom, A., J.K. Clark, and R. Palin, *New approaches to reversal of neuromuscular block.* Current Opinion in Drug Discovery & Development, 2002. **5**(5): p. 793-800.
16. Kheterpal, S., et al., *Sugammadex versus Neostigmine for Reversal of Neuromuscular Blockade and Postoperative Pulmonary Complications (STRONGER) A Multicenter Matched Cohort Analysis.* Anesthesiology, 2020. **132**(6): p. 1371-1381.
17. Keogh, B., et al., *The legacy of Bristol: public disclosure of individual surgeons' results.* Bmj, 2004. **329**(7463): p. 450-454.
18. Aylin, P., et al., *Paediatric cardiac surgical mortality in England after Bristol: descriptive analysis of hospital episode statistics 1991-2002.* Bmj, 2004. **329**(7470): p. 825.
19. Sidloff, D., et al., *National Vascular Registry Report on surgical outcomes and implications for vascular centres.* Journal of British Surgery, 2014. **101**(6): p. 637-642.
20. Holt, P., et al., *Provider volume and long-term outcome after elective abdominal aortic aneurysm repair.* Journal of British Surgery, 2012. **99**(5): p. 666-672.
21. Werner, R.M. and D.A. Asch, *The unintended consequences of publicly reporting quality information.* Jama, 2005. **293**(10): p. 1239-1244.

22. Abbott, T., et al., *Frequency of surgical treatment and related hospital procedures in the UK: a national ecological study using hospital episode statistics.* BJA: British Journal of Anaesthesia, 2017. **119**(2): p. 249-257.
23. Li, G., et al. *Epidemiology of anesthesia-related mortality in the United States, 1999–2005*. in *The Journal of the American Society of Anesthesiologists*. 2009. The American Society of Anesthesiologists.
24. Hackett, N.J., et al., *ASA class is a reliable independent predictor of medical complications and mortality following surgery.* International journal of surgery, 2015. **18**: p. 184-190.
25. Spence, J., et al., *Association between complications and death within 30 days after noncardiac surgery.* Cmaj, 2019. **191**(30): p. E830-E837.
26. Devereaux, P. and D.I. Sessler, *Cardiac complications in patients undergoing major noncardiac surgery.* New England Journal of Medicine, 2015. **373**(23): p. 2258-2269.
27. Weiser, T.G., et al., *An estimation of the global volume of surgery: a modelling strategy based on available data.* The Lancet, 2008. **372**(9633): p. 139-144.
28. Meara, J.G., et al., *Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development.* The lancet, 2015. **386**(9993): p. 569-624.
29. Khuri, S.F., et al., *Determinants of long-term survival after major surgery and the adverse effect of postoperative complications.* Annals of surgery, 2005. **242**(3): p. 326.
30. Moonesinghe, S., et al., *Survival after postoperative morbidity: a longitudinal observational cohort study.* British journal of anaesthesia, 2014. **113**(6): p. 977-984.
31. Tjeertes, E.K., et al., *Perioperative complications are associated with adverse long-term prognosis and affect the cause of death after general surgery.* World journal of surgery, 2016. **40**: p. 2581-2590.
32. Hossain, M., et al., *Sarcopenia and adverse post-surgical outcomes in geriatric patients: a scoping review.* The Journal of Frailty & Aging, 2021. **10**: p. 63-69.
33. Toner, A. and M. Hamilton, *The long-term effects of postoperative complications.* Current opinion in critical care, 2013. **19**(4): p. 364-368.
34. Casserly, I. and E.J. Topol, *Convergence of atherosclerosis and Alzheimer's disease: inflammation, cholesterol, and misfolded proteins.* The Lancet, 2004. **363**(9415): p. 1139-1146.
35. Di Angelantonio, E., et al., *Association of cardiometabolic multimorbidity with mortality.* Jama, 2015. **314**(1): p. 52-60.
36. Papathanassoglou, E.D., J.A. Moynihan, and M.H. Ackerman, *Does programmed cell death (apoptosis) play a role in the development of multiple organ dysfunction in critically ill patients? A review and a theoretical framework.* Critical care medicine, 2000. **28**(2): p. 537-549.
37. Care, P., *The Higher Risk General Surgical Patient: Towards Improved Care for a Forgotten Group.* London: The Royal College of Surgeons of England/Department of Health, 2021.
38. Moore, J., et al., *Impact of a peri-operative quality improvement programme on postoperative pulmonary complications.* Anaesthesia, 2017. **72**(3): p. 317-327.
39. Bardram, L., et al., *Recovery after laparoscopic colonic surgery with epidural analgesia, and early oral nutrition and mobilisation.* The Lancet, 1995. **345**(8952): p. 763-764.
40. Foss, N. and H. Kehlet, *Challenges in optimising recovery after emergency laparotomy.* Anaesthesia, 2020. **75**: p. e83-e89.
41. Brindle, M., et al., *Recommendations from the ERAS® Society for standards for the development of enhanced recovery after surgery guidelines.* BJS open, 2020. **4**(1): p. 157-163.
42. Ljungqvist, O., M. Scott, and K.C. Fearon, *Enhanced recovery after surgery: a review.* JAMA surgery, 2017. **152**(3): p. 292-298.
43. Varadhan, K.K., et al., *The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized controlled trials.* Clinical nutrition, 2010. **29**(4): p. 434-440.

44. Lemer, C., et al., *Understanding healthcare processes: how marginal gains can improve quality and value for children and families.* Archives of Disease in Childhood-Education and Practice, 2016. **101**(1): p. 31-37.
45. Berian, J.R., et al., *Adherence to enhanced recovery protocols in NSQIP and association with colectomy outcomes.* Annals of surgery, 2019. **269**(3): p. 486-493.
46. Simpson, J., et al., *Enhanced recovery from surgery in the UK: an audit of the enhanced recovery partnership programme 2009–2012.* BJA: British Journal of Anaesthesia, 2015. **115**(4): p. 560-568.
47. Mythen, M.G., *Spread and adoption of enhanced recovery from elective surgery in the English National Health Service.* Canadian Journal of Anaesthesia, 2015. **62**(2): p. 105.
48. Clarkson, D.M., *The role of 'care bundles' in healthcare.* British Journal of Healthcare Management, 2013. **19**(2): p. 63-68.
49. Group, E.E.R.C., et al., *An international assessment of the adoption of enhanced recovery after surgery (ERAS®) principles across colorectal units in 2019–2020.* Colorectal Disease, 2021. **23**(11): p. 2980-2987.
50. Levy, N., P. Mills, and M. Mythen, *Is the pursuit of DREAMing (drinking, eating and mobilising) the ultimate goal of anaesthesia?* Anaesthesia, 2016. **71**(9): p. 1008-1012.
51. Loftus, T.J., et al., *A System-Wide Enhanced Recovery Program Focusing on Two Key Process Steps Reduces Complications and Readmissions in Patients Undergoing Bowel Surgery.* Journal for Healthcare Quality, 2014.
52. Canet, J., et al., *Prediction of postoperative pulmonary complications in a population-based surgical cohort.* The Journal of the American Society of Anesthesiologists, 2010. **113**(6): p. 1338-1350.
53. Mazo, V., et al., *Prospective external validation of a predictive score for postoperative pulmonary complications.* Anesthesiology, 2014. **121**(2): p. 219-231.
54. Cassidy, M.R., et al., *I COUGH: reducing postoperative pulmonary complications with a multidisciplinary patient care program.* JAMA surgery, 2013. **148**(8): p. 740-745.
55. Hedenstierna, G. and H.U. Rothen, *Respiratory function during anesthesia: effects on gas exchange.* Comprehensive Physiology, 2011. **2**(1): p. 69-96.
56. Grocott, M. and R. Pearse, *Perioperative medicine: the future of anaesthesia?* 2012, Oxford University Press. p. 723-726.
57. Grocott, M., et al., *Peri-operative care pathways: re-engineering care to achieve the 'triple aim'.* Anaesthesia, 2019. **74**: p. 90-99.
58. Berwick, D.M., T.W. Nolan, and J. Whittington, *The triple aim: care, health, and cost.* Health affairs, 2008. **27**(3): p. 759-769.
59. Sturgess, J., J. Clapp, and L. Fleisher, *Shared decision-making in peri-operative medicine: a narrative review.* Anaesthesia, 2019. **74**: p. 13-19.
60. Grant, S., et al., *Cardiopulmonary exercise testing and survival after elective abdominal aortic aneurysm repair.* British journal of anaesthesia, 2015. **114**(3): p. 430-436.
61. Junejo, M., et al., *Cardiopulmonary exercise testing for preoperative risk assessment before hepatic resection.* Journal of British Surgery, 2012. **99**(8): p. 1097-1104.
62. Shulman, M., et al., *Using the 6-minute walk test to predict disability-free survival after major surgery.* British journal of anaesthesia, 2019. **122**(1): p. 111-119.
63. Granger, C.L., et al., *Functional capacity, physical activity and muscle strength assessment of individuals with non-small cell lung cancer: a systematic review of instruments and their measurement properties.* BMC cancer, 2013. **13**: p. 1-19.
64. Gofus, J., et al., *The outcome of a preoperative one-minute sit-to-stand test is associated with ventilation time after cardiac surgery.* Scandinavian Cardiovascular Journal, 2021. **55**(3): p. 187-193.
65. Hall, D.E., et al., *Association of a frailty screening initiative with postoperative survival at 30, 180, and 365 days.* JAMA surgery, 2017. **152**(3): p. 233-240.

66. Clegg, A., et al., *Frailty in elderly people.* The lancet, 2013. **381**(9868): p. 752-762.
67. Fried, L.P., et al., *Frailty in older adults: evidence for a phenotype.* The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 2001. **56**(3): p. M146-M157.
68. Buigues, C., et al., *Frailty syndrome and pre-operative risk evaluation: a systematic review.* Archives of Gerontology and Geriatrics, 2015. **61**(3): p. 309-321.
69. Gray, W.K., et al., *Identifying unwarranted variation in clinical practice between healthcare providers in England: Analysis of administrative data over time for the Getting It Right First Time programme.* Journal of Evaluation in Clinical Practice, 2021. **27**(4): p. 743-750.
70. Fowler, A., et al., *Association of preoperative anaemia with postoperative morbidity and mortality: an observational cohort study in low-, middle-, and high-income countries.* British journal of anaesthesia, 2018. **121**(6): p. 1227-1235.
71. Munting, K. and A. Klein, *Optimisation of pre-operative anaemia in patients before elective major surgery–why, who, when and how?* Anaesthesia, 2019. **74**: p. 49-57.
72. Filiberto, A.C., et al., *Intraoperative hypotension and complications after vascular surgery: A scoping review.* Surgery, 2021. **170**(1): p. 311-317.
73. CPOC, *Enhanced Perioperative Care*. 2020.
74. Durrand, J., et al., *Prehabilitation.* Perioperative Medicine–Current Controversies, 2016: p. 15-47.
75. Thomas, G., et al., *Prehabilitation before major intra-abdominal cancer surgery: a systematic review of randomised controlled trials.* European journal of anaesthesiology, 2019. **36**(12): p. 933.
76. Van Rooijen, S., et al., *Systematic review of exercise training in colorectal cancer patients during treatment.* Scandinavian journal of medicine & science in sports, 2018. **28**(2): p. 360-370.
77. Weston, M., et al., *High-intensity interval training (HIT) for effective and time-efficient pre-surgical exercise interventions.* Perioperative Medicine, 2016. **5**: p. 1-9.
78. Rosero, I.D., et al., *Systematic review and meta-analysis of randomized, controlled trials on preoperative physical exercise interventions in patients with non-small-cell lung cancer.* Cancers, 2019. **11**(7): p. 944.
79. Waterland, J.L., et al., *Efficacy of prehabilitation including exercise on postoperative outcomes following abdominal cancer surgery: a systematic review and meta-analysis.* Frontiers in surgery, 2021: p. 55.
80. Stout, N.L., et al., *Prehabilitation: an emerging standard in exercise oncology.* Exercise oncology: prescribing physical activity before and after a cancer diagnosis, 2020: p. 111-143.
81. Schmitz, K.H., et al., *Exercise is medicine in oncology: engaging clinicians to help patients move through cancer.* CA: a cancer journal for clinicians, 2019. **69**(6): p. 468-484.
82. Pressoir, M., et al., *Prevalence, risk factors and clinical implications of malnutrition in French Comprehensive Cancer Centres.* British journal of cancer, 2010. **102**(6): p. 966-971.
83. Wie, G.-A., et al., *Prevalence and risk factors of malnutrition among cancer patients according to tumor location and stage in the National Cancer Center in Korea.* Nutrition, 2010. **26**(3): p. 263-268.
84. Boltong, A.G., J.M. Loeliger, and B.L. Steer, *Using a public hospital funding model to strengthen a case for improved nutritional care in a cancer setting.* Australian Health Review, 2013. **37**(3): p. 286-290.
85. Zhang, X., et al., *Prevalence and factors associated with malnutrition in older patients with cancer.* Journal of geriatric oncology, 2019. **10**(5): p. 763-769.
86. Gillis, C. and P. Wischmeyer, *Pre-operative nutrition and the elective surgical patient: why, how and what?* Anaesthesia, 2019. **74**: p. 27-35.
87. Gillis, C. and F. Carli, *Promoting perioperative metabolic and nutritional care.* Anesthesiology, 2015. **123**(6): p. 1455-1472.

88. Gillis, C., et al., *Effects of nutritional prehabilitation, with and without exercise, on outcomes of patients who undergo colorectal surgery: a systematic review and meta-analysis.* Gastroenterology, 2018. **155**(2): p. 391-410. e4.
89. MacMillan, R.C.o.A.a., *Prehabilitation report for people with cancer*. 2019.
90. Powell, R., et al., *Psychological preparation and postoperative outcomes for adults undergoing surgery under general anaesthesia.* Cochrane Database of Systematic Reviews, 2016(5).
91. Liska, T.M. and A.M. Kolen, *The role of physical activity in cancer survivors' quality of life.* Health and Quality of Life Outcomes, 2020. **18**(1): p. 1-8.
92. Kissane, D.W., et al., *Psychological morbidity in the families of patients with cancer.* Psycho-Oncology, 1994. **3**(1): p. 47-56.
93. Curtis, N., et al., *Time from colorectal cancer diagnosis to laparoscopic curative surgery—is there a safe window for prehabilitation?* International journal of colorectal disease, 2018. **33**: p. 979-983.
94. Moore, J., et al., *Implementing a system-wide cancer prehabilitation programme: the journey of greater Manchester's 'Prehab4cancer'.* European Journal of Surgical Oncology, 2021. **47**(3): p. 524-532.
95. Dumas, R.G. and R.C. Leonard, *The effect of nursing on the incidence of postoperative vomiting.* Nursing Research, 1963. **12**(1): p. 12-14.
96. Healy, K.M., *Does Preoperative Instruction*. 1968, LWW. p. 62-67.
97. Mezzanotte, E.J., *Group instruction in preparation for surgery.* AJN The American Journal of Nursing, 1970. **70**(1): p. 89-91.
98. Lonsdale, M. and G. Hutchison, *Patients' desire for information about anaesthesia Scottish and Canadian attitudes.* Anaesthesia, 1991. **46**(5): p. 410-412.
99. Williams, O., *Patient knowledge of operative care.* Journal of the Royal Society of Medicine, 1993. **86**(6): p. 328-331.
100. Dawson, S., *Principles of preoperative preparation.* Surgical Nursing: Advancing Practice. Edinburgh: Churchill Livingstone, 2000: p. 386-407.
101. Giraudet-Le Quintrec, J.-S., et al., *Positive effect of patient education for hip surgery: a randomized trial.* Clinical Orthopaedics and Related Research®, 2003. **414**: p. 112-120.
102. McGregor, A.H., et al., *Does preoperative hip rehabilitation advice improve recovery and patient satisfaction?* The Journal of arthroplasty, 2004. **19**(4): p. 464-468.
103. Shi, Y. and D.O. Warner, *Surgery as a teachable moment for smoking cessation.* The Journal of the American Society of Anesthesiologists, 2010. **112**(1): p. 102-107.
104. Hall, P.A., G.T. Fong, and G. Sansone, *Time perspective as a predictor of healthy behaviors and disease-mediating states.* Time Perspective Theory; Review, research and application: essays in honor of Philip G. Zimbardo, 2015: p. 339-352.
105. McDonald, S., et al., *Exploring patient attitudes to behaviour change before surgery to reduce peri-operative risk: preferences for short-vs. long-term behaviour change.* Anaesthesia, 2019. **74**(12): p. 1580-1588.
106. Coons, S.J., et al., *Recommendations on evidence needed to support measurement equivalence between electronic and paper-based patient-reported outcome (PRO) measures: ISPOR ePRO Good Research Practices Task Force report.* Value in Health, 2009. **12**(4): p. 419-429.
107. Cleeland, C.S., J.A. Sloan, and A.O. Group, *Assessing the symptoms of cancer using patient-reported outcomes (ASCPRO): searching for standards.* Journal of pain and symptom management, 2010. **39**(6): p. 1077-1085.
108. Berry, D.L., et al., *Electronic self-report assessment for cancer and self-care support: results of a multicenter randomized trial.* Journal of Clinical Oncology, 2014. **32**(3): p. 199.
109. Velikova, G., et al., *Measuring quality of life in routine oncology practice improves communication and patient well-being: a randomized controlled trial.* Journal of Clinical Oncology, 2004. **22**(4): p. 714-724.

110. Barry, M.J. and S. Edgman-Levitan, *Shared decision making—The pinnacle patient-centered care.* 2012.
111. Ross, J., et al., *Helping patients choose wisely*. 2018, British Medical Journal Publishing Group.
112. Joseph-Williams, N., et al., *Implementing shared decision making in the NHS: lessons from the MAGIC programme.* Bmj, 2017. **357**.
113. Stiggelbout, A.M., A.H. Pieterse, and J.C. De Haes, *Shared decision making: concepts, evidence, and practice.* Patient education and counseling, 2015. **98**(10): p. 1172-1179.
114. McNulty, M., et al., *Implementation research methodologies for achieving scientific equity and health equity.* Ethnicity & disease, 2019. **29**(Suppl 1): p. 83.
115. Betrán, A.P., et al., *Provision of medical supply kits to improve quality of antenatal care in Mozambique: a stepped-wedge cluster randomised trial.* The Lancet Global Health, 2018. **6**(1): p. e57-e65.
116. Kirchner, J.E., et al., *Outcomes of a partnered facilitation strategy to implement primary care–mental health.* Journal of general internal medicine, 2014. **29**: p. 904-912.
117. Taljaard, M., et al., *The use of segmented regression in analysing interrupted time series studies: an example in pre-hospital ambulance care.* Implementation Science, 2014. **9**(1): p. 1-4.
118. Foundation, H. *https://www.health.org.uk/improvement-projects/improving-surgical-care-for-patients-and-their-families-in-greater-manchester-%E2%80%93*. 2018 11/04/2023].
119. Power, M., et al., *Did a quality improvement collaborative make stroke care better? A cluster randomized trial.* Implementation science, 2014. **9**: p. 1-9.
120. Ogrinc, G., et al., *SQUIRE 2.0 (S tandards for QU ality I mprovement R eporting E xcellence): Revised publication guidelines from a detailed consensus process.* The Journal of Continuing Education in Nursing, 2015. **46**(11): p. 501-507.
121. Qin, P.-p., et al., *Perioperative breathing training to prevent postoperative pulmonary complications in patients undergoing laparoscopic colorectal surgery: A randomized controlled trial.* Clinical Rehabilitation, 2021. **35**(5): p. 692-702.
122. Kursumovic, E., et al., *The impact of COVID-19 on anaesthesia and critical care services in the UK: a serial service evaluation.* Anaesthesia, 2021. **76**(9): p. 1167-1175.
123. Kirby, J. and R.G. Duffett, *COVID-19 pandemic… what about the obesity and inactivity "pandemics"?* South African Journal of Clinical Nutrition, 2020. **33**(2): p. 27-30.
124. Kehlet, H., *Enhanced postoperative recovery: good from afar, but far from good?* Anaesthesia, 2020. **75**: p. e54-e61.
125. Fawcett, W.J., M.G. Mythen, and M.J. Scott, *Enhanced recovery: joining the dots.* British Journal of Anaesthesia, 2021. **126**(4): p. 751-755.
126. Walshe, K., et al., *Devolving health and social care: learning from Greater Manchester.* Devolving Health and Social Care: Learning from Greater Manchester, 2018.
127. Unit, T. *https://transformationunit.nhs.uk/*. 2023 11/04/2023].
128. Haelo. *https://www.england.nhs.uk/signuptosafety/wp-content/uplads/sites/16/2015/11/haelo-measurement-webinars.pdf*. 2016 2016 11/04/2023].
129. Varkey, P., M.K. Reller, and R.K. Resar. *Basics of quality improvement in health care*. in *Mayo clinic proceedings*. 2007. Elsevier.
130. Aqua. *https://aqua.nhs.uk/*. 2023 11/04/2023].
131. Rubis. *https://nhsrubisqi.co.uk/*. 2023 11/04/2023].
132. PQIP. *https://pqip.org.uk/content/home*. 2023 11/04/2023].
133. Manchester, H.I. *https://healthinnovationmanchester.com/*. 2023 11/04/2023].
134. Craig, P. and M. Petticrew, *Developing and evaluating complex interventions: reflections on the 2008 MRC guidance.* International journal of nursing studies, 2013. **50**(5): p. 585-587.
135. Parry, G.J., et al., *Recommendations for evaluation of health care improvement initiatives.* Academic pediatrics, 2013. **13**(6): p. S23-S30.

136. Eras+. https://www.erasplus.co.uk/. 2023 11/04/2023].
137. Eras+. https://apps.apple.com/gb/app/eras/id1415699098?ls=1. 2023 11/04/2023].
138. Nemoto, T. and D. Beglar. *Likert-scale questionnaires*. in *JALT 2013 conference proceedings*. 2014.
139. Provost, L.P. and S.K. Murray, *The health care data guide: learning from data for improvement*. 2022: John Wiley & Sons.
140. Herbert, A., et al., *Data resource profile: hospital episode statistics admitted patient care (HES APC).* International journal of epidemiology, 2017. **46**(4): p. 1093-1093i.
141. NBOCA. https://www.nboca.org.uk/. 2023 11/04/2023].
142. Baker, T.B., et al., *Implementing clinical research using factorial designs: a primer.* Behavior therapy, 2017. **48**(4): p. 567-580.
143. Pellegrini, C.A., et al., *Optimization of remotely delivered intensive lifestyle treatment for obesity using the Multiphase Optimization Strategy: Opt-IN study protocol.* Contemporary clinical trials, 2014. **38**(2): p. 251-259.
144. Ritchie, J., et al., *Qualitative research practice: A guide for social science students and researchers*. 2013: sage.
145. Øvretveit, J., L. Garofalo, and B. Mittman, *Scaling up improvements more quickly and effectively.* International Journal for Quality in Health Care, 2017. **29**(8): p. 1014-1019.
146. Murray, E., et al., *Normalisation process theory: a framework for developing, evaluating and implementing complex interventions.* BMC medicine, 2010. **8**: p. 1-11.
147. Baker, F., *Quality assurance and program evaluation.* Evaluation & the health professions, 1983. **6**(2): p. 149-160.
148. Donabedian, A., *An introduction to quality assurance in health care*. 2002: Oxford University Press.
149. Klaic, M., et al., *Implementability of healthcare interventions: an overview of reviews and development of a conceptual framework.* Implementation Science, 2022. **17**(1): p. 10.
150. Shander, A., et al., *Clinical and economic burden of postoperative pulmonary complications: patient safety summit on definition, risk-reducing interventions, and preventive strategies.* Critical care medicine, 2011. **39**(9): p. 2163-2172.
151. Morris, C., et al., *Informing the NHS Outcomes Framework: evaluating meaningful health outcomes for children with neurodisability using multiple methods including systematic review, qualitative research, Delphi survey and consensus meeting.* 2014.
152. Kitson, A., G. Harvey, and B. McCormack, *Enabling the implementation of evidence based practice: a conceptual framework.* BMJ Quality & Safety, 1998. **7**(3): p. 149-158.
153. Aarons, G.A., M. Hurlburt, and S.M. Horwitz, *Advancing a conceptual model of evidence-based practice implementation in public service sectors.* Administration and policy in mental health and mental health services research, 2011. **38**: p. 4-23.
154. Kaplan, H.C., et al., *The Model for Understanding Success in Quality (MUSIQ): building a theory of context in healthcare quality improvement.* BMJ quality & safety, 2012. **21**(1): p. 13-20.
155. Bougeard, A.-M. and J. Moore, *Delivering perioperative care in integrated care systems.* Clinical Medicine, 2019. **19**(6): p. 450.
156. Wall, J., S. Ray, and T.W. Briggs, *Delivery of elective care in the future.* Future healthcare journal, 2022. **9**(2): p. 144.
157. Rogers, E.M. and R.J. Burdge, *Community norms, opinion leadership and innovativeness among truck growers.* 1962.
158. Greenhalgh, J. and K. Meadows, *The effectiveness of the use of patient-based measures of health in routine practice in improving the process and outcomes of patient care: a literature review.* Journal of evaluation in clinical practice, 1999. **5**(4): p. 401-416.
159. Damschroder, L.J., C.M. Reardon, and J.C. Lowery, *The consolidated framework for implementation research (CFIR)*, in *Handbook on implementation science*. 2020, Edward Elgar Publishing. p. 88-113.

160. Ottesen, S., *The influence of thoracic epidural analgesia on the circulation at rest and during physical exercise in man.* Acta Anaesthesiologica Scandinavica, 1978. **22**(5): p. 537-547.
161. Gillis, C., et al., *Patients' perspectives of prehabilitation as an extension of Enhanced Recovery After Surgery protocols.* Canadian Journal of Surgery, 2021. **64**(6): p. E578.
162. Bonetti, D., et al., *Improving oral hygiene for patients.* Nursing Standard (2014+), 2015. **29**(19): p. 44.
163. Proctor, E., et al., *Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda.* Administration and policy in mental health and mental health services research, 2011. **38**: p. 65-76.
164. Bates, A., M. West, and S. Jack, *Framework for prehabilitation services.* Journal of British Surgery, 2020. **107**(2): p. e11-e14.
165. Mythen, M.G., *COVID-19 and the challenges of the surgery backlog: the greatest healthcare innovation would be to do what we know.* British Journal of Anaesthesia, 2021. **127**(2): p. 192-195.
166. Montroni, I., et al., *Outcomes that matter to patients: The Geriatric Oncology Surgical Assessment and Functional rEcovery after Surgery (GOSAFE) study—Analysis of 471 patients*. 2019, American Society of Clinical Oncology.
167. Bachini, M., et al., *The patient perspective to cancer care: Aligning physician expectations with patients' wishes.* HPB, 2019. **21**: p. S2.
168. Johnson, E.M. and D.B. Ross, *The Cost of Cancer: The Association of Financial and Cancer-Related Stress on Maladaptive Coping Styles in Families with a Cancer Diagnosis.* Contemporary Family Therapy, 2021.
169. Edwards, B. and V. Clarke, *The psychological impact of a cancer diagnosis on families: the influence of family functioning and patients' illness characteristics on depression and anxiety.* Psycho-Oncology: Journal of the Psychological, Social and Behavioral Dimensions of Cancer, 2004. **13**(8): p. 562-576.
170. de Boer, H.D., W.J. Fawcett, and M.J. Scott, *Enhanced recovery after surgery: The road to improve peri-operative care globally*. 2021, LWW. p. 905-907.
171. Nelson, G., et al., *Evaluation of the implementation of multiple enhanced recovery after surgery pathways across a provincial health care system in Alberta, Canada.* JAMA Network Open, 2021. **4**(8): p. e2119769-e2119769.
172. Thanh, N.X., et al., *Return on investment of the Enhanced Recovery After Surgery (ERAS) multiguideline, multisite implementation in Alberta, Canada.* Canadian Journal of Surgery, 2020. **63**(6): p. E542.
173. Fecher-Jones, I., et al., *Surgery school—who, what, when, and how: results of a national survey of multidisciplinary teams delivering group preoperative education.* Perioperative Medicine, 2021. **10**(1): p. 20.
174. Fukawa, Y., et al., *Clinical Impact of the introduction of an early rehabilitation protocol on infectious complications in patients after gastrointestinal cancer surgery.* Progress in Rehabilitation Medicine, 2019. **4**: p. 20190005.
175. Levett-Jones, T., *Early enteral nutrition within 24 hours of lower gastrointestinal surgery versus later commencement for length of hospital stay and postoperative complications.* Clinical Nurse Specialist, 2019. **33**(5): p. 212-213.
176. Salamone, K., et al., *Oral care of hospitalised older patients in the acute medical setting.* Nursing research and practice, 2013. **2013**.
177. Babyar, J., *Inclusive oral healthcare for a better future together.* Journal of Medical Systems, 2020. **44**(4): p. 89.
178. Garvey, M.I., et al., *Mouth care matters–A HAP prevention strategy.* Journal of Infection, 2021. **83**(3): p. 381-412.

179. Soutome, S., et al., *Prevention of postoperative pneumonia by perioperative oral care in patients with esophageal cancer undergoing surgery: a multicenter retrospective study of 775 patients.* Supportive Care in Cancer, 2020. **28**: p. 4155-4162.
180. Eltorai, A.E.M., et al., *Financial Impact of Incentive Spirometry.* Inquiry, 2018. **55**: p. 46958018794993.
181. Boden, I., et al., *Effects of preoperative physiotherapy on signs and symptoms of pulmonary collapse and infection after major abdominal surgery: secondary analysis of the LIPPSMAck-POP multicentre randomised controlled trial.* Perioperative Medicine, 2021. **10**: p. 1-11.
182. Eltorai, A.E., et al., *Effect of an incentive spirometer patient reminder after coronary artery bypass grafting: a randomized clinical trial.* JAMA surgery, 2019. **154**(7): p. 579-588.
183. Gustafsson, U., et al., *Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations: 2018.* World journal of surgery, 2019. **43**: p. 659-695.
184. Pomey, M.-P., et al., *Patients as partners: a qualitative study of patients' engagement in their health care.* PloS one, 2015. **10**(4): p. e0122499.
185. Cohen, R. and R. Gooberman-Hill, *Staff experiences of enhanced recovery after surgery: systematic review of qualitative studies.* BMJ open, 2019. **9**(2): p. e022259.
186. Gotlib Conn, L., et al., *Successful implementation of an enhanced recovery after surgery programme for elective colorectal surgery: a process evaluation of champions' experiences.* Implementation Science, 2015. **10**(1): p. 1-11.
187. Weiner, B.J., H. Amick, and S.-Y.D. Lee, *Conceptualization and measurement of organizational readiness for change: a review of the literature in health services research and other fields.* Medical care research and review, 2008. **65**(4): p. 379-436.
188. Rafferty, A.E., N.L. Jimmieson, and A.A. Armenakis, *Change readiness: A multilevel review.* Journal of management, 2013. **39**(1): p. 110-135.
189. Shea, C.M., et al., *Organizational readiness for implementing change: a psychometric assessment of a new measure.* Implementation science, 2014. **9**(1): p. 1-15.
190. Curcin, V., et al., *Model-driven approach to data collection and reporting for quality improvement.* Journal of biomedical informatics, 2014. **52**: p. 151-162.
191. Nelson, G., et al., *Implementation of Enhanced Recovery After Surgery (ERAS) across a provincial healthcare system: the ERAS Alberta colorectal surgery experience.* World journal of surgery, 2016. **40**: p. 1092-1103.
192. Murray, D., *What should we do when traditional research fails?* Anaesthesia, 2017. **72**(9): p. 1059-1063.
193. Gustafsson, U.O., et al., *Adherence to the ERAS protocol is associated with 5-year survival after colorectal cancer surgery: a retrospective cohort study.* World journal of surgery, 2016. **40**: p. 1741-1747.
194. Pisarska, M., et al., *Compliance with the ERAS protocol and 3-year survival after laparoscopic surgery for non-metastatic colorectal cancer.* World journal of surgery, 2019. **43**: p. 2552-2560.
195. Almirall, D., et al., *Designing a pilot sequential multiple assignment randomized trial for developing an adaptive treatment strategy.* Statistics in medicine, 2012. **31**(17): p. 1887-1902.

Appendix 1. York Health Economic Evaluation of Original ERAS+ single site implementation

YHEC
York Health Economics Consortium

NHS Innovation Accelerator

Economic Impact Evaluation Case Study: *ERAS+*

Summary

ERAS+ is a pathway reducing post-operative pulmonary complication (PPC) risk by preparing patients for and recovery from major surgery. ERAS+ was developed and implemented in Greater Manchester from where a published trial has been used as the basis for this case study. The results show a net saving of £564 per person and £392,875 for the whole trial. This is on the basis of inputs including nursing and data collection support, purchase of incentive spirometers and surgery school sessions for patients.

1. BACKGROUND

Postoperative pulmonary complications (PPCs) are associated with adverse outcomes that include death, longer hospital stay and reduced long-term survival. [1] An audit conducted in 2013 identified a PPC rate of 16/83 (19.3%) in patients undergoing elective major surgery who were admitted to critical care postoperatively. [2]

A perioperative care pathway called Enhanced Recovery After Surgery (ERAS) was developed to reduce postoperative complications and facilitate rapid discharge. It is based on the participation of patients in a planned programme of recovery in hospital. It has been used with patients having major surgery and its implementation has had success in the UK. However it does not specifically address PPC. As a result of this, ERAS+ has recently been developed, building on the original ERAS and incorporating elements of an American programme called ICOUGH (Incentive spirometry, Cough/deep breath, Oral care, Understanding patient education, Get out of bed, Head of bed elevation), which has shown some success in reducing the incidence of PPC. [3]

[1] Moore JA, Conway DH, Thomas N, Cummings D & Atkinson D. (2017) Impact of a peri-operative quality improvement programme on postoperative pulmonary complications. Anaesthesia, 72, 317–327.
[2] Ibid.
[3] Cassidy MR, Rosenkranz P, McCabe K, et al. (2013) I COUGH: reducing postoperative pulmonary complications with a multidisciplinary patient care program. Journal of the American Medical Association Surgery, 148, 740–5.

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ERAS+ is targeted at patients requiring critical care admission after elective surgery, specifically major elective colorectal, gynaecology, head and neck, hepatobiliary, upper gastrointestinal, urology and vascular surgery.

ERAS+ works across four phases of the full operative process:

- Preparation at home.
- Postoperative critical care.
- Postoperative surgical ward.
- Recovery at home.

There are seven elements to the contents of the ERAS+ programme, which are applied across the four phases above:

- Nutrition – including healthy eating and post-operative supplements.
- Breathing – including breathing and coughing exercises and incentive spirometry.
- Activity – including increased usual physical activity and postoperative mobilisation.
- Oral health – including cleaning with toothbrush and chlorhexidine mouthwash.
- Psychological support – including links to Macmillan resources.
- General health – including smoking cessation and alcohol reduction.
- Family support – including family attendance at Surgery School.

ERAS+ was developed and progressively implemented in Greater Manchester. A full implementation of the programme was carried out from September 2014. The population included in this trial was elective surgical patients admitted to critical care who were at intermediate or high risk of developing PPC according to the prediction tool ARISCAT (Assess Respiratory risk in Surgical patients in CATalonia). [4] This case study is based on the information provided about that implementation.

The analysis was developed in spring/summer 2019 and was based on the information and evidence available at the time.

The limitations of the analysis are as follows:

- The study from which data are taken was a before and after rather than randomised trial.
- New techniques in anaesthesia or surgery, may have contributed to improved patient outcomes
- The values of costs, particularly of benefits, are approximate, based on an example condition, and may not reflect the true values of reduced length of stay.

[4] Canet J, Gallart L, Gomar C, et al. (2010) Prediction of postoperative pulmonary complications in a population-based surgical cohort. Anesthesiology; 113: 1338 –50.

2. INPUT COSTS

The main inputs for the ERAS+ programme are: nursing; data collection support; incentive spirometers (devices used to improve lung function by teaching patients to take slow, deep breaths); and 'surgery school' sessions. The nursing and data collection roles are both full time employed staff. The cost of incentive spirometers has been taken from the average prices paid by five trusts. [5] Patients and relatives were provided with training for ERAS+ at multidisciplinary-led 'surgery school' session, where they were given education on the ERAS+ programme and were trained to use an incentive spirometer.

The values for these inputs, as used in this analysis, are shown in Table 2.1

Table 2.1 Annual costs for the ERAS+ programme (2019/20 values)

Input	Description	Annual cost
Nursing support for the programme	One full time nurse at Band 6 [a]	£78,819
Data collection support	One full time Band 4 [b]	£50,084
Incentive spirometers	Average unit cost £4.13 for 696 patients [c]	£2,876
Surgery School sessions	£56.19 per attendance for 696 patients [c]	£39,106
Total annual cost		£170,885

Sources:

[a] PSSRU. Unit Costs of Health & Social Care. 2018. Hospital-based nurses. Band 6.

[b] PSSRU. Unit Costs of Health & Social Care. 2018. Hospital-based scientific and professional staff. Band 4.

[c] Estimated from data provided by NHS Transformation Unit

The cost of the surgery school sessions is based on 90 minutes of time for a surgical consultant and other multidisciplinary team member(s) which is taken here to mean a full time specialist Physiotherapist, Band 6. [6] The Band 6 nurse would be expected to be part of the surgery school, but his/her time is not included in the cost of this element as that would entail double-counting their time, given that their employment costs are already accounted for.

The cost of the incentive spirometers is based on the costs provided for five centres that each purchase their own devices. The cost is the average, excluding one that is an outlier. [7] All costs are given at 2019/20 values.

The number of patients is based on the numbers in a full implementation trial that took place from September to December 2014 (232 patients). [8] This is then multiplied up to give the number for a full year at full implementation (696 patients).

There may be administrative support for the surgical consultant leading the program, who will also and help to deliver the surgery school. This will depend on the size of the programme and has not been included in this analysis.

[5] Data provided by NHS Transformation Unit for this case study.

[6] Cost taken from: PSSRU. Unit Costs of Health & Social Care. 2018. Hospital-based health care staff.

[7] Data provided by NHS Transformation Unit for this case study.

[8] Moore JA, Conway DH, Thomas N, Cummings D & Atkinson D. (2017) Impact of a peri-operative quality improvement programme on postoperative pulmonary complications. Anaesthesia, 72, 317–327.

3. OUTCOMES & ECONOMIC ANALYSIS

ERAS+ has been shown to reduce the incidence of PPC from 18.7% to 8.7%, one year after implementation. [9] The same source reports an average reduction in length of stay (LOS) of three days following surgery, from a median of 12 to 9 days. It is assumed here that the average three day reduction in LOS is across all patients in the trial, and not just for those who had PPC.

The cost of a three day reduction in length of stay is estimated at £810, based on a cost of £270 per elective inpatient excess bed day, for a reference condition of 'complex large intestine procedures, 19 years and over, with CC score 6-8'. [10] Comparing the costs and economic benefits of ERAS+ give the results shown in Table 3.1.

Table 3.1 Annual costs and savings for the ERAS+ programme over one year at full implementation (2019/29 values)

	Per person	Whole programme (n=696)
Total cost. From Table 2.1	£246	£170,885
Total saving	£810	£563,760
Net saving	£564	£392,875

4. CONCLUSION

This case study indicates a net cost saving for the use of ERAS+ of £392,875 for one year with full implementation in a single trust. This is based on a four-month trial that took place in 2014. There are currently plans to implement the programme across Greater Manchester which would have an annual participation of around 5,000 patients a year. [11] If the same level of savings per patient were achieved, that would imply total net savings of around £3.6m for the region.

ERAS+ is also reported to produce benefits in quality of life, measured with EQ5D and in reducing disability, measured with the WHO Disability Assessment Schedule (WHODAS2.0). However, the data for these benefits were not available for this case study and it is challenging to ascribe economic values for them.

As previously mentioned, there are some limitations within the analysis, relating to the fact that the study from which data are taken was a before and after rather than randomised trial. This makes it more difficult to ascribe impacts to the intervention. Some new techniques in anaesthesia or surgery, may have contributed to the improved patient outcomes seen. [12] In addition, the values of costs, and particularly of benefits, are approximate. The latter are based on an example condition, and this may not reflect the true values of reduced length of stay for the patients in the trial from which data on impacts were taken. Any assumptions have been clearly stated.

[9] Moore JA, Conway DH, et al. Op cit.
[10] National Schedule of Reference Costs Year : 2017-18 - All NHS trusts and NHS foundation trusts - HRG Data
[11] Information provided by the NIA Fellow, from a Health Foundation application
[12] Moore JA, Conway DH, et al. Op cit.

Appendix 2. Summary of learning from the monthly ERAS+ steering group meetings

1) Display run charts for ICOUGH compliance, length of stay and PPC An initiative to create ward display areas and A1 sized laminated run chart displays of the ERAS+ data on each of the wards was trialled at several sites and a template sent out to all sites to use.

2) Development of a new patient satisfaction measure Upon discussing the lack of consistency across the sites around collecting patient satisfaction scores, the steering group decided in December 2018 that a standardised patient satisfaction question would be added to post-Surgery School questionnaires at all sites (see appendix 10).

3) Development of a pro forma for data outliers with an agreed LOS cut-off point After discussion around LOS data, Stepping Hill Hospital have been developing a clinical review proforma to support the review of data outliers. It was planned that this proforma would be shared across sites and hopefully adopted by all implementation teams to see where improvements can be made.

4) Core group of ERAS+ champions This initiative was agreed in December 2018 to boost awareness and engagement with the programme. Some sites have experienced difficulty getting 'buy-in' from clinical members of staff for whom ERAS+ is not included in their allocated clinical activity, as well as experiencing problems due to high turnover of staff. This is an ongoing issue discussed at the steering group meetings.

5) Data collector role and contract Following feedback from steering group attendees and the evaluation team the data collector JD was reviewed. Plans were put in place to rework the Job Description and Person Specification and put the role through the Agenda for Change with a view to upgrading it to a Band 4, Data Facilitator position. Template business case developed to assist Trusts in making this role part of business as usual. The Job Description was amended to include a clinical component as well as data collection responsibilities. Another site site reported that they have secured a permanent position for their ERAS+ data collector.

6) Qualitative data collection Some of the qualitative data collection for the evaluation has been informed by learning from the steering groups. The steering group discussions fed into the decision to send out questionnaires to the nurses and data collectors for the Interim Report. Suggestions for the interview schedule for the final evaluation were taken at steering group.

7) Abstracts and journals for publications

There have been three successful submissions of abstracts by ERAS+ team members to the 7th World ERAS Congress due to be held on the 1st-3rd May 2019. The ERAS+ Nurse at Stepping Hill Hospital submitted an abstract on the implementation of the ERAS+ Surgery School. The Consultant Anaesthetist at Salford Royal Hospital submitted an abstract on the implementation of ERAS+ and incidence of post-operative pulmonary complications. The Consultant Anaesthetist at Stepping Hill Hospital submitted an abstract on the initiation of physical activity prehabilitation and rehabilitation for major colorectal surgery.

8) Changes to the data collection tool In March 2019, after a 12 month process the Greater Manchester (GM) version of PQIP was updated to include an ERAS+ specific data set. Several of the ERAS+ data sets have also been taken up by PQIP for inclusion on the national PQIP dataset, such as the Rockwood Frailty Score. The collaboration with PQIP will allow for national comparison of ERAS+ data.

9) ERAS+ patient belongings pack One site has begun to develop an ERAS+ 'pack' for patients, which will contain an incentive spirometer, toothbrush and slippers. The site representative explained that the pack would travel with the patient to the surgical admissions ward and the high dependency unit. This site are getting quotes for ERAS+ branded gym bags and are in the process of filming a video for the ERAS+ website explaining how to use the pack. They are also working with their dental care associates to further publicise the importance of mouth care after surgery.

10) Oral Diet and Nutrition It was noted that there are different standards at each site around eating and weighing patients. An action was agreed to gather information on how this is managed and agree an ERAS+ consensus here. GIT was reported that differences in how nutirion is managed shows why other ICOUGH elements are so important at some sites.

11) Discussion about the relative importance of ICOUGH elements There was some discussion on the inclusion of mouth washing. It was emphasised in July that the total bundle is more than the sum of its parts and that we need to be cautious around the priorities of individual trusts (e.g. oral health teams). ICOUGH weightings were discussed at a milestone meeting in April 2019 (see Appendixc13).

12) Sustainability In September 2019 discussions included how to get sustained data collection within GM. A business case template was created to present to local hospitals. The importance of the need for a permanent data collector/facilitator was discussed, as well as convincing sites that PQIP is the way forward 80% of patients should be on PQIP. It was agreed that a letter should be

drafted to Medical Directors gain their support for ERAS+ becoming part of BAU and to ask what is needed from them to enable them to best support the project. This letter should include information on how surgery school can be set up as an MDT and a case study of a site that has seen improvement due to ERAS+. Executive support for ERAS+ can then be used as leverage in any specific business cases.

Appendix 3. Summary of learning from the ERAS+ milestone meetings

Meeting 1, September 2019

The first Milestone meeting centred on revisiting the ERAS+ goals and how the project was currently supporting them. The three key elements to the ERAS+ pathway – prehabilitation, in-hospital and post-hospital – were clarified. The key outcome measures and the expected reduction in the rate of PPCs and LOS within the colorectal surgical speciality were discussed.

Variation in the delivery of Surgery School at each of the participating sites and the implications of this were discussed, but and it was stressed that the same core educational content was being delivered across all formats. Some of the sites were implementing classroom-style group session Surgery Schools, while others were using online resources and one-to-one nurse-led pre-assessments.

The sites were advised to start collecting a baseline for comparison by exploring the historical data available on the chosen outcome measures. Issues that might affect data interpretation at each site, such as low patient numbers and the length of the period of data collection, were also discussed.

The pilot interview schedule for the qualitative data collection was approved, and it was suggested that ERAS+ nurses, consultants and data collectors should be included. The ERAS+ scale up logic model was also reviewed and the rationale for resourcing was discussed, e.g. it was suggested that there should be time given in job plans for the delivery of Surgery School. It was also decided that data collectors and site clinical leads should be invited to the next Milestone meeting.

Meeting 2, December 2019

The second meeting featured a review of the data at each site and collective view of each phase. Issues relating to data quality and difficulties accessing historical data were discussed. The problem of high staff turnover of data collector and nurses was raised, and the impact this was having on data collector and data quality.

One of the sites noted a dip in compliance with ERAS+ in the absence of their ERAS+ nurse. The nurse in question was solely delivering the ERAS+ education – these tasks were not spread across the other ERAS nurses. The other sites were invited to think critically about fluctuations in their data.

A number of site representatives stressed that the workload of ERAS+ was quite high and it was an outgoing struggle to embed the principles of ERAS+ into normal practice. A need for clearer job plans and increased SPA (Supporting Professional Activities) allocation for the clinical leads was identified. Plans for scaling up ERAS+ to other specialities within the participating trusts were discussed and barriers to these plans, e.g. lack of funding and resource, were also mentioned.

The evaluation team presented preliminary findings from the semi-structured interviews with core ERAS+ staff. The key themes were outlined and attendees fed back; discussions around the lack of resource and time, staff and patient awareness and culture shift were had. It was agreed that the evaluation team, would devise questionnaires and send them out to the ERAS+ nurses and data collectors to further explore the development of their roles.

Meeting 3, April 2019

At the third meeting the definitions of success for pre-hospital, in-hospital and post-hospital management were reviewed. It was noted that re-admission rate is a complex outcome measure with a number of influencing factors, and that there is a danger of over interpretation. It was agreed that this would be taken to the next Steering Group meeting to discuss and the decision to use re-admission rate as a balance measure would be signed off.

It was noted that following the development of the standardised patient satisfaction question, there was still a lack of data being submitted. The site representatives present noted that there was not yet a data dashboard for this measure. In addition to this barrier, some sites reported that they were unable to get this information from patients as ward staff were advising which patients were not well or not appropriate to speak to. It was agreed that the patient satisfaction score should be collected as close to discharge as possible.

The aggregate data was discussed and SPC charts were displayed. It was noted that there had been no significant change in length of stay so far. The sites were asked to provide historical LOS data going back 3 years to help determine change over time. A drop in Surgery School attendance around December was noted; this was attributed to the fewer Surgery School dates being scheduled over the Christmas period. It was noted that variability in PPC data was starting to reduce but that the lack of baseline data continued to be an issue across all sites.

It was reported that there wasn't yet a statistically significant increase in compliance with the ICOUGH bundle. Attendees felt that the compliance with teeth brushing was generally the measure that was most difficult to achieve. It was discussed that the two most important components in the bundle are mobilising and diet. Attendees discussed the option of having 4/5

compliance with diet and mobilising as the core compliance requirements. The mobilising measure was lower than expected, however it was noted that the interpretation of the mobilising recording method had only recently been identified and clarified.

The main concerns raised at this milestone meeting were around the quality and consistency of the data. For example, different Surgery School formats and different methods of mobilisation have been recorded inconsistently across sites, which has affected the accuracy of compliance data. It was suggested that the best way to mitigate the inconsistency in the data would be to re-validate the data in time for the annual ERAS+ data review meeting in July 2019. It was requested that an updated SOP (Standard Operating Policy) or checklist for the data collection was circulated to the data collectors to support this validation process.

Findings from the qualitative interviews with the nurses and data collectors were fed back to the group. Attendees agreed that nurses at some of the sites experienced a lack of support, and that help from senior staff was needed to define and direct the role. The data collector role was discussed, and it was felt that the data collector role was very broad and ill-defined. It was suggested that work is undertaken to look at adding in a more clinical aspect to the role and increasing it to a Band 4. Attendees also expressed concern that the end of the data collector contracts approaching and flagged as a priority issue for all trusts going forwards. The gaps in data collection, due to data collectors not being in post, and the lack of historical baseline for baseline comparisons have been major issues throughout implementation. It was noted that it has been difficult to standardise the approach to data collection. It was agreed that it might be easier for sites to submit raw data to Haelo to help achieve consistency.

Meeting 4, October 2019

A reduction in variation of the aggregate length of stay was reported at this meeting. However, there was only historic data for three sites and more data was needed to see a change in the process It was identified that more specific data is needed on when incidences of PPC happen to be able to review cases. It would be good to know specific dates of when incidences happened. We need to look at cases between but need guidance on when this is possible. The aggregate data showed that Surgery School attendance had increased and the mobilisation had decreased. Difficulties mobilising patients at The Christie were now improving since the new data collector role was filled, with patients being mobilised on the day of surgery. A vacancy in a key ERAS+ role was noted and the impact on data collection. Another site reported two elements of ICOUGH (teeth brushing and mouth washing) had become part of the HDU bundle.

Meeting 5, November 2019

A meeting took place at the end of November 2019 in lieu of a formal milestone meeting in December 2019. The primary focus of this meeting was to address data quality issues. The actions from this meeting are listed below:

- HES data to be provided for readmission (question on whether this is from day of surgery or day of discharge), mortality and length of stay. Lung codes to be shared with AQuA
    - Each site
    - Aggregate view of Wigan and Tameside as control sites
    - GIRFT peer groups
- Present PPC data at a quarterly/monthly level for reports
- Check PPC data at sites where there are consecutive 0% months
- AQuA to connect with Prehab4Cancer research application with University of Manchester
- Collection of data to end on 31st December 2019 followed by a 3 month period of data quality improvement, validation and cleansing.
    - Communicate this change to data collectors by phone then email.
    - AQuA to communicate at Steering Group on 5th December
    - Meeting to be organised with data collectors at the beginning of January to give guidance on January – March 2020 activity
- Letter to Medical Directors to include request for historic data, data collection finish date/plan and request for ERAS+ to be incorporated into business as usual

ERAS+ One Year Data Evaluation Meeting, July 2019

One 1 Year Data Evaluation meeting was held in July. This was well attended by team members from all sites. The meeting provided an opportunity to review the data collection to date and highlight areas for each of the sites to target going forwards (e.g. ICOUGH compliance, Surgery School referrals) and drive consistency in data collection. A PQIP Fellow also came to present at the meeting to discuss PQIP data collection and how this could be utilised in the future of ERAS+. It was later agreed that Data Collectors would try to get all ERAS+ patients also inputted on PQIP.

ERAS+ One Year Data Review Feedback – Thematic Analysis

The site teams were given eight prompt questions:

1. What is the data telling you?

2. Is this what you expected to see?

3. Do you see any change? If so, what caused it?

4. What can you learn from others for this measure?

5. What opportunities do you have to test and improve?

6. What opportunities do you have to share success?

7. Is anything missing?

8. Do you have any questions of the data?

Their responses aligned with the following themes and subthemes:

Best practice

- Guidance from exemplar sites

A number of teams expressed a need for guidance from sites that have successfully implemented ERAS+, e.g. MRI and sites that have had high compliance rates.

- Sharing successes

A number of teams were keen to share their learning and successful methods of implementation with other sites.

- Lack of communication platforms

One team felt that they hadn't had an opportunity to share their findings with other sites.

Consistency in data collection

- Data guidelines

Some teams felt that it was important to have clear guidelines for data collection in the interest of achieving consistency across the sites.

Consistency in implementation

- Oral hygiene

Concerns were raised around the consistency of the oral hygiene component of the intervention, specifically mouth wash.

- Definition of Surgery School

Some teams were looking for clarification around the definition of Surgery School, e.g. are 1:1 sessions compliant?

Surgery School

- Goals for improvement

One of the sites had a specific goal to improve the quality of Surgery School delivery and Surgery School attendance.

- Examining why some patients don't attend

One site was hoping to further examine why some patients weren't attending their Surgery School.

Data quality

- Variation

A number of sites were concerned about variation in the data. This was queried with regards to small sample size and questioned the reliability. While the data is varied, the reliability is entirely based on how it is entered.

- Small sample size

A number of sites were concerned about the small sample sizes. This creates wide variation in the data. Sites also wanted to see the sample size with respect to the data points (numerator).

- Different types of colorectal surgery

One site questioned the impact of different types of surgery on the interpretation of the data, e.g. some types of surgery have longer LOS than others.

- Patient-level data A number of sites expressed an interest in having access to patient-level data as well as weekly and monthly data

Appendix 4. Patient level quantitative data collected by the site data collectors for the GM ERAS+ programme

Pre-operative data

Patient demographics	
Age	
NHS Number	
DOB	
Significant PMSHx	
Pre-op HBG	
SaO2	
ASA	
Baseline daily exercise (mins) Type of activity	
Pre-op daily exercise (mins) Type of activity	
BMI	
Weight	
Smoking status	
Recent chest infection < 2 weeks	
Anaemia treatment pre-op	
Use of ERAS+ virtual resources Website or Application	

Operative data

Surgery type	
Cancer or benign	
Length of procedure	
Type of anaesthesia [GA/TIVA/Regional]	
Planned post-op location	

Post-operative data

PPC within 7 days	
Clavien-Dindo (I-V)	
Critical care length of stay	
Hospital length of stay	
Discharge destination	
Readmission within 30 days	
Mortality at 30 days	
Mortality at 90 days	
Mortality at 1 year	

ERAS+ Process measures

Surgery School attendance pre-op	
Within first 24 hours:	
Mobilisation	
Drinking	
Nutrition (oral diet)	
Using Incentive spirometer [number balls recorded]	
Mouthwash	
Brushed teeth	

Balancing measures

PPC	
LOS	
Readmissions	

Appendix 5. GM ERAS+ colorectal surgical codes

H04 Total excision of colon and rectum

H04.1 Panproctocolectomy and ileostomy Includes: Proctocolectomy not elsewhere classified

H04.2 Panproctocolectomy and anastomosis of ileum to anus and creation of pouch however further qualified

H04.3 Panproctocolectomy and anastomosis of ileum to anus not elsewhere classified

H04.8 Other specified Total excision of colon and rectum

H04.9 Unspecified Total excision of colon and rectum

H05 Total excision of colon H05 Total excision of colon (Clean-Contaminated)

H05.1 Total colectomy and anastomosis of ileum to rectum

H05.2 Total colectomy and ileostomy and creation of rectal fistula however further qualified

H05.3 Total colectomy and ileostomy not elsewhere classified

H05.8 Other specified Total excision of colon

H05.9 Unspecified Total excision of colon

H06 Extended excision of right hemicolon

H06.1 Extended right hemicolectomy and end to end anastomosis

H06.2 Extended right hemicolectomy and anastomosis of ileum to colon

H06.3 Extended right hemicolectomy and anastomosis not elsewhere classified

H06.4 Extended right hemicolectomy and ileostomy however further qualified

H06.8 Other specified Extended excision of right hemicolon

H06.9 Unspecified Extended excision of right hemicolon

H07 Other excision of right hemicolon

H07.1 Right hemicolectomy and end to end anastomosis of ileum to colon Includes: Ileocaecal resection

H07.2 Right hemicolectomy and side to side anastomosis of ileum to transverse colon

H07.3 Right hemicolectomy and anastomosis not elsewhere classified

H07.4 Right hemicolectomy and ileostomy however further qualified

H07.8 Other specified Other excision of right hemicolon

H07.9 Unspecified Other excision of right hemicolon

H08 Excision of transverse colon

H08.1 Transverse colectomy and end to end anastomosis

H08.2 Transverse colectomy and anastomosis of ileum to colon

H08.3 Transverse colectomy and anastomosis not elsewhere classified

H08.4 Transverse colectomy and ileostomy however further qualified

H08.5 Transverse colectomy and exteriorisation of bowel not elsewhere classified

H08.8 Other specified Excision of transverse colon H08.9 Unspecified Excision of transverse colon

H09 Excision of left hemicolon

H09.1 Left hemicolectomy and end to end anastomosis of colon to rectum

H09.2 Left hemicolectomy and end to end anastomosis of colon to colon

H09.3 Left hemicolectomy and anastomosis not elsewhere classified

H09.4 Left hemicolectomy and ileostomy however further qualified

H09.5 Left hemicolectomy and exteriorisation of bowel not elsewhere classified

H09.8 Other specified Excision of left hemicolon

H09.9 Unspecified Excision of left hemicolon

H10 Excision of sigmoid colon

H10.1 Sigmoid colectomy and end to end anastomosis of ileum to rectum

H10.2 Sigmoid colectomy and anastomosis of colon to rectum

H10.3 Sigmoid colectomy and anastomosis not elsewhere classified

H10.4 Sigmoid colectomy and ileostomy however further qualified

H10.5 Sigmoid colectomy and exteriorisation of bowel not elsewhere classified

H10.8 Other specified Excision of sigmoid colon

H10.9 Unspecified Excision of sigmoid colon

H11 Other excision of colon

H11.1 Colectomy and end to end anastomosis of colon to colon not elsewhere classified

H11.2 Colectomy and side to side anastomosis of ileum to colon not elsewhere classified

H11.3 Colectomy and anastomosis not elsewhere classified

H11.4 Colectomy and ileostomy not elsewhere classified

H11.5 Colectomy and exteriorisation of bowel not elsewhere classified*

H11.8 Other specified Other excision of colon

H11.9 Unspecified Includes: Colectomy or hemicolectomy not elsewhere classified

H12 Extirpation of lesion of colon Includes: Caecum

H12.1 Excision of diverticulum of colon (Dirty)

H12.2 Excision of lesion of colon to not elsewhere classified

H12.3 Destruction of lesion of colon not elsewhere classified

H12.8 Other specified Extirpation of lesion of colon

H12.9 Unspecified Extirpation of lesion of colon

H13 Bypass of colon Includes: Caecum Excludes: Bypass of colon when associated with excision of colon

H13.1 Bypass of colon by anastomosis of ileum to colon

H13.2 Bypass of colon by anastomosis of caecum to sigmoid colon

H13.3 Bypass of colon by anastomosis of transverse colon to sigmoid colon

H13.4 Bypass of colon by anastomosis of transverse colon to rectum

H13.5 Bypass of colon by anastomosis of colon to rectum not elsewhere classified

H13.8 Other specified Bypass of colon

H13.9 Unspecified Bypass of colon

H14.2 Refashioning of caecostomy

H14.3 Closure of caecostomy

H14.8 Other specified Exteriorisation of caecum

H14.9 Unspecified Includes: Caecostomy not elsewhere classified

H15 Other exteriorisation of colon:

H15.1 Loop colostomy (Clean-Contaminated)

H15.2 End colostomy (Clean-Contaminated)

H15.3 Refashioning of colostomy (Contaminated)

H15.4 Closure of colostomy (Contaminated)

H15.6 Reduction of prolapse of colostomy (Clean-Contaminated)

H15.8 Other specified exteriorisation of colon

H15.9 Unspecified Includes: colostomy not elsewhere classified

H29 Subtotal excision of colon

H29.1 Subtotal excision of colon and rectum and creation of colonic pouch and anastomosis of colon to anus

H29.2 Subtotal excision of colon and rectum and creation of colonic pouch NEC

H29.3 Subtotal excision of colon and creation of colonic pouch and anastomosis of colon to rectum.

H29.4 Subtotal excision of colon and creation of colonic pouch NEC

H29.8 Other specified subtotal excision of colon

H29.9 Unspecified subtotal excision of colon

H33 Excision of rectum

H33.1 Abdominoperineal excision of rectum and end colostomy

H33.2 Proctectomy and anastomosis of colon to anus

H33.3 Anterior resection of rectum and anastomosis of colon to rectum using staples Includes: Rectosigmoidectomy and anastomosis of colon to rectum

H33.4 Anterior resection of rectum and anastomosis not elsewhere classified

H33.5 Rectosigmoidectomy and closure of rectal stump and exteriorisation of bowel

H33.6 Anterior resection of rectum and exteriorisation of bowel

H33.7 Perineal resection of rectum HFQ

H33.8 Other specified Excision of rectum

H33.9 Unspecified Excision of rectum Includes: Rectosigmoidectomy not elsewhere classified

Appendix 6. A summary of the various methods implemented by sites to gather patient satisfaction comments and experience of ERAS+

Site	Type of form used	Type of data captured	Time of data capture	Person who collected data
A	Bespoke surgery school feedback form Standard ERAS+ feedback form	Quantitative and qualitative	At surgery school At discharge	Data collector Data Collector
B	Standard ERAS+ feedback form	Quantitative and qualitative	At discharge	Form handed to patient for them to fill in
C	Standard ERAS+ feedback form	Quantitative and qualitative	At discharge	Verbal feedback recorded by data collector
D	Standard ERAS+ feedback form	Quantitative and qualitative	Day 3 or day 7 post-op	Verbal feedback recorded by data collector
E	Bespoke form including standard ERAS+ feedback information	Quantitative and qualitative	At discharge	Verbal feedback recorded by data collector
F	Standard ERAS+ feedback form	Quantitative and qualitative	3 days post-op or on discharge	Form handed to patient for them to fill in

Appendix 7. GM ERAS+ Nurse business case

OUTLINE BUSINESS CASE PROPOSAL

Enhancing peri-operative care for major surgery in Greater Manchester

Name and contact details of applicant			
Business Group		Service	
Sponsoring Director		Sponsoring Executive Director	

1. REASON FOR REQUEST

1.1 The following request seeks approval of 1WTE / Band 6 of an ERAS+ Nurse to help support with the implementation and project management of ERAS+, which Medical Directors across Greater Manchester (GM) have endorsed the roll out of, the benefits of ERAS+ pathway for the GMN population have been recognised by the Healthier Together & Devo Manchester programmes.

1.2 Enhanced Recovery After Surgery (ERAS) is an evidence-based approach that helps people recover more quickly after major surgery. There are several established ERAS programmes in use within the NHS with proven benefits. Post-operative pulmonary complications (PPC) are the most common complication after major surgery, with rates as high as 30%. Patients who suffer these complications will endure a prolonged length of stay (LOS) (extra 8 days) with a 10% increase in mortality. Existing ERAS programmes do not specifically address the issues of PPC.

1.3 Postoperative pulmonary complications are common after major surgery with a reported incidence of 30% - 40%. Adverse outcomes include death, longer hospital stays and reduced long-term survival. Enhanced recovery after Surgery (ERAS) is now a standard of care for patients undergoing elective major surgery. Despite the high prevalence of pulmonary complications in this population, few elements of enhanced recovery specifically address reducing these complications.

2. THE CURRENT PROBLEM

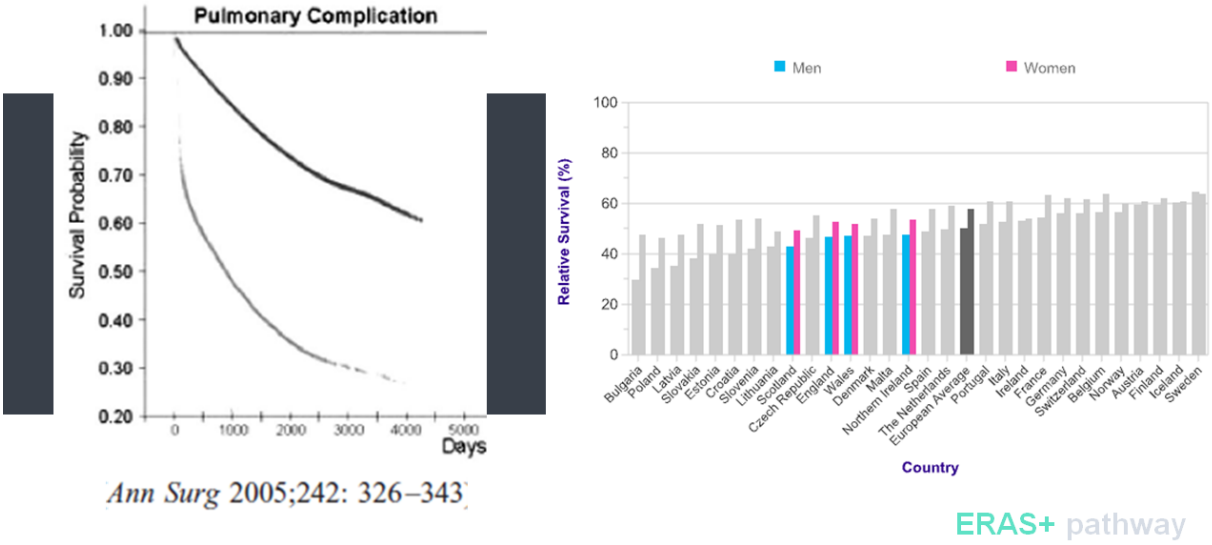
2.1 Greater Manchester is a vibrant and dynamic conurbation with great potential for economic growth and prosperity. However, the population of Greater Manchester has traditionally suffered some of the poorest health in England. Good progress

has been made in addressing the health challenges posed by the burden of disease associated with social deprivation, poor mental health, cancers, cardiovascular disease and poor lifestyle choices leading to problems of obesity, alcohol related morbidity and smoking related disease, however further focus to reduce health inequalities is essential.

2.2 Currently, hospital services in Greater Manchester are not financially sustainable. Over recent years, despite planned cost savings, a number of Trusts in Greater Manchester are facing challenging financial difficulties. This situation must be addressed to ensure high quality services are consistently provided.
The Health and Social Care Partnership has offered GM to become a 'new era', as the region became the first in the country to take control of its combined health and social care budgets. It presents health officials with a unique opportunity to tackle some of the poor health inequalities that currently blight the region. Enabling each person to receive the same level of care, despite location.

Why does cancer surgery need a new pathway?

2.3



2.4

There are strong views that ERAS+ can be rapidly adopted by other centres around the UK, with a reduction in both short and long-term morbidity and mortality. There are more than 250,000 major surgery procedures a year in the UK. A 25-50% reduction in PPCs would realise a saving for medium to large hospitals of +300K annual saving (based upon 500 patients reducing LOS by 2 days). ERAS+ has been selected by the NHS as 1 of only 8 National Innovation Accelerator fellowships for mass scaling of the innovation across the NHS. The selection team included the involvement of NICE, national AHSN leads and the

group chaired by Sir Bruce Keogh. The effectiveness and cost-effectiveness of specialist ERAS+ services are supported by the Health and Social Care Partnership, Provider Federation Board and NHS England, and describes a number of ways that rehabilitation intervention can deliver savings for health and social care, for example:

- reduce the cost of nursing, residential and social care;
- reduce PPC complications;
- reduce length of stay costs;
- enable a person to return to work, get into or stay in work.

***The ERAS+ Standards*: How we currently perform and where we would like to be post implementation;**

1) **Advice: Activity, Muscle strengthening, chest training, nutritional, wellbeing, anaemia management**
   This will be as part of our surgery school and we are also striving to set up a link with local councils / health facilities in both Stockport and Tameside to facilitate some community based pre-operative optimisation of diet, smoking cessation and activity. This is via local council's public health departments. We currently have a well organised (award winning) anaemia management program up and running.

2) **Prehab: Surgery school, every patient with a family member invited to attend, focusing on iCOUGH.**
   As a department we have arranged to visit CMFT on 11th May 2017, to witness a surgery school session, on our return we hope to iron out the details in terms of content, function and funding etc. Currently patients go straight from OPD to our level 2 pre-operative nurse assessment; suggestions are that patients would be referred to 'surgery school' from clinic or via the pre op team as an MDT, which is being explored and finalised. The ERP pre op document and ERP ICP already contain much of the content for these periods of education; we would have to arrange for the information to be transferred across and adding further documentation in around Critical Care / Pain / Dieticians and Physio.

3) **In hospital stepped recovery**: **Package for each major surgery pathway, incorporating iCOUGH respiratory bundle**
   We have ERAS ICP; integrating ICOUGH into this would require minimal change to the existing bundle. The main addition and financial outlay would be for incentive spirometers for the patients. I feel it would be of benefit to have an ICOUGH prescription on EPMA, we already have an order set for these patients going to HDU so adding this on would not be an issue. Locoregional anaesthesia, avoidance of excessive crystalloid / colloid, lung protective ventilation, avoidance of NG tubes / drains, laparoscopic surgery established. Looking at our audit data there is

improvement to be made in our compliance with early postoperative measures such as removal or avoidance of urinary catheters and discontinuation of IV fluids. Dr Loveridge is currently carrying out an audit on this, the audit will continue as ERAS + is launched and hopefully the appointment of an ERAS+ nurse will see a measured improvement.

4) **ERAS+ implementation team: Measuring compliance with ICOUGH throughout with ward roundWith** ward round, measure compliance with iCOUGH
In 2011, the Trust agreed for an ERAS nurse to join the team, LOS significantly reduced as a result of this appointment as the ERAS nurse was integral to coordinating patients expectations and patients pathway, the ERAS nurse was excellent at appropriately challenging the Consultants regarding their patients care, paperwork being completed accurately and timely and updating and policing the guidelines and standards which should be adhered to. Since the ERAS left there has been an increase in LOS which has impacted on the elective programme and fewer audits completed due to time constraints.

5) **Rehab advice: Activity, muscle strengthening and nutrition**
Working in partnership with the councils and leisure centres we hope to integrate with community services to provide an exercise and rehab programme for these patients to be discharged into the community, this will be a key element of the ERAS+ nurse job, they will provide a link in to this service and be able to be a point of contact for patients once discharged from the hospital and engaged rehabilitation. Telephone follow up clinics were previously part of the ERAS nurse's role which helped reduce the number of patients needing a follow up appointment with a Consultant or in a Nurse Led clinic, the telephone clinics also prevented the patient representing in A+E. If a problem was identified on the telephone an appropriate and time efficient appointment was arranged resulting in low readmission rate equating maintained income for the Trust and also a much improved patient experience as we were deflecting patients away from A+E.

6) **Measure outcomes: on hospital discharge, 30 days, 6 months and 1 year**
Currently we have the standard national bowel cancer audit information but nothing specifically relating to ERAS. This would be a key responsibility for the ERAS+ nurse role.

3. PROPOSAL & OPTIONS BEING CONSIDERED

3.1 Access to the current ERAS+ is not available widely across GM, developing the Stepping Hill ERAS+ model with the support of an ERAS+ nurse will mean that more people will:

- Have access to timely, high quality ERAS+ services at the intensity best suited to their need
- Have a shorter length of stay
- Reduced access to hospital based services
- Improved outcomes
- Quicker return to work
- Care with Greater Manchester

3.2 This is supported by Surgery School education tools, videos, booklets, multi-professional education and involvement, recognising the existing ERAS+ system will benefit from further innovation. Currently patients follow similar programmes irrespective of their current condition or ability, and there is no method for a clinician to check whether patients are following the exercises or to remind them to stick with the programme.

The options described below make the assumption that without substantive recruitment, 4 middle grade locums required to cover rota gap. The following options are considered:

Option	Comments
Option 1 Do nothing	If we were to do nothing we would not be able to implement the ERAS+ model as the ERAS+ nurse will be coordinating all of the patient pathways pre and post operatively.
Option 2	Employ 1 WTE ERAS+ nurse at a Band 6 once the appointment has been made SHH would be able to deliver on the roll out of the ERAS+ model which is proven to reduce post op respiratory complications and shorten length of stay.

3.3 The vision is for Stepping Hill ERAS+ to assist patients in recovering as quickly as possible after surgery. Support from the both clinical, executive directors and an ERAS+ will help Stepping Hill Foundation Trust deliver state of the art personalised care at every step of a person's surgical journey:

- The holistic approach will focus not only on the individual experience and outcomes, but also the support provided to family and carers. ERAS+ will support a person's recovery during each stage of their pathway, from pre-surgery care to post surgery.

- Given commissioning intentions for Enhanced Recovery for surgical patients, it is envisaged that the GM ERAS+ service will be amongst the first Enhanced recovery packages built to service GM population using the expertise of constituent organisations.
- Developing a platform for effective pathways for surgical patients across Manchester will require support from Health and Social care providers as well as commissioners. The pathways recognise the importance of easy access to experts in providing care. Access to all parts of the ERAS+ pathway needs to be timely, responsive and appropriate.
- ERAS+ aims to deliver care on a regional/local basis where possible, the exception being when individuals require more specialist care that can only be provided by a team with specialist expertise or if people choose to access care from another part of the region.
- Greater Manchester residents will have access to the same standard of service regardless of which borough they are resident. Programmes of care will align to standardisation of care, to support effective and efficient service delivery enabling the sustainability of good clinical care across the whole patient pathway.
- Through monitoring the service, quality and effectiveness will be ensured.

4. FINANCIAL VALUE

4.1 
ERAS + Nurse.xlsx

Option one is the preferred option. UHSM have recently appointed two ERAS+ nurses.

5. STRATEGIC FIT

5.1 The current organisation of health services in Greater Manchester was designed to meet the needs of the last century. Today, the greatest requirement is the ongoing care of people with multiple long term conditions and, to meet these needs, the NHS needs to take a more strategic approach to shifting the balance of care form hospital to community, primary, social and self-care. It is also recognised that access to specialist care needs to be improved across Greater Manchester. The presence of leading international institutes within GM should ensure that all national quality standards are met ensuring current inequalities of access and related outcomes for patients are improved.

Improved quality of health care for GM residents will be underpinned by the following key principles of a new system which were agreed with AGMA on 22nd February 2013:

- People can expect services to support them to retain their independence and be in control of their lives, recognising the importance of family and community in supporting health and well-being.
- When people need hospital services, they should expect to receive outcomes delivered in accordance with best practice standards with quality and safety paramount – the right staff, doing the right things, at the right time.
- Where possible we will bring more services closer to home (for example there are models of Christie led Cancer services delivered from local hospitals).
- For a relatively small number of patients (for example those requiring high risk general surgery) better outcomes depend on having a smaller number of bigger services.

5.2

Implementation of ERAS+ will be led at a Greater Manchester level, with a Greater Manchester Oversight and Governance function. During implementation there will be a programme of activities, led by the ERAS+ nurse, which encompass the design and preparatory work required for all Greater Manchester. In addition Greater Manchester wide pathways have been developed, ERAS+ clinical standards and ERAS+ Implementation standards:

- Each trust is required to follow the implementation standards and self-assess against clinical standards. This involves pathways, service specifications, protocols and data analysis.

- On the lead up to implementation a go-live readiness assessment.

These redesigns were supported by the clinical alliance and associated task and finish groups.

6. EXPECTED BENEFITS

The benefit of ERAS+ pathway for the GM population has been recognised by the Heathier Together/Devo Manc. The sectors of GM are being tasked with implementation and project management of ERAS+ supported by the Transformation Unit.

Coordinated commissioning of ERAS+ services:
ERAS+ will operate as a network encompassing hospitals undertaking major elective surgery in GM. With the support of an ERAS+ nurse the function will be to meet the needs of surgical patients, delivering the right care at the right time.

The service will be underpinned by strong clinical governance structures through a lead-provider model. Patient outcomes will improve as a result of receiving high quality reliable and timely care and treatment.

In summary the Stepping Hill Foundation Trust ERAS+ service with the support from an ERAS+ nurse will:

- Provide the optimum person-centred care and treatment for adults needing high risk or emergency surgery at Stepping Hill Foundation Trust, as well as people transitioning to adult services from children's services;
- Be a needs-led service, with a goals-based approach, achieving the best outcomes with an ERAS+ aligning the whole pathway;
- Maximise outcomes and independence, returning people to their usual residence wherever possible;
- Promote self-management to support sustainable change and;
- Help families and carers to support their loved ones

The implementation of ERAS+ across GM, as described here in, is in line with the Greater Manchester Health and Social Care Devolution Plan 'Taking Charge of Our Health and Social Care in Greater Manchester', specifically:

- Improving health, wealth and wellbeing;
- Increasing independence and reducing demand on public services;
- Developing community services to keep people out of hospital;
- Supporting people to return to work and as a result more families will be economically active.

7. RISKS

1.1 RISK IDENTIFICATION	1.2 RISK ASSESSMENT			1.3 RISK PLANNING AND MITIGATION			
What is the risk?	Pre-mitigation score Likelihood Impact	Risk score pre-mitigation	Risk rating pre-mitigation	Action to mitigate	Post mitigation score Likelihood Impact	Risk score post-mitigation	Risk rating post-mitigation

Risk: Clinical teams within the sectors have conflicting demands on time, specifically through the implementation of the changes to General Surgery. Impact: ERAS+ MDT meetings, surgery school, and training may be difficult to resource.	2	4	8	H	HT will ensure meetings do not clash with sector General Surgery HT changes and ensure structured meetings to ensure maximum effectiveness. Project team to link in with ERAS+ team to ensure dependencies are understood.	2	2	4	L
Risk: Potential capital requirement needed at hub sites, meaning that there is a potential capital spends needed. Impact: If capital is not available or secured this will have serious implications regarding the feasibility of the project, such as the need for surgery school.	2	5	10	H	It is believed that very little capital spend should be identified and can be mitigated through use of current space at the hub sites, such as training rooms. GM can revisit capital estimates in light of the above being highlighted as an issue.	1	1	2	L
Risk: There is a risk that the potential pre implementation baseline may not be feasible and completed to a high standard due to the tight timescales and resources. Impact: Delays in analysis of the pre implementation baseline will delay the implementation of ERAS+.	2	2	4	L	Ensure a trained data collector screens patients on days 3, 5, 7 and 15 after surgery and there is an ERAS+ dedicated consultant team member available to review clinical cases to confirm the diagnosis of PPC at the earliest opportunity. Engage Clinical Leads and data collectors.	1	1	1	L

Risk: Lack of clarity of scope of ERAS+ and remit of general surgery. Impact: Sectors may struggle to progress without further clarity. Impact: Concerns that other services will be affected, misunderstanding about the changes in General Surgery and the implementation of ERAS+ from both staff, publics and other stakeholders.	2	3	6	H	Ensure training has commenced for all front line staff who will be involved in ERAS+, including critical care, consultants and anaesthetic staff, supported by ICOUGH TV, brochures and posters. Create version for public and staff. Ensure local Communication Leads are engaged. Assurance from sectors to include assurance of local comms and engagement plans. Issue clarification of ERAS+ for sectors. Offer for ERAS+ Clinical Lead and HT Programme Team to meet with all sectors to discuss and clarify.	2	2	4	L
Risk: Due to the change in General Surgery, there have been sector risks related to lack of workforce to implement Healthier Together and potential recruitment barriers. Due to limited workforce, there is a risk that ERAS+ resources will not be in place for implementation.	3	3	9	H	Ensure the pre implementation audit is done to a high level to highlight the workforce gap. The HT change in General Surgery has the potential to increase General Surgeons at hub sites and there is an opportunity to include ERAS+ in consultant and supporting staff job plans, including anaesthetics, specialist nurses and medical staff.	2	4	8	H

8. MANAGEMENT ARRANGEMENTS

- Approval by SMG for the appointment of 1 WTE ERAS+ nurse
- Advertise and Interview
- Appointment to be live by August 2017

APROVAL ROUTE & OUTCOME

This is section is for completion by the planning department only

Reference number			
Date proposal received by Planning department		Date proposal considered by SMG:	
Potential value of investment sought	☐ Up to £100k ☒ £100k to £500k ☐ £500k >	= Director of Finance = Chief Executive = Trust Board	
Funding already identified?	☐ Yes ☒ No		
Outcome	☐ Recommend for development to FBC	☐ Recommend for rejection	☐ Further work required
Agreed next steps			

Appendix 8 Publications in peer reviewed journals associated with this MD (printed below)

1) Feasibility and outcomes of a real-world regional lung cancer prehabilitation programme in the UK. Bradley P, Merchant Z, Rowlinson-Groves K, Taylor M, **Moore J***, Evison M* (*Joint senior authors). British Journal of Anaesthesia, 2022, Jul 13.

2) Nutritional screening in a cancer prehabilitation programme: A cohort study. Burden ST, Bibby N, Donald K, Owen K, Rowlinson-Groves K, French C, Gillespie L, Murphy J, Hurst SJ, Mentha R, Baguley K, Rowlands Ash, McEwan K, Merchant Z, **Moore J.** Journal of Human Nutrition and Dietetics. 2022 Jul 1.

3) Prehabilitation and preparation for surgery: has the digital revolution arrived? Durrand J, **Moore J**, Danjoux G. Anaesthesia 2022 June 77;6:635-639.

4) Prehabilitation and Rehabilitation in Older Adults with Cancer and Frailty. Merchant, Z, Denehy L, Santa Mina D, Alibhai S and **Moore J**. 2022. In *Frailty in Older Adults with Cancer* 2022, (pp. 155-176). Springer, Cham.

5) Surgery school—who, what, when, and how: results of a national survey of multidisciplinary teams delivering group preoperative education. Fecher-Jones I, Grimmett C, Carter FJ, Conway DH, Levett DZ, **Moore JA**. Perioperative Medicine. 2021 Dec;10(1):1-9.

6) Implementing a system-wide cancer prehabilitation programme: the journey of greater Manchester's 'Prehab4cancer'. **Moore J**, Merchant Z, Rowlinson K, McEwan K, Evison M, Faulkner G, Sultan J, McPhee JS, Steele J. European Journal of Surgical Oncology. 2021 Mar 1;47(3):524-32

7) The care of older cancer patients in the United Kingdom. Gomes F, Lewis A, Morris R, Parks R, Kalsi T, Babic-Illamn G, Baxter M, Colquhoun K, Rodgers L, Smith E, Greystoke A. **Moore J**, Simcock R. ecancermedicalscience. 2020;14.

8) Delivering perioperative care in integrated care systems. Bougeard M and **Moore J**. Clinical Medicine 2019 19(6): 450-453.

9) Impact of a peri-operative quality improvement programme on postoperative pulmonary complications**. Moore JA**, Conway DH, Thomas N, Cummings D, Atkinson D. Anaesthesia. 2017 Mar;72(3):317-27.

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Advance Access Publication Date: xxx
Clinical Investigation

CLINICAL INVESTIGATION

Feasibility and outcomes of a real-world regional lung cancer prehabilitation programme in the UK

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Abstract

Background: Prehabilitation, or multimodality patient optimisation before major treatment, has demonstrated meaningful improvements in patients' outcomes. In the setting of lung cancer surgery, postoperative complications and length of hospital stay are reduced, but there is currently limited access to prehabilitation. Prehab4Cancer (P4C) is an innovative regional programme serving all areas of Greater Manchester (GM).
Methods: The lung cancer P4C service commenced in 2019 as a collaboration between the GM Cancer alliance and 12 leisure and community organisations. Patients planning surgical resection could be referred to receive exercise, nutrition, and well-being assessment and interventions before surgery. We evaluated the programme's feasibility, uptake, and outcomes during the 11 months before COVID-19 restrictions.
Results: In total, 377 patients were referred to the lung cancer P4C service from all 11 hospitals in GM. Of the patients reached by telephone, 80.0% (n=280/348) attended initial P4C assessment, which occurred a median of 8 days (interquartile range [IQR]: 4–14) after referral. In addition, 74.3% (n=280/377) attended for baseline assessment and 47.7% (n=180/377) completed prehabilitation, attending a median of six sessions (IQR: 4–9). Statistically significant improvements in all objective physiological and subjective functional assessments were observed preoperatively, including a mean increase in the incremental shuttle walk test of 50 m (95% confidence interval: 25–74; P<0.001).
Conclusions: The P4C programme demonstrated feasibility at scale, high uptake, and promising impact on the status of patients with lung cancer before surgery. P4C is the first regional prehabilitation service internationally, and this evaluation provides a framework for implementing similar services in other regions.

Keywords: exercise therapy; lung cancer; prehabilitation; quality of healthcare; thoracic surgery

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Editor's key points

- Postoperative complications and length of hospital stay are reduced by prehabilitation.
- Prehab4Cancer is an innovative regional programme serving the Greater Manchester area in the UK, in which patients planning surgical resection receive assessment and interventions before surgery.
- This paper describes the programme's feasibility, uptake, and outcomes in 377 patients referred before the COVID-19 pandemic.
- The programme was feasible at scale with high uptake and had a positive impact on preoperative physiological and subjective functional assessments, providing a framework for wider implementation.

Lung cancer is the most common cause of cancer-related death in the UK with approximately 35 000 deaths every year.[1] Surgical resection at an early stage offers the best chance of long-term survival, and the number of lung cancer operations in the UK is increasing year on year (~7000 per year currently).[2] Further improvements in early detection, such as through targeted screening, are leading to a greater proportion of patients with lung cancer being diagnosed at a stage where surgical resection is possible.[3,4] Therefore, there is renewed focus on optimising outcomes in lung cancer surgery.

Prehabilitation describes patient optimisation before treatment, such as lung cancer surgery.[5] Exercise training is a core intervention, but prehabilitation also involves allied components, such as nutritional and psychological well-being assessment and support. It is increasingly recognised as an important phase of cancer treatment pathways, reducing complication rates, improving functional capacity, and improving quality of life.[6,7] A recent meta-analysis of RCTs of exercise training before lung cancer surgery demonstrated a significant reduction in the rate of postoperative complications (risk ratio 0.42; 95% confidence interval [CI]: 0.25–0.69), postoperative length of stay in hospital (mean difference −2.29 days; 95% CI: −0.98 to −3.59), and improved exercise capacity (6 min walk distance mean difference +37.6 m; 95% CI: +20.5 to +54.7).[8] Given this strong evidence supporting the efficacy of prehabilitation before lung cancer surgery alongside the increasing volume of lung cancer surgery, service delivery is the primary challenge.

Despite this evidence and its recommendation in international guidelines,[9] there is a wide variation in prehabilitation provision across cancer services, rendering it unavailable to a large proportion of patients. Whilst a small number of individual hospital-based services exist,[10–12] implementation of resilient, sustainable, and effective prehabilitation services at scale across large geographical areas is a key priority. This challenge is not unique to the UK; a recent survey of thoracic surgeons in Australia identified a high perceived need for prehabilitation, but only 16.7% of respondents could access services.[13]

The Greater Manchester (GM) Prehab4Cancer (P4C) programme is a system-wide prehabilitation programme for patients in GM delivered as a collaboration between hospital-based clinical teams, the regional cancer alliance (GM Cancer), and the community leisure sector (GM Active). Here, we examine the feasibility, uptake, participation, and clinical outcomes from this service delivery model.

Methods

Service setting

GM is a metropolitan county in the Northwest of England with a population of 3.2 million, with ~2500 patients diagnosed with lung cancer annually across the GM conurbation. There are 11 acute NHS hospitals in GM. Thoracic surgery is provided at a single site. The cancer system is led by the 'GM Cancer' alliance, which sets the cancer priorities for the region and allocates transformation funding aligned to these priorities. 'GM Active' is a collective of 12 leisure and community organisations from across GM, with a shared vision to get more people physically active.[14] This collaboration comprises 87 leisure and sports facilities across the region, ensuring there is a facility within 5 miles of all GM residents. GM active is supported through numerous partnerships, including the local health authorities, the GM Health and Social Care Partnership, the GM Combined Authority, GreaterSport, UKActive, and Sport England.

P4C inception

The series of events that culminated in the P4C programme has been published.[15] In short, a team of GM perioperative clinicians delivering an enhanced surgery programme ERAS+ (Enhanced Recovery After Surgery Plus[16]) formed a partnership with GM Active to develop and deliver a GM-wide community-based multimodal prehabilitation programme for patients preparing for cancer surgery. This was supported by transformation funding from the GM Cancer Alliance, which had made prehabilitation and rehabilitation implementation a regional cancer priority. The P4C programme was allocated £1.3 million over 2 yr to support 2000 patients through a prehab–rehab programme. This funding allowed recruitment of a P4C team consisting of a clinical lead, a transformation programme lead, a primary care lead, an operational programme manager and a team of six exercise specialists (Level 4 cancer rehabilitation qualified exercise practitioners able to design, agree, and adapt a physical activity programme to aide patients living with cancer), three Level 3 qualified exercise instructors (Level 3 qualification is the standard to practice as a personal trainer), and a referral coordinator deployed within the GM Active system. The P4C team engaged with each cancer pathway board included in this initial project (lung, colorectal, oesophago-gastric) to develop site-specific referral pathways and engage with the local teams at all GM hospitals *via* a site-specific P4C subgroup. The P4C Lung subgroup was established in September 2018 with a planned service launch date of April 2019. The Lung subgroup included a multidisciplinary team (MDT) of healthcare professionals, patient representatives, and P4C delivery team members. The subgroup agreed and defined the prehabilitation pathway and the red–amber–green (RAG) ratings for key performance indicators (KPIs), defined *a priori*, as set out as follows.

Lung cancer P4C pathway

In the pilot programme, patients with lung cancer were eligible for P4C if surgical resection was planned, as it is this cohort of patients who have the clearest evidence of benefit.[8] The inclusion criteria were lung cancer MDT-agreed diagnosis of primary lung cancer with a treatment recommendation of surgical resection, aged 18 yr or over, registered with a GM primary care service, able to access the programme either

Table 1 Prehab4Cancer nutritional and well-being support assessment and management frameworks. EQ-5D, European Quality of Life Five Dimensions; P4C, Prehab4Cancer.

		Risk alerts	Action
Nutritional risk category	Low	None • Healthy BMI (20–25 kg m^{-2}) • Stable weight • No appetite concerns	• Continuous monitoring • General advice leaflet given
	Medium	One of the following: • ≥1% weight loss in past fortnight • Drop in food intake to <75% normal	• Diet information sheet provided • Raise concern with clinical team • Monitor closely
	High	One of the following: • BMI ≤20 kg m^{-2} • ≥10% weight loss past 6 months Or two of the following: • ≥5% weight loss in past month • Drop in food intake to <75% normal	• Give high-risk diet sheet • Highlight concern to clinical team and monitor outcome • Patient to contact dietician if already known to a dietetic service • *P4C team can contact nutrition subgroup lead for advice*
Well-being risk category	Low	• No concerns on both objective measures (e.g. EQ-5D) and subjective assessment	• Continuous monitoring • Generic Macmillan information leaflets
	Medium	• Change in assessment results • Clear change in mood and behaviour • Misses more than three continuous sessions with no contact	• Make a well-being call • If appropriate, arrange face-to-face appointment • Macmillan service leaflet • Local service contact • Raise with clinical nurse specialist
	High	• Clear need for intervention • Significant change in assessment scores • Extreme stress or emotional distress • Concern for safety of individual	• Report to clinical nurse specialist • Report to clinical psychological need • Call P4C manager and begin crisis procedure if necessary *(only to be done if significant and immediate risk to individual)*

independently or with support from a carer/family member, indicated informed consent to be referred, and walked more than 250 m on the incremental shuttle walk test (ISWT). As a community programme without clinical facility support, embedded risk assessment at all stages of the pathway was crucial to mitigate the risk of adverse events during prehabilitation. The ISWT is widely used across GM in the lung cancer pathway because of its reproducibility, accessibility, and a strong evidence base.[17] An ISWT >40 shuttles (400 m) correlates to a VO_{2max} >15 ml kg^{-1} min^{-1} on cardiopulmonary exercise testing (CPET), a value deemed to represent good physiological function in national guidelines on the risk assessment for lung cancer surgery.[18,19] However, the shuttle walk may underestimate VO_{2max} at the lower ranges with more than half of patients with a shuttle walk <250 m having a VO_{2max} >15 ml kg^{-1} min^{-1}.[20,21] More recent data demonstrated that a shuttle walk of >25 shuttles (250 m) has a 90% positive predictive value for VO_{2max} >15 ml kg^{-1} min^{-1}.[22] Consequently, the P4C Lung subgroup recommended that patients with an ISWT >400 m would be suitable for a universal (unsupervised) prehabilitation programme, those with an ISWT of 250–400 m would be suitable for a targeted (supervised) prehabilitation programme, but those with an ISWT <250 m would require further assessment with CPET. After CPET, patients with a $VO2_{max}$ >15 ml kg^{-1} min^{-1} were deemed eligible for a universal (unsupervised) prehabilitation programme, those with a VO_{2max} 10–15 ml kg^{-1} min^{-1} would be suitable for a targeted (supervised) prehabilitation programme, but those with a VO_{2max} <10 ml kg^{-1} min^{-1} generally signified prohibitive risk for lung cancer surgery and were also unlikely to be able to safely complete a community-based exercise programme. These patients were therefore deemed ineligible for the programme. A future requirement for cancer prehabilitation will be the development of specialist pathways for patients with greater levels of frailty and comorbidity to ensure equity of access to the benefits of prehabilitation safely, but this was not available in this transformation and implementation phase.

Eligible patients were identified at the lung cancer MDT and were provided with written information on the programme and on the benefits of prehabilitation. Education was provided to clinicians about the programme and strategies to communicate these benefits to patients. Referral to P4C was performed using an online referral portal. Patients were initially contacted by telephone to organise a face-to-face appointment at one of 17 first assessment clinics. At this assessment, medical history and baseline assessments were performed and an individualised prehabilitation programme prescribed. The patient could then complete this programme at any one of the 87 GM Active leisure facilities. The same functional and quality-of-life assessments were repeated immediately before the date of surgery. After treatment, a 12 week postoperative rehabilitation programme was provided.

Prehabilitation intervention

Patients were offered a prehabilitation programme tailored to their baseline fitness, as determined at assessment clinic.

Table 2 Feasibility and uptake red–amber–green rating definitions and performance for the Greater Manchester Prehab4Cancer programme, March 2019–April 2020. ITT, intention to treat; P4C, Prehab4Cancer.

Performance metric	Red rating	Amber rating	Green rating	Outcome (n/N)
Total number of referrals to P4C	<230	230–345	>345	377
Proportion of referrals successfully contacted by telephone (%)	<75	75–90	90	92 (348/377)
Proportion of patients completing a first assessment consultation after a successful telephone contact (%)	<50	50–75	>75	80 (280/348)
Proportion of patients completing a first assessment consultation (ITT) (%)	<30	30–65	>65	74 (280/377)
Proportion of first assessment clinics completed within 7 days of referral (%)	<50	50–75	>75	48 (135/280)
Proportion of patients deemed medically unsuitable for P4C at first assessment clinic (%)	>20	10–20	<10	9 (30/348)
Proportion of patients completing the P4C programme after first assessment (%)	<50	50–75	>75	64 (180/280)
Proportion of patients completing the P4C programme (ITT) (%)	<25	25–50	>50	48 (180/377)

Patients were triaged into 'universal' or 'targeted' pathways, based on principles of NHS England's Personalised Care model.[23] Exercise prescriptions for the targeted pathway included three supervised group gym sessions per week. For the universal pathway, patients could exercise independently with weekly monitoring with the exercise specialist. Exercise prescriptions included reduced-exertion high-intensity interval training and resistance training prescribed according to percentage of maximum HR or perceived rate of exertion.[24] Training prescriptions were escalated as fitness improved. Nutritional status was assessed at baseline and at intervals through the programme. Three risk categories were used to identify those in need of nutritional support, and each category received simple interventions or onward referral when required (Table 1). Psychological well-being is the third component of P4C, aiming to improve motivation, resilience, and quality of life through the period of distress that a new diagnosis of cancer brings. This was similarly assessed using a three-tier risk assessment mapped to interventions that P4C can provide (Table 1).

Study period

This evaluation of the Lung P4C programme describes the period from the service launch in April 2019 until the suspension of face-to-face services because of the COVID-19 pandemic in March 2020 (11 month period).

Measures of feasibility, uptake, participation, and outcomes

We hypothesised that offering P4C to patients with lung cancer as a standard of care would be feasible at regional scale, have good uptake and participation, and have a positive impact on clinical outcomes and quality of life. Feasibility would be judged by the engagement of clinical teams across the region to refer eligible patients *via* the online portal and for referrals to be actioned within the KPIs. With an estimated 500 lung cancer resections in GM per year (equivalent to ~460 in this 11 month study period), we estimated that a referral rate of 75% (n=345) would represent a green RAG rating for feasibility (Table 2). To test uptake amongst referred patients, we calculated the proportion of those who were successfully contacted by phone (green RAG rating of >90%) and the proportion of those who completed an assessment (green >75%). The number of patients completing an assessment was also considered as a proportion of the total number of referrals on an intention-to-treat (ITT) basis (green >65% based on expected dropout at each step). To assess the feasibility of providing rapid access to prehabilitation to ensure progress through the cancer pathway, a KPI of 7 days or less from referral to first assessment clinic was established. To assess feasibility of the eligibility criteria and clinician selection for P4C, the proportion of patients deemed ineligible and unsafe to proceed with community prehabilitation at the first telephone call or when seen at the first assessment clinic was calculated (green <10%). To assess participation, we defined engagement with the programme as attending at least the initial face-to-face assessment session and any subsequent prehabilitation sessions up to point of surgery (green >75% of those attending the first assessment and >50% of the ITT population).

Clinical impact and outcomes were explored using measures recorded during initial assessment and at the repeat assessment immediately before surgery. The following objective assessments were made at baseline and end of prehabilitation to assess fitness: ISWT, 6 min walk test (6MWT), 60 s sit-to-stand test (STS), hand grip dynamometry (HGD), BMI, and clinical frailty scale. Subjective measures were used to assess health-related quality of life at baseline and at follow-up: 12-item WHO Disability Assessment Schedule (WHODAS) 2.0, Self-Efficacy for Exercise (SEE) scale, International Physical Activity Questionnaire (IPAQ), and European Quality of Life Five Dimensions (EQ-5D) scores. Descriptive statistics were used to assess changes in these objective and subjective measures between the beginning and end of prehabilitation. Pearson's χ^2 test was used for comparisons of categorical variables (IPAQ). For continuous variables, paired *t*-test was used to compare repeated measures of parametric data (6MWT, ISWT, STS, and HGD) and Wilcoxon signed-rank test for non-parametric data (WHODAS, SEE, and EQ-5D-5L).

Results

Feasibility, uptake, and participation

During the 11 month period evaluated, 377 patients were referred to the Lung P4C service, originating from 11 hospitals

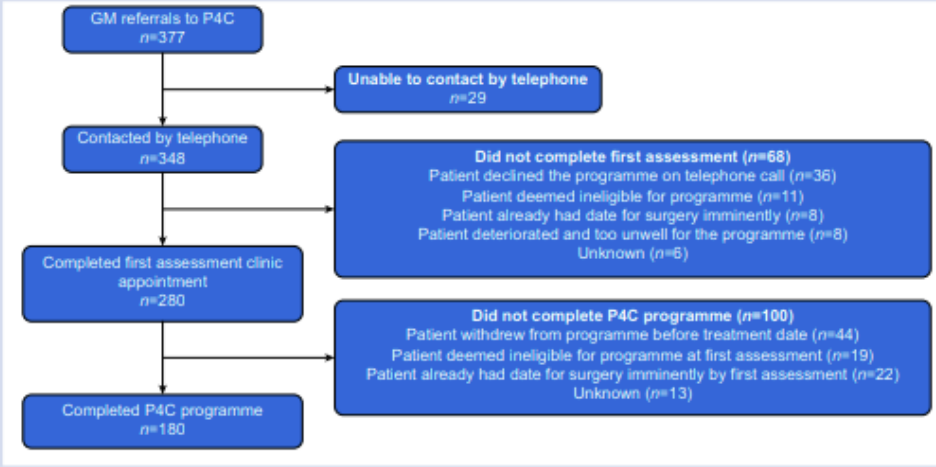

Fig 1. Flow diagram to illustrate uptake and participation rates at each stage of the Prehab4Cancer lung pathway. GM, Greater Manchester; P4C, Prehab4Cancer.

across the GM region (range: from nine to 70 referrals per centre). Amongst the 377 patients referred to P4C, 52.3% (*n*=197) were female, and the median age was 72 yr (interquartile range [IQR]: 66–77). Twenty-nine patients could not be contacted by telephone, primarily because the referrals did not include a valid telephone number. From the contacted patients (*n*=348), 80.5% (*n*=280) attended the first assessment. On ITT analysis, 74.3% (*n*=280/377) of patients referred completed an assessment. The median interval between referral and initial assessment was 8 days (IQR: 4–14) with 48.2% (*n*=135/280) of assessments within 7 days.

During the initial telephone contact and first assessment, 8.6% (*n*=30/348) were deemed medically unsuitable to participate in P4C. Overall, 64.3% (*n*=180/280) of patients who attended a first assessment went on to complete the prehabilitation phase with a median number of sessions completed of 6 (IQR: 4–9). The median interval from assessment to surgery was 36 days (IQR: 22–55). Overall participation on an ITT basis was 47.7% (*n*=180/377). Fig. 1 provides the reasons for non-participation at each stage of the pathway. Overall, 21.2% (*n*=80/377) of referred patients declined or withdrew. From the 377 referrals, 30 patients (8%) were deemed unsafe to participate or proceed with the programme because of concerns about their physiological reserve and safety to undertake the prescribed prehabilitation programme. During this service delivery period, there were no adverse events during participation in exercise sessions reported by the exercise specialists to the P4C steering group.

Outcomes

The results of objective and subjective assessments performed by P4C participants, including both initial assessment and at the end of prehabilitation (preoperatively), are shown in Table 3. Statistically significant improvements were observed in ISWT, 6MWT, STS, HGD, WHODAS, SEE, IPAQ, and EQ-5D. The mean difference in ISWT was +50 m (95% CI: +25 to +74; P<0.001). Amongst those participants with repeated subjective functional assessment results available, 30% (*n*=36/120) reported most disability (WHODAS score ≥9) at baseline, a proportion that reduced to 19% after prehabilitation. The proportion scoring best (WHODAS 0) improved from 17% to 20% preoperatively. Further detail regarding patient-level changes is shown in Figs. 2 and 3.

Discussion

To our knowledge, this is the first regional lung cancer prehabilitation service internationally to be offered as a standard of care and delivered to patients in the community *via* an established leisure network. The high number of referrals over an 11 month period (*n*=377 in a region with 458 lung cancer resections over the same time period) suggests good engagement by hospital-based clinical teams. Our rates of uptake and participation are comparable with those reported in clinical trials as a proportion of patients screened reaching inclusion in final analyses (range: 41–80%).[7,25–28]

The referral pathway and service delivery model appear feasible, achieving 'green' rating on five out of eight predefined feasibility indicators. The programme scored 'red' for one indicator with only 48% of first clinic appointments being completed within 7 days of referral. However, the median time was 8 days, suggesting the service is close to achieving this indicator. The number of sessions attended provides some assurance that the programme delivers adequate prehabilitation before treatment. The low rate of patients deemed unsafe to proceed with the prehabilitation programme after referral and the lack of adverse events reported through the governance system provides evidence of appropriate patient

Table 3 Physiological and functional assessments performed on Prehab4Cancer participants after referral to prehabilitation, and at the end of prehabilitation (before surgery), with differences calculated for those with repeated measures available. †Mean (standard deviation); median (inter-quartile range); *n* (%). ‡Paired *t*-test (parametric repeated measures); Wilcoxon signed-rank test (non-parametric repeated measures); Pearson's χ^2 test (categorical data). CI, confidence interval; HGD, hand grip dynamometry; IPAQ, International Physical Activity Questionnaire; ISWT, incremental shuttle walk test; SEE, Self-Efficacy for Exercise scale; STS, sit-to-stand test; WHODAS, WHO Disability Assessment Schedule 2.0; 6MWT, 6 min walk test.

Variable	*n*	Initial assessment†	End of prehabilitation†	*n* paired results	Difference (95% CI‡)	*P*-value‡
6MWT (m)	108	297 (98)	356 (114)	50	+43 (+31 to +54)	<0.001
ISWT (m)	145	361 (168)	405 (159)	56	+50 (+25 to +74)	<0.001
STS (repetitions in 60 s)	149	18 (8)	23 (8)	70	+4.8 (+3.5 to +6.0)	<0.001
HGD (kg)	265	26 (9)	26 (8)	105	+0.7 (+0.2 to +1.2)	0.011
WHODAS	280	5 (2–10)	3 (1–7)	120	−1.8 (−2.6 to −0.9)	<0.001
SEE	280	66 (49–77)	74 (63–81)	120	+7.1 (+4.4 to +9.9)	<0.001
IPAQ, *n* (%)	280			120		<0.001
Low		158 (56)	13 (11)			
Moderate		91 (32)	76 (63)			
High		31 (11)	31 (26)			
EQ-5D-5L	280	0.80 (0.68–0.88)	0.84 (0.71–1.00)	120		<0.001

selection using the ISWT and CPET parameters and assurance on the safety of the programme.

The objective measures of functional capacity and quality of life also provide assurance of effectiveness. The most recent meta-analysis of exercise training before lung cancer surgery, which demonstrated a reduction in postoperative complications of ~50%, also demonstrated a mean increase in 6MWT of 37 m. We report mean increases in 6MWT and ISWT of 43 and 50 m, respectively. Hence, it can be inferred that a similar reduction in the rate of postoperative complications may also be achievable.

Quality of life is an understudied outcome measure in prehabilitation. This evaluation provides a comprehensive assessment of quality of life demonstrating improvements

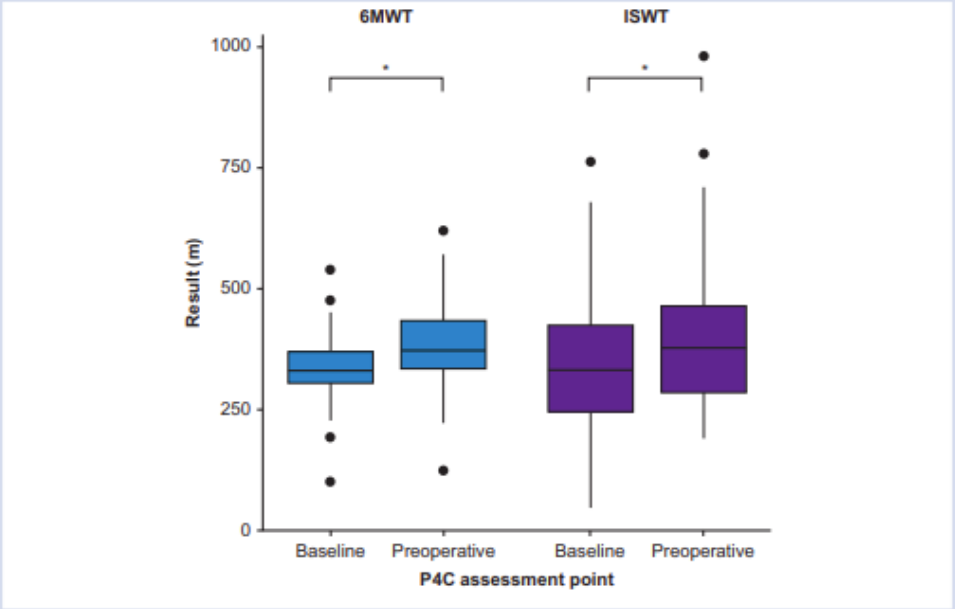

Fig 2. Comparison of patient-level changes in performance in 6 min walk test (6MWT) and incremental shuttle walk test (ISWT) before and after prehabilitation. *P<0.001; paired *t*-test. P4C, Prehab4Cancer.

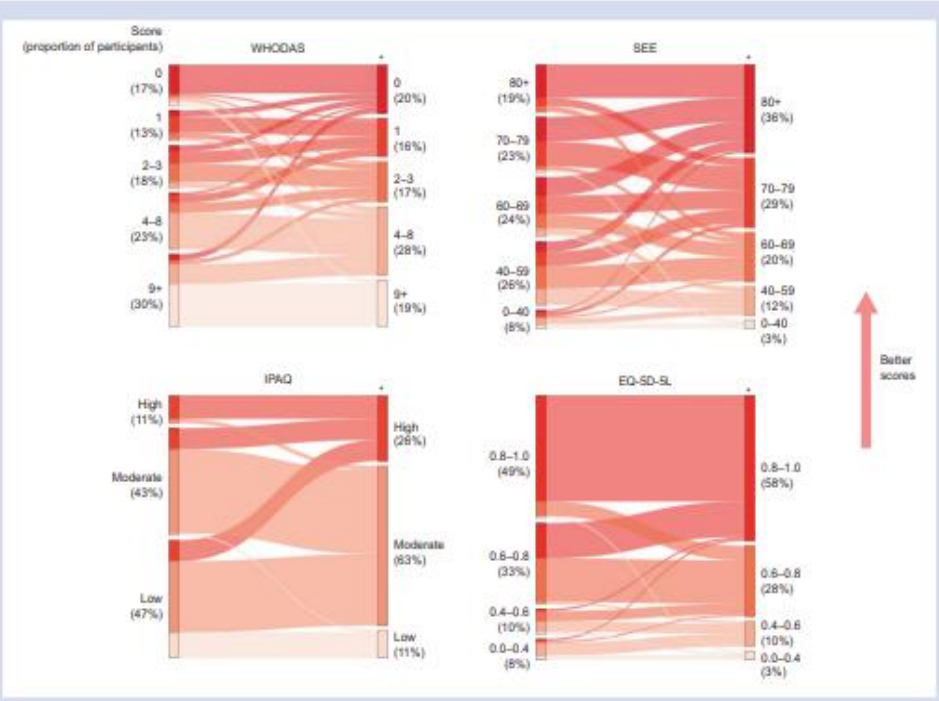

Fig 3. Comparison of changes in subjective assessment scores before and after prehabilitation. Proportions of participants in each score category are given in parentheses as the percentage of the cohort with repeated measures available (n=120). *P<0.001 for test of difference; Wilcoxon signed-rank test (WHO Disability Assessment Schedule [WHODAS], Self-Efficacy for Exercise scale [SEE], and European Quality of Life Five Dimensions [EQ-5D-5L]); Pearson's χ^2 test (International Physical Activity Questionnaire [IPAQ]).

across multiple assessment scales, adding a further dimension to the benefits of prehabilitation.

One in five patients referred to the programme opted not to participate at different stages of the pathway. Reasons for non-participation are poorly understood. Self-reported reasons for participation in P4C include perception of the benefits of prehabilitation, which are influenced by the treating medical team. The implicit psychosocial support of having an element of coaching through a difficult patient journey is also thought to be important (unpublished data).

This service evaluation describes a regional standard-of-care intervention with no allocated control group. For this reason, the likelihood of selection bias was considered too significant to allow comparison of clinical outcomes, such as complication rates and early mortality between patients undergoing surgery who participated in P4C and those who did not. Participation data are incomplete owing to a lack of data on unsupervised exercise; reported participation rates are therefore an underestimate. Obtaining full 'end-of-prehabilitation' assessment data (n=120 completed) proved challenging, particularly given that scheduling such an appointment in advance of the surgery date, once known, requires significant service flexibility and patient availability. A strength of this evaluation lies in its potential to inform expansion of prehabilitation services. The P4C framework of a system-wide collaboration across clinical groups, the community leisure sector, and the regional cancer alliance is novel and could be adopted in other regions. The described RAG-rated indicators of feasibility, uptake, and participation could be used to benchmark other services and build a wider understanding of uptake and participation and strategies for optimising them.

Reflecting on the P4C programme journey in GM, there were some key pillars of success and some key challenges to overcome, relevant to all areas considering such programmes. The GM Cancer alliance must be praised for placing prehabilitation as one of the top cancer priorities for the region and investing one of its largest single cancer transformation funding awards to this programme. This transformation funding ensured adequately resourced clinical leadership and programme management, which were critical to success in the implementation phase. The programme deployed a strong governance structure from the outset with patient representation at every level (Supplementary Fig. S1). This ensured good engagement and communication across the cancer system, rapid development of agreed protocols/pathways, and regular

quality assurance review from the moment of launch. The key strength of this programme is the collaboration with an existing community leisure service infrastructure and creating smooth referral pathways from NHS care to community leisure teams. Strong connections were made between clinical teams and the P4C exercise specialists, with healthcare professionals providing a regular programme of education for the P4C team in all aspects of cancer care to support their professional development and enhance the support they provided to patients with cancer.

One challenge was to embed a clinician-led discussion on the benefits of P4C within NHS consultations and ensuring that P4C referral became a standard of care. Referral rates did vary across different hospitals with some engaging more than others. To support this process, the P4C programme became a regular agenda item on the regional lung cancer board meetings where there was representation from all hospitals. Patient testimonials and outcome data proved to be valuable tools to increase referrals. Patients and family members/carers were signposted to easy-to-use, codesigned patient information leaflets and resources, such as the programme website (www.prehab4cancer.co.uk).[29] Lung cancer teams were encouraged to record P4C referral within the treatment recommendations in lung cancer multidisciplinary team meetings to act as a reminder to the clinical staff in subsequent consultations. The service also benefited from utilising two opportunities to refer a patient to P4C within the lung cancer pathway: referral from the local hospital team at the time of diagnosis and on receipt of a referral to or clinical consultation at the regional thoracic surgery centre. An opposite issue encountered was some clinical teams referring patients too early in the pathway before completing their staging investigations and before MDT confirmation of the management plan. This sometimes led to difficult scenarios for the exercise specialists, going beyond their boundaries of practice, where patients would be asking them for test results and treatment plans, which risks compromising the relationship and trust building required between specialists and patients in a prehabilitation programme. This was addressed through communications *via* the lung cancer pathway board to ensure a standardised point of referral when the diagnosis, stage, and management plan (surgery) had been confirmed at a lung cancer MDT.

When the COVID-19 pandemic started in March 2020, P4C converted to a remote model of service delivery through telephone and video consultations, online sessions, and provision of simple home exercise equipment.[30] This alternative service delivery model will be similarly evaluated for comparison. From October 2020, P4C expanded to include patients undergoing non-surgical curative-intent treatment. This is an understudied area where outcomes also ought to be evaluated.

Conclusions

P4C has implemented a comprehensive prehabilitation service for patients with lung cancer across the GM region, demonstrating feasibility as a standard-of-care service at scale with appropriate levels of uptake and participation to ensure the meaningful clinical benefits already proved in RCTs. Measures of functional performance and quality of life improved amongst participants between initial and preoperative assessments. P4C provides a potential framework for further roll-out across large geographical areas and provides a standardised assessment of uptake, participation, and outcomes against which real-world services can be benchmarked.

Authors' contributions

Study conceptualisation: ME, JM
Data collection/cleaning: PB, ZM, KR-G
Data analysis: PB, MT
Drafting of article: PB, MT
Review/editing of article: all authors

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Declarations of interest

There are no conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2022.05.034.

References

1. Cancer Research UK. Lung cancer statistics, 2021. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer (accessed December 2021).
2. Royal College of Physicians. Lung cancer clinical outcomes publication 2019. In: *Report for the 2017 audit period*; 2020. London
3. Crosbie PA, Balata H, Evison M, et al. Implementing lung cancer screening: baseline results from a community-based 'Lung Health Check' pilot in deprived areas of Manchester. *Thorax* 2019; **74**: 405–9
4. NHS England. *Targeted screening for lung cancer with low radiation dose computed tomography: standard protocol prepared for the Targeted Lung Health Checks Programme*. NHS England; 2019. Available from: https://www.england.nhs.uk/wp-content/uploads/2019/02/targeted-lung-health-checks-standard-protocol-v1.pdf. [Accessed December 2021]
5. Macmillan Cancer Support. Principles and guidance for prehabilitation within the management and support of people with cancer 2020. Available from: https://cdn.macmillan.org.uk/dfsmedia/1a6f23537f7f4519bb0cf14c45b2a629/1532-10061/prehabilitation-for-people-with-cancer-tcm9-353994. [Accessed December 2021]
6. Treanor C, Kyaw T, Donnelly M. An international review and meta-analysis of prehabilitation compared to usual care for cancer patients. *J Cancer Surviv* 2018; **12**: 64–73
7. Liu Z, Qiu T, Pei L, et al. Two-week multimodal prehabilitation program improves perioperative functional capability in patients undergoing thoracoscopic

lobectomy for lung cancer: a randomized controlled trial. *Anesth Analg* 2020; **131**: 840–9
8. Gravier FE, Smondack P, Prieur G, et al. Effects of exercise training in people with non-small cell lung cancer before lung resection: a systematic review and meta-analysis. *Thorax* 2022; **77**: 486–96
9. Batchelor TJP, Rasburn NJ, Abdelnour-Berchtold E, et al. Guidelines for enhanced recovery after lung surgery: recommendations of the enhanced Recovery after surgery (ERAS®) society and the European society of thoracic surgeons (ESTS). *Eur J Cardiothorac Surg* 2019; **55**: 91–115
10. Ricketts WM, Bollard K, Streets E, Hutton K, Hornby C, Lau K. Feasibility of setting up a pre-operative optimisation 'pre-hab' service for lung cancer surgery in the UK. *Perioper Med (Lond)* 2020; **9**: 14
11. Goldsmith I, Chesterfield-Thomas G, Toghill H. Pre-treatment optimization with pulmonary rehabilitation in lung cancer: making the inoperable patients operable. *EClinicalMedicine* 2020; **31**, 100663
12. **St George's University Hospitals NHS Foundation Trust. Prehabilitation before surgery with our get set 4 surgery programme 2021. Available from:** https://www.stgeorges.nhs.uk/service/prehabilitation/ **(accessed December 2021).**
13. Shukla A, Granger CL, Wright GM, Edbrooke L, Denehy L. Attitudes and perceptions to prehabilitation in lung cancer. *Integr Cancer Ther* 2020; **19**, 1534735420924466
14. **GM Active. GM active 2021. Available from:** https://www.gmactive.co.uk. **[Accessed December 2021].**
15. Moore J, Merchant Z, Rowlinson K, et al. Implementing a system-wide cancer prehabilitation programme: the journey of Greater Manchester's 'Prehab4cancer'. *Eur J Surg Oncol* 2021; **47**: 524–32
16. Moore J, Conway DH, Thomas N, Cummings D, Atkinson D. Impact of a peri-operative quality improvement programme on postoperative pulmonary complications. *Anaesthesia* 2017; **72**: 317–27
17. Fennelly J, Potter L, Pompili C, Brunelli A. Performance in the shuttle walk test is associated with cardiopulmonary complications after lung resections. *J Thorac Dis* 2017; **9**: 789–95
18. Lim E, Baldwin D, Beckles M, et al. Guidelines on the radical management of patients with lung cancer. *Thorax* 2010; **65**. iii1–27
19. **National Institute for Health and Care Excellence. Lung cancer: diagnosis and management 2019. Available from:** https://www.nice.org.uk/guidance/ng122 **(accessed December 2021).**
20. Win T, Jackson A, Groves A, et al. Relationship of shuttle walk test and lung cancer surgical outcome. *Eur J Cardiothorac Surg* 2004; **26**: 1216–9
21. Win T, Jackson A, Groves A, Sharlpes L, Charman S, Laroche C. Comparison of shuttle walk with measured peak oxygen consumption in patients with operable lung cancer. *Thorax* 2006; **61**: 57–60
22. Benzo RP, Sciurba FC. Oxygen consumption, shuttle walking test and the evaluation of lung resection. *Respiration* 2010; **80**: 19–23
23. **NHS England. *Comprehensive model of personalised care* 2018. Available from:** https://www.england.nhs.uk/personalisedcare/comprehensive-model-of-personalised-care/. **[Accessed December 2021]**
24. Metcalfe RS, Babraj JA, Fawkner SG, Vollaard NBJ. Towards the minimal amount of exercise for improving metabolic health: beneficial effects of reduced-exertion high-intensity interval training. *Eur J Appl Physiol* 2012; **112**: 2767–75
25. Ferreira V, Minnella EM, Awasthi R, et al. Multimodal prehabilitation for lung cancer surgery: a randomized controlled trial. *Ann Thorac Surg* 2021; **112**: 1600–8
26. Lai Y, Huang J, Yang M, Su J, Liu J, Che G. Seven-day intensive preoperative rehabilitation for elderly patients with lung cancer: a randomized controlled trial. *J Surg Res* 2017; **209**: 30–6
27. Huang J, Lai Y, Zhou X, et al. Short-term high-intensity rehabilitation in radically treated lung cancer: a three-armed randomized controlled trial. *J Thorac Dis* 2017; **9**: 1919–29
28. Licker M, Karenovics W, Diaper J, et al. Short-term preoperative high-intensity interval training in patients awaiting lung cancer surgery: a randomized controlled trial. *J Thorac Oncol* 2017; **12**: 323–33
29. http://www.prehab4cancer.co.uk. **[Accessed December 2021]**
30. **Prehab4Cancer. Prehab4Cancer COVID-19 page 2020. Available from:** http://www.prehab4cancer.co.uk/coronavirus-covid-19/ **(accessed December 2021).**

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INVITED REVIEW

JHND BDA

Nutritional screening in a cancer prehabilitation programme: A cohort study

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Abstract

Background: Cancer patients are often malnourished pre-operatively. The present study aimed to establish whether current screening was appropriate for use in prehabilitation and investigate any association between nutritional risk, functionality and quality of life (QoL).

Methods: This cohort study used routinely collected data from September 2020 to August 2021 from patients in a Prehab4cancer programme. Included patients were aged ≥ 18 years, had colorectal, lung or oesophago-gastric cancer and were scheduled for surgery. Nutritional assessment included Patient-Generated Subjective Global Assessment (PG-SGA) Short-Form and QoL with a sit-to-stand test. Association between nutritional risk and outcomes was analysed using adjusted logistic regression.

Results: From 928 patients referred to Prehab4Cancer service over 12 months, data on nutritional risk were collected from 526 patients. Pre-operatively, 233 out of 526 (44%) patients were at nutritional risk (score ≥ 2). During prehabilitation, 31% of patients improved their PG-SGA and 74% of patients maintained or improved their weight. Odds ratios (OR) with confidence intervals (CI) showed that patients with better QoL using EuroQol-5 Dimensions (OR = 0.05, 95% CI = 0.01, 0.45, $p = 0.01$), EuroQol Visual Analogue Scale (OR = 0.96, 95% CI = 0.93, 1.00, $p = 0.04$) or sit-to-stand (OR = 0.96, 95% 0.93, 1.00, p = 0.04) were less likely to be nutritional at risk.

Conclusions: Almost half of patients in Prehab4Cancer programme assessed using PG-SGA were at risk of malnutrition. However, almost half of the sample did not have their risk assessed. Patients at risk of malnutrition were more likely to have a poorer QoL and sit-to-stand test than those who were not at risk.

KEYWORDS

cancer, cellular and physiological function, disease/therapeutic areas, malnutrition, quality of life

Key points

Colorectal, lung or oesopho-gastric cancer patients referred to the Prehab4-Cancer service underwent a nutritional assessment. Almost half of patients assessed using the Patient-Generated Subjective Global Assessment (i.e.,

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PG-SGA) were at risk of malnutrition. Patients at risk of malnutrition were more likely to have a worse quality of life and sit-to-stand test indicating reduced physical function than those who were not at risk of malnutrition. This indicates that optimising the nutritional status of cancer patients in the prehabilitation period can maximise the nutritional status, functionality and quality of life of patients.

INTRODUCTION

Globally, cancer is the leading cause of premature death[1] with approximately 19 million new incidences each year, and this is predicted to rise to 27.5 million new cases by 2040.[2]

In the UK alone, the number of people aged ≥ 65 years living with cancer is increasing annually[3] and is complicated further by the additional co-morbidities encountered in older people.[4] A cancer diagnosis can lead to changes in physical status, activity levels and emotional or cognitive decline.[5] This functional impact of cancer and subsequent surgical and oncological treatments places an enormous burden on individuals.[6]

Despite advancing techniques, morbidity and mortality rates following elective surgery remain high[7,8] and malnutrition in the pre-operative period is an independent risk factor.[9] Several prospective cohort studies indicate that surgical patients with malnutrition have poorer clinical outcomes, higher rates of readmission, longer hospital admissions and increased associated healthcare costs.[10,11] However, when weight loss is identified pre-operatively and attenuated with oral nutritional supplements, there are benefits in relation to overall nutritional status and clinical endpoints.[12,13] Perioperative malnutrition has also been shown to reduce the number of patients who are able to go on to receive neo-adjuvant treatments such as chemotherapy.[14]

Prehabilitation (commonly known as "prehab") is a process that prepares people with cancer for treatment following their diagnosis. It focuses on improving an individual's physical, nutritional and psychological health to promote resilience throughout treatment and thereafter.[15] The key elements of a prehabilitation programme include cardiovascular and strength training, nutritional optimisation and psychological support to prepare patients for the challenges of treatment and to improve post-operative recovery.[16]

Evidence suggests that this style of multimodal prehab reduces post-operative length of stay and allows patients to return to their functional baseline at an increased rate.[17] There is, however, a paucity of literature within prehab investigating nutritional screening and nutrition specific interventions.[18,19] Malnutrition is estimated to affect 65% of patients undergoing surgery for cancer treatment.[20] Patients who are malnourished are additionally compromised by changes in body composition, cancer cachexia, systemic inflammation, symptom burden and treatment side effects.[21] Consequently, it is prudent to identify these patients early in their cancer pathway to enable appropriate nutritional interventions to commence. This also aligns with the expert consensus, Global Leadership Initiative on Malnutrition (GLIM), which highlights the requirement for appropriate screening and diagnosis of malnutrition.[22] Subjective Global Assessment (SGA) has been modified to create the Patient-Generated Subjective Global Assessment-Short Form (PG-SGA-[SF]), which is a screening tool validated for use in people with cancer.[23,24]

Malnutrition not only influences clinical outcome and hospital length of stay but impacts on patients' overall quality of life (QoL) and function after surgery.[25,26] These are key issues for patients post-operatively, which have been identified by qualitative evaluation using interviews and focus groups.[27] Additionally, length of time to recover after surgery and rehabilitation were reported by patients as important factors to facilitate transition to their pre-illness health status.[27] Post-operative functionality is an indicator of rehabilitation and is often measured using handgrip strength, which is associated with malnutrition,[28] along with measures of dynamic physical performance tests, which include the chair stand test and timed up and go test.[29] Moreover, sit-to-stand time has been shown to be a valid and reliable measure of lower limb strength.[30]

The present study aimed to establish whether screening for nutritional risk during a prehabilitation programme is advantageous to enable triage of patients for nutritional interventions and if there is any association between nutritional risk, functionality and quality of life.

METHODS

The present study is a cohort study using data that were collected as part of clinical practice in the Prehab4Cancer prehabilitation and recovery programme. The Prehab4-Cancer programme[31] was launched in April 2019 and aimed to provide system level prehabilitation for Greater Manchester cancer patients with colorectal, lung or oesophago-gastric cancer. Data included in the present study were collected between September 2020 and August 2021. Patients were included if they were diagnosed with cancer, registered with a General

Practitioner in one of the 10 Greater Manchester boroughs, were aged ≥ 18 years, had either colorectal, lung or oesophago-gastric cancer and were being offered curative surgery in a Greater Manchester National Health Service hospital. All 10 hospitals in Greater Manchester could refer patients into the prehabilitation service if they met the inclusion criteria described above. Referrals were accepted from all members of the multidisciplinary team working in colorectal, lung or oesophago-gastric surgical oncology or general practice teams within Greater Manchester localities.

Setting

Initially the setting for Prehab4Cancer was community-based localities including gyms and health centres. However, from March 2020, as a result of the COVID-19 pandemic, the service delivery transitioned rapidly from face-to-face contact to remote 'virtual' format. The setting for the service was therefore patient's homes or place of residence in the community for the duration of data collection for this cohort study. At this point, the PG-SGA (SF) was introduced and has been the primary nutritional screening tool used within the Prehab4Cancer and recovery programme. Following COVID-19 restrictions, the assessment of participants, and their access and receipt of the service were all delivered remotely.

Exposure

The purpose of the Prehab4Cancer and recovery programme was to provide exercise interventions, nutritional screening, nutritional advice and wellbeing support to people diagnosed with cancer, residing in Greater Manchester before, during and after their cancer treatment. Stakeholders were engaged from all the relevant clinical multidisciplinary teams across the region and agreement was made for patients to be referred at the point cancer surgery was planned using a single point of access. A full description of the overall service implementation has been provided by Moore *et al.*[31]

For nutritional screening, the first four boxes from PG-SGA(SF) including weight history, food intake, symptoms and activities combined with function designed for patients to self-screen were completed. The PG-SGA(SF) was used to triage patients into low, moderate or high risk of malnutrition. Patients deemed low risk (PG-SGA[SF], score 0-1), were provided with a Prehab4Cancer diet sheet designed by the Prehab4Cancer Greater Manchester nutrition group. Patients who were assessed as moderate risk (PG-SGA[SF], score 2–3) were provided with an 'Eating help yourself' booklet produced by dietitians at The Christie hospital. Those patients deemed to be high risk of malnutrition (PG-SGA[SF], score ≥4) were also provided with the 'Eating help yourself' booklet plus the exercise specialists escalated back to the referring clinical team. Escalation to the referring team was usually undertaken by liaising with the cancer nurse specialist supporting the patient at the hospital where surgery was scheduled. The cancer nurse specialist then referred individuals for specialist dietetic or medical assessment or intervention. In some instances, the Prehab4Cancer team could contact named specialist dietitians directly and this was the arrangement for patients with oesophago-gastric cancer who were referred to the oesophago-gastric centres in Greater Manchester with dietetic support.

Data collection

Level 4 Prehab4Cancer qualified exercise specialists within the core delivery team collected data at four assessment points; start of rehab, pre-operatively, post-operatively and at the end of rehabilitation. Patient's characteristics and clinical details were collected from initial referrals. The PG-SGA(SF) were completed remotely based on patient's memory recall from their hospital visit or measured using a range of domestic weighing scales. Sit-to-stand tests, aiming to assess functionality, were collected by self-report from patients with instructions from the core delivery team remotely. EuroQol Visual Analogue Scale (EQ-VAS) and EuroQol-5 Dimension Scale (EQ-5D) were recorded via the telephone or a video platform.

Follow-up

The nutrition screening tool was completed remotely at follow up with patients (via a phone or video call) as required by COVID-19 restrictions. The Prehab4Cancer exercise specialists recorded scores from the PG-SGA (SF) within the bespoke database for the programme 'Refer-All'. The PG-SGA(SF), EQ-5D, EQ-VAS and sit-to-stand test were recorded at each assessment time point.

- Assessment 1: Initial assessment – Start of prehabilitation phase
- Assessment 2: Pre-operatively/treatment – End of prehabilitation phase
- Assessment 3: Post-operatively/treatment – Start of rehabilitation phase
- Assessment 4: End of rehabilitation

The time between each of these assessment points varied and was based on the individual's cancer pathway. The points in the pathway included: diagnosis, referral, initial assessment, prehabilitation, surgery and rehabilitation. Rehabilitation commenced when participants were 'fit', and it was safe for them to

engage post-operatively. The time to rehabilitation post-operatively varied but was a maximum of 12 weeks. The time in prehabilitation also varied, which was based on cancer type and individuals' circumstances. Participants with oesophago-gastric cancer have a prolonged period of prehabilitation, when receiving neo-adjuvant chemotherapy that could be scheduled for up to 3 months, pre-operatively. The prehabilitation phase for patients with lung and colorectal cancer was normally shorter.

Statistical analysis

Survey responses were transferred into Excel (Microsoft Corp.) and then analysed using the SPSS, version 25.0 (IBM Corp.),[32] figures were generated using R Studio, version 1.3.1056 (https://www.rstudio.com).[33] The mean ± SDdeviations or frequencies and percentages were used to present the characteristics of patients. Outcome variables (EQ-VAS, EQ-5D and sit-to-stand) along with type of cancer were investigated in a logistic regression model to identify their impact on PG-SGA score and change in weight at assessment one, two and three. Assessment one was considered the baseline, and the findings from assessment four (i.e., end of rehabilitation) were not included due to the small sample size. The logistic regression model was first assessed unadjusted and then adjusted for potential confounders (age and gender) chosen a priori. Results were reported as odds ratios (OR), or adjusted odds ratios (aOR) and 95% confidence intervals (95% CI). Chi-squared was used to assess whether the proportion of patients who gained weight before versus after prehabilitation arose by chance. All appropriate goodness of fit and model assumptions were checked, and sensitivity analyses tested the robustness of the independent associations to additional confounding.

Sample size

Data were collected as part of clinical practice and therefore a sample size estimate was not undertaken. The size of the sample was therefore pragmatic based on an analysis of all participants referred to the service within the given period with complete datasets.

Ethical and data management

Healthcare practitioners collected data as part of routine clinical practice and therefore this study was exempt from formal ethical approval. For data management, the principles of good practice for data management outlined by Manchester Foundation Trust Research and Innovation team were followed along with appropriate governance procedures. All analyses were undertaken on unidentifiable data. Data were stored on a protected shared drive only accessible to those undertaking the analysis.

RESULTS

Characteristics of patients in the sample

In total, 928 patients were referred to the Prehab4Cancer service over 12 months. Patients were excluded from this

TABLE 1 Socio-demographic characteristics of 526 cancer patients assessed pre-operatively using the Patient-Generated Subjective Global Assessment.

	Number (%) of patients
Age (years)	
<50	25 (4.8)
51–60	96 (18.3)
61–70	179 (34.0)
71–80	190 (36.1)
81+	36 (6.8)
Gender	
Male	300 (57.0)
Female	226 (43.0)
Body mass index	
Male	27.5 (5.3)
Female	27.3 (6.7)
District	
Bolton	57 (10.8)
Bury	41 (7.8)
Manchester	101 (19.2)
Oldham	34 (6.5)
Rochdale	44 (8.4)
Salford	43 (8.2)
Stockport	56 (10.6)
Tameside	58 (11.0)
Trafford	41 (7.8)
Wigan	51 (7.8)
Type of cancer	
Colorectal	228 (43.3)
Lung	238 (45.2)
Upper gastrointestinal	60 (11.4)

analysis if they did not enrol in the programme ($n = 71$) or did not have the PG-SGA(SF) completed ($n = 331$). At assessment 1, there were 526 patients with a cancer diagnosis from across Greater Manchester with a PG-SGA score. Out of these patients, 57% were male, mean age was 68 years and patients had been diagnosed with either colorectal (43.3%), lung (45.2%) or oesophago-gastric cancer (11.4%) (Table 1).

PG-SGA

Assessments at time points 1 and 2 were undertaken prior to the operation; assessments 3 and 4 were conducted post-operatively. PG-SGA(SF) was assessed at each assessment and patients were considered at risk of malnutrition if they had an additive score ≥2 (Table 2). The number at risk of malnutrition at the initial assessment was 233 (44.3%); at assessment 2, this was 82 (41.3%); post-operatively, at assessment 3, 68 (62.4%) participants were at risk of malnutrition; however, by assessment 4, only four patients (20%) were at risk of malnutrition. Almost one-third of patients (30.8%) improved their PG-SGA(SF) score between assessments 1 and 2. An additional 15.6% of patients were considered not at risk of malnutrition at assessment 1 and maintained this status at assessment 2.

There were 293 patients with a baseline PG-SGA (SF) score between 0 and 1 and so were assessed not to be at risk of malnutrition. The remaining 233 patients with a baseline PG-SGA(SF) score ≥ 2 required some form of intervention and were at risk of malnutrition. Results of EQ-VAS, EQ-5D and sit-to-stand test from each assessment along with type of cancer were included in a logistic regression model to assess their impact on the likelihood of predicting patients being at risk of malnutrition. A logistic regression analysis shows that model 1 was statistically significant compared to the null model ($\chi^2 = 59.7$, d.f. = 5, $p < 0.001$), explaining 27.8% of the variation of PG-SGA(SF) score (Nagelkerke R^2) and correctly predicted 57.2% of cases. Table 3 shows that a higher EQ-5D score (indicating a better health related quality of life) at all assessments was associated with a reduction in the likelihood of being malnourished at assessment 1. A higher EQ-VAS score (indicating a better health related quality of life) at assessment 1 was associated with a reduction in the likelihood of being malnourished at baseline. A higher sit-to-stand test (indicating a greater level of strength) at assessments 1 and 2 was associated with a reduction in the likelihood of being malnourished at baseline after adjusting for age and gender. In addition, patients with oesophago-gastric cancer were almost six times more likely to be malnourished compared to patients with colorectal cancer at baseline after adjusting for age and gender.

Change in weight

Weight loss was also considered a predictor of malnutrition; 25.1% of patients lost weight in the 4 weeks prior to assessment 1, and 42.7% of patients lost weight in the 6 months prior to assessment 1. After attending assessment 1, most patients subsequently gained (26.7%) or maintained (47.6%) their weight until their operation (assessment 2). Figure 1 shows how patients' fluctuate in weight before and after assessment 1 regardless of cancer type. A chi-square test of independence was performed to examine the relation between weight change (gained, maintained or lost) before and after assessment 1 (4 weeks before vs. assessment 2, which occurred a mean of 6 days after assessment 1). The relation between these variables was significant ($\chi^2 = 24.5$, d.f. = 4, $p < 0.001$; $n = 188$), such that patients were more likely to gain

TABLE 2 Patient-Generated Subjective Global Assessment Score (PG-SGA) at assessment time points one to four

	Triage recommendation	Assessment time point			
PG-SGA additive Score		Time 1, *n* (%) *n* = 526	Time 2, *n* (%) *n* = 198	Time 3, *n* (%) *n* = 109	Time 4, *n* (%) *n* = 20
0–1	No intervention required at this time. Re-assessment on routine and regular basis during treatment.	293 (55.7)	116 (58.6)	41 (37.6)	16 (80.0)
2–3	Patient and family education by dietitian, nurse, or other clinician with pharmacological intervention as indicated by symptom survey and lab values as appropriate	96 (18.3)	45 (22.7)	29 (26.6)	3 (15.0)
4–8	Required intervention by dietitian, in conjunction with nurse or physician directed by symptoms	96 (18.3)	28 (14.1)	30 (27.5)	1 (5.0)
≥ 9	Indicates a critical need for improved symptom management and/or dietetic intervention	41 (7.8)	9 (4.5)	9 (8.3)	0 (0)

TABLE 3 Logistic regression to show the impact of being at risk of being malnourished at baseline on patients at assessments 1, 2 and 3.

	Model 1 Assessment 1 $n = 257$ OR (95% CI), p	Model 2 Assessment 1 $n = 257$ aOR (95% CI), p	Model 3 Assessment 2 $n = 140$ aOR (95% CI), p	Model 4 Assessment 3 $n = 73$ aOR (95% CI), p
EQ-VAS	**0.97 (0.95–0.99), 0.02**	**0.97 (0.95–0.99), 0.01**	1.00 (0.96–1.04), 0.97	1.03 (0.98–1.09), 0.27
EQ-5D	**0.03 (0.00–0.26), 0.001**	**0.05 (0.01–0.45), 0.01**	**0.02 (0.00–0.39), 0.01**	**0.01 (0.00–0.73), 0.04**
Sit-to-stand	0.97 (0.93–1.01), 0.06	**0.96 (0.93–1.00), 0.04**	**0.94 (0.90–0.99), 0.02**	0.94 (0.86–1.03), 0.18
Cancer site:				
Colorectal (ref)				
Lung	1.31 (0.71–2.44), 0.39	1.18 (0.62–2.24), 0.61	0.87 (0.36–2.09), 0.75	1.22 (0.36–4.12), 0.75
Upper gastrointestinal	**5.75 (2.28–14.52), < 0.001**	**5.96 (2.22–15.96), < 0.001**	3.19 (0.86–11.80), 0.08	3.57 (0.23–54.54), 0.36
Age (years)				
81+ (ref)				
71–80		1.22 (0.21–7.13), 0.83	0.38 (0.13–10.91), 0.58	4.83 (0.19–120.72), 0.34
61–70		0.92 (0.25–3.46), 0.90	0.82 (0.14–4.83), 0.83	1.57 (0.12–19.95), 0.73
51–60		1.22 (0.36–4.18), 0.75	1.43 (0.28–7.30), 0.67	1.03 (0.10–11.01), 0.98
<51		0.52 (0.15–1.74), 0.29	0.64 (0.14–2.97), 0.57	0.65 (0.06–7.13), 0.72
Gender				
Male (ref)				
Female		1.76 (0.93–3.30), 0.08	2.01 (0.86–4.68), 0.11	1.67 (0.48–5.79), 0.42

Models 2, 3 and 4 were adjusted for age and gender. Model 1 and 2 used data from assessment 1, model 3 used data from assessment 2 and model 4 used data from assessment 3. *$p < 0.05$. CI, confidence interval of odds ratio; EQ-VAS- EuroQoL Visual Analogue Scale; EQ-5D, EuroQoL 5 Dimension; ref, reference category; OR, odds ratio; aOR, adjusted odds ratio.

weight after attending assessment 1 compared to the 4 weeks prior to assessment 1 (see Table S1). Assessment 2 represented the time before the operation and is likely to explain the weight loss identified in most patients between assessment 2 and assessment 3.

A second logistic regression model was conducted to evaluate how each outcome (EQ-VAS, EQ-5D, sit-to-stand and cancer type) influenced the likelihood of a patient experiencing weight loss in the 6 months prior to assessment 1. In the 6 months before starting prehabilitation, 209 patients gained or maintained their weight, whereas 281 patients had lost weight. A logistic regression analysis found that model 2 was statistically significant when compared to the null model ($\chi^2 = 14.0$, d.f. = 5, $p = 0.02$), explained 8.0% of the variation of weight loss (Nagelkerke R^2) and correctly predicted 62.5% of cases. Table 4 shows that after adjusting for age and gender patients with a higher EQ-5D score at assessment 1 were more likely to have gained or maintained their weight in the 6 months prior to assessment 1. Table 4 also shows that the type of cancer has no impact on the likelihood of a patient losing weight in the 6 months prior to assessment 1. In addition, patients under the age of 70 years were less likely to have lost weight in the 6 months before assessment 1 compared to patients over the age of 81 years.

DISCUSSION

There were 44.3% of patients at risk of malnutrition at assessment 1 identified from the PG-SGA(SF). It is evident in the literature that malnutrition is a strong risk factor for complications during and after surgery, including increased levels of mortality, morbidity and length of hospital stay.[10,11,20] However, it is recognised that malnutrition is one of the few modifiable risk factors pre-operatively.[34] Unintentional weight loss, which is a measure used to calculate the PG-SGA(SF), has been directly associated with functional impairment, decreased immune defences, delayed wound healing and organ dysfunction.[35] Interestingly, people after cancer reported a poor nutritional status affected their energy levels, rehabilitation, psychosocial and overall quality of life after surgery.[36] The prehabilitation phase therefore provides a critical time to maximise patient's physical and psychological health to optimise outcomes in preparation for surgical procedures. Incorporating a nutrition-screening tool into prehabilitation is therefore essential.

Almost one third of participants improved their PG-SGA(SF) score in the prehabilitation period following the protocol for triaging nutritional support interventions. This is not surprising because trials have

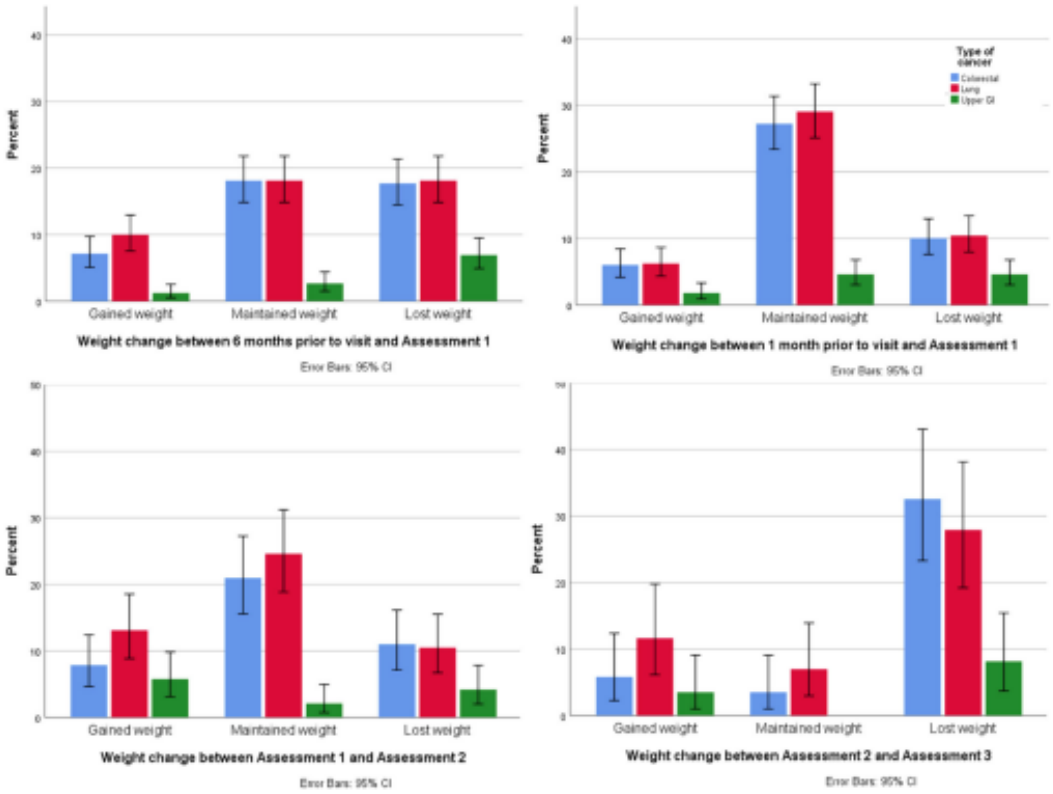

FIGURE 1 Change in weight pre- and post-operatively for patients with colorectal, lung and oesophago-gastric (OG) Cancer

demonstrated that when malnutrition or unintentional weight loss is treated pre-operatively nutritional status is improved and positive outcomes reported in terms of complications and quality of life.[12,37] In addition, most patients (74.3%) maintained or gained weight between assessment 1 and assessment 2. The results show that patients were more likely to improve their nutritional status compared to the weeks preceding initiation of prehabilitation. These findings demonstrate that nutrition screening, as part of a prehabilitation programme is beneficial at identifying risk and then informing the delivery of appropriate nutritional interventions in a real-world clinical environment.

Over half of the participants were at risk of being malnourished after surgery. This is an important finding indicating that the provision of nutritional support interventions are important in the rehabilitation phase as well as prehabiliation. There is a clear drop off in the number of patients attending each of the assessments, with only 20 patients completing all four assessments. This reflects the ongoing nature of the programme with a large number of patients still enrolled and awaiting future assessments.

The PG-SGA(SF) has previously been validated to assess and identify malnutrition in patients with cancer.[23] The present study adds to the current knowledge base by demonstrating that PG-SGA(SF) can effectively triage patents with cancer to specific interventions. The nutritional interventions were delivered by a multidisciplinary team across many healthcare localities, and were aimed at preventing weight loss and reducing the risk of malnutrition with the purpose of optimising health status of patients going into surgery. However, almost half of the patients referred to the Prehab4Cancer programme were not screened for risk of malnutrition. The completion of PG-SGA(SF) required actual weight and weight from the previous 3–6 months. However, because the data collection took part during the pandemic, people without home scales could not visit a relative's house to be weighed or a local chemist or general practitioner's surgery. The main reason given

TABLE 4 Logistic regression to show the impact of weight loss within the previous six months compared to assessment 1 on patients at assessments 1, 2 and 3

	Model 1 Assessment 1 $n = 232$ OR (95% CI), p	Model 2 Assessment 1 $n = 232$ aOR (95% CI), p	Model 3 Assessment 2 $n = 128$ aOR (95% CI), p	Model 4 Assessment 3 $n = 64$ aOR (95% CI), p
EQ-VAS	0.991 (0.97–1.01), 0.37	0.99 (0.97–1.01), 0.26	0.97 (0.93–1.01), 0.18	1.00 (0.94–1.06), 0.98
EQ-5D	0.14 (0.02–1.06), 0.06	**0.11 (0.01–0.98), 0.05**	0.53 (0.03–9.27), 0.66	1.08 (0.00–318.46), 0.98
Sit-to-stand	0.99 (0.96–1.02), 0.45	1.00 (0.97–1.04), 0.94	1.03 (0.98–1.08), 0.22	1.02 (0.93–1.12), 0.63
Cancer site				
Colorectal (ref)				
Lung	0.69 (0.37–1.28), 0.24	0.63 (0.33–1.20), 0.16	0.52 (0.21–1.27), 0.15	0.62 (0.17–2.34), 0.48
Upper gastrointestinal	1.89 (0.79–4.52), 0.15	2.10 (0.85–5.19), 0.11	2.18 (0.61–7.77), 0.23	
Age (years)				
81+ (ref)				
71–80		0.23 (0.04–1.41), 0.11		0.67 (0.02–26.07), 0.83
61–70		**0.12 (0.03–0.53), 0.01**	0.21 (0.04–1.27), 0.09	0.15 (0.01–3.36), 0.23
51–60		**0.14 (0.04–0.52), 0.004**	0.21 (0.04–1.03), 0.06	0.10 (0.01–2.05), 0.14
<51		**0.15 (0.04–0.59), 0.01**	0.30 (0.07–1.31), 0.11	0.17 (0.01–3.19), 0.24
Gender				
Male (ref)				
Female		1.16 (0.62–2.18), 0.65	2.07 (0.87–4.89), 0.10	3.01 (0.82–11.05), 0.10

Models 2, 3 and 4 were adjusted for age and gender. Model 1 and 2 used data from assessment 1, model 3 used data from assessment 2 and model 4 used data from assessment 3. *$p < 0.05$. CI, confidence interval of odds ratio; EQ-VAS, EuroQoL Visual Analogue Scale; EQ-5D, EuroQoL 5 Dimension; ref, reference category; OR, odds ratio; aOR, adjusted odds ratio.

for missing data here was unknown weight and weight recall. Methods of collecting weight data were explored within the Prehab4Cancer team and one suggestion was to provide vulnerable older people with digital scales. Conversely, surrogate markers for weight, including loose fitting clothes, decreasing a dress size or collar size, loosening trousers or tightening of belts notches, have been considered. Other tools that do not require an actual weight would also be an option including the Paperweight Armband or the Modified Patient Association Checklist.[38,39] Nutritional assessment and dietary interventions for housebound vulnerable adults have been previously identified as a priority area for research[40]

Patients with upper gastrointestinal cancer were six times more likely to be malnourished compared to patients with colorectal cancer.[41] In addition, older patients were more likely to have lost weight in the 6 months prior to prehabilitation compared to younger patients. Given these differences, future practice should reflect these finding so that both older patients and those diagnosed with upper gastrointestinal cancer are offered more intense prehabilitation to optimise their nutritional status pre-operatively. Additional dietetic resources were available for patients with upper gastrointestinal cancer prior to surgery in the present study, which may have contributed to such positive results. However, dietetic interventions may not have been implemented in a timely manner, which could have been improved by dedicated time within the prehabilitation service. Other studies have shown benefits of nutritional support in upper gastrointestinal cancers and nutritional interventions have recently been reviewed highlighting clinical and nutritional benefits during the perioperative period in gastrointestinal surgery.[13,42]

Despite these promising findings, 52.5% of patients maintained and 16.7% of patients increased their PG-SGA(SF) score during the prehab phase, demonstrating no improvement and a possible deterioration. This may reflect the lack of time and scope for interventions to be delivered, as the timelines were dependent on the cancer site and on surgical schedules. It may be beneficial to extend the prehab phase to maximise outcomes further, where possible, without delays to surgical interventions. In addition, dedicated nutrition Prehab4Cancer staff would be a considerable advantage to initiate and follow up patients at risk of malnutrition within a timely fashion. However, these results show some positive outcomes from nutritional screening and the implementation of a triage system that can sign post to different nutritional interventions as appropriate. Another limitation is that there were no screening

scores on a large proportion of patients who were referred and assessed at prehabiliation. Further investigation is required to understand why patients did not undergo screening. This was not formally documented as part of the service delivery, and so would be a useful addition to future evaluations and data collection. In addition, the extent of dietary advice and nutritional support interventions provided as a result of screening is unknown and this is an area that would benefit from further research.

These data were collected during the COVID-19 pandemic and so are reflective of service modifications that were made according to public health advice for the data collection period. During the pandemic, many patients opted for home delivery of prehabilitation, which may affect the data in relation to service uptake and engagement levels.

These findings are from a clinical service covering a large geographical area in the North of England including both male and female patients with different demographic backgrounds, socio-economic groups and ages. The PG-SGA(SF) tool has been reported as being accurate, sensitive and specific at diagnosing malnutrition[43]; therefore, this tool can be used with other cancer patients across the UK to identify and triage patients. However, only patients with either lung, colorectal or upper gastrointestinal cancer were included in the present study. Given the nature of the assessment, patients with a cognitive impairment such as dementia or those who are unable to read or write were excluded. In addition, the results are limited because they did not include people who could not speak English, and so the findings are not necessarily generalisable to all ethnic groups.

The triage system for this service focused on risk of malnutrition addressing primarily undernutrition. Malnutrition includes both under and over nutrition and further service developments may include addressing issues such as sarcopenic obesity in cancer patients. Sarcopenic obesity indicates a reduced lean mass and increased fat mass creating a high risk body composition phenotype. A cancer diagnosis is described as a teachable moment[44] and presents an opportunity for healthcare professionals to provide sign posting for healthy eating and strengthening exercises to encourage weight reduction at the same time as maintaining muscle mass. Indeed, resistance exercises are important for all cancer patients and should be encouraged and supported when appropriate to maintain muscle mass and physical function.

The data presented provides new information on nutritional screening and a triage system. The findings suggest that PG-SGA(SF) can be used within a prehabilitation service and nutritional triaging is feasible within a real world environment. The results highlight a need for appropriate staffing resources to be able to implement a triage system and facilitate the provision of nutritional interventions where a risk of malnutrition is identified. The outcome data show that both quality of life and functionality are associated with nutritional status and, specifically, poorer quality of life and function are related to poorer nutritional status.

Further research is required to assess the impact of nutritional interventions delivered as a result of triaging and how the uptake of nutritional screening can be improved.

CONCLUSIONS

This service evaluation shows that the PG-SGA(SF) tool is easy to use in a virtual setting and effectively triages patients to receive the appropriate intervention. Prehabilitation is an important phase to maximise nutritional status, functionality and quality of life in patients with a diagnosis of cancer awaiting a surgical procedure. A longer prehabilitation period could be beneficial to maximise the impact of the intervention, particularly for patients with upper gastrointestinal cancers and older people who have been shown to be at a greater risk of malnutrition.

AUTHOR CONTRIBUTIONS

KRG, JM, SJH, RM, AR, KB collected the data at the Prehab4Cancer assessment time points, CF, STB analysed the data, NB, KO, KD, LG JM, KM, ZM were involved in setting up the service and the study. All authors contributed to the interpretation of findings and the writing of the manuscript.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The lead author affirms that no important aspects of the study have been omitted. The original protocol had to be amended because of the exclusion of case–control studies and studies that assessed only physical activity, as a result of an excessive number of studies identified during the full-text screening search.

REFERENCES

1. Bray F, Laversanne M, Weiderpass E, Soerjomataram I. The ever-increasing importance of cancer as a leading cause of premature death worldwide. Cancer. 2021;127(16):3029–30.
2. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209–49.
3. Maddams J, Utley M, Moller H. Projections of cancer prevalence in the United Kingdom, 2010-2040. Br J Cancer. 2012;107(7):1195–202.
4. Volkert D, Beck AM, Cederholm T, Cruz-Jentoft A, Goisser S, Hooper L, et al. ESPEN guideline on clinical nutrition and hydration in geriatrics. Clin Nutr. 2019;38(1):10–47.
5. Fabi A, Bhargava R, Fatigoni S, Guglielmo M, Horneber M, Roila F, et al. Cancer-related fatigue: ESMO Clinical Practice Guidelines for diagnosis and treatment. Ann Oncol. 2020;31(6):713–23.
6. Silver JK. Cancer rehabilitation and prehabilitation may reduce disability and early retirement. Cancer. 2014;120(14):2072–6.
7. International Surgical Outcomes Study g. Global patient outcomes after elective surgery: prospective cohort study in 27 low-, middle- and high-income countries. Br J Anaesth. 2016;117(5):601–9.
8. Tjeertes EKM, Ultee KHJ, Stolker RJ, Verhagen HJM, Bastos Gonçalves FM, Hoofwijk AGM, Hoeks SE. Perioperative Complications are Associated With Adverse Long-Term Prognosis and Affect the Cause of Death After General Surgery. World J Surg. 2016;40(11):2581–90.
9. Aya M, Riad SRK, Ewen M. Harrison on behalf of GlobalSurg Collaborative, O19. The effect of malnutrition on early outcomes after elective cancer surgery: an international prospective cohort study in 82 countries. *Br J Surg*. 2021;108.
10. Tangvik RJ, Tell GS, Eisman JA, Guttormsen AB, Henriksen A, Nilsen RM, et al. The nutritional strategy: four questions predict morbidity, mortality and health care costs. Clin Nutr. 2014;33(4):634–41.
11. Jeejeebhoy KN, Keller H, Gramlich L, Allard JP, Laporte M, Duerksen DR, et al. Nutritional assessment: comparison of clinical assessment and objective variables for the prediction of length of hospital stay and readmission. Am J Clin Nutr. 2015;101(5):956–65.
12. Burden ST, Gibson DJ, Lal S, Hill J, Pilling M, Soop M, et al. Pre-operative oral nutritional supplementation with dietary advice versus dietary advice alone in weight-losing patients with colorectal cancer: single-blind randomized controlled trial. J Cachexia Sarcopenia Muscle. 2017;8(3):437–46.
13. Carmichael L, Rocca R, Laing E, Ashford P, Collins J, Jackson L, et al. Early postoperative feeding following surgery for upper gastrointestinal cancer: A systematic review. J Hum Nutr Diet. 2022;35(1):33–48.
14. Marshall KM, Loeliger J, Nolte L, Kelaart A, Kiss NK. Prevalence of malnutrition and impact on clinical outcomes in cancer services: A comparison of two time points. Clin Nutr. 2019;38(2):644–51.
15. Macmillan Cancer Support RCoA, National Institute for Health Research Cancer and Nutrition. Prehabilitation for people with cancer: Principles and guidance for prehabilitation within the management and support of people with cancer 2019. Available from: https://cdn.macmillan.org.uk/dfsmedia/1a6f23537f7f4519bb0cf14c45b2a629/1532-source/prehabilitation-for-people-with-cancer-tcm9-353994?_ga=2.61038574.371921948.1637765606-1901792209.1637765606
16. Carli F, Gillis C, Scheede-Bergdahl C. Promoting a culture of prehabilitation for the surgical cancer patient. Acta Oncol. 2017;56(2):128–33.
17. Gillis C, Buhler K, Bresee L, Carli F, Gramlich L, Culos-Reed N, et al. Effects of Nutritional Prehabilitation, With and Without Exercise, on Outcomes of Patients Who Undergo Colorectal Surgery: A Systematic Review and Meta-analysis. Gastroenterology. 2018;155(2):391–410.
18. Gillis C, Davies SJ, Carli F, Wischmeyer PE, Wootton SA, Jackson AA, et al. Current Landscape of Nutrition Within Prehabilitation Oncology Research: A Scoping Review. Front Nutr. 2021;8:644723.
19. West MA, Wischmeyer PE, Grocott MPW. Prehabilitation and Nutritional Support to Improve Perioperative Outcomes. Curr Anesthesiol Rep. 2017;7(4):340–9.
20. Wischmeyer PE, Carli F, Evans DC, Guilbert S, Kozar R, Pryor A, et al. American Society for Enhanced Recovery and Perioperative Quality Initiative Joint Consensus Statement on Nutrition Screening and Therapy Within a Surgical Enhanced Recovery Pathway. Anesth Analg. 2018;126(6):1883–95.
21. Zhang Y, Li Z, Jiang L, Xue Z, Ma Z, Kang W, et al. Marked loss of adipose tissue during neoadjuvant therapy as a predictor for poor prognosis in patients with gastric cancer: A retrospective cohort study. J Hum Nutr Diet. 2021;34(3):585–94.
22. Jensen GL, Cederholm T, Correia M, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM Criteria for the Diagnosis of Malnutrition: A Consensus Report From the Global Clinical Nutrition Community. JPEN J Parenter Enteral Nutr. 2019;43(1):32–40.
23. Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. Eur J Clin Nutr. 2002;56(8):779–85.
24. Balstad TR, Bye A, Jenssen CR, Solheim TS, Thoresen L, Sand K. Patient interpretation of the Patient-Generated Subjective Global Assessment (PG-SGA) Short Form. Patient Prefer Adherence. 2019;13:1391–400.
25. Matthews LS, Wootton SA, Davies SJ, Levett DZH. Screening, assessment and management of perioperative malnutrition: a survey of UK practice. Perioper Med. 2021;10(1):30.
26. Narendra K, Kiss N, Margerison C, Johnston B, Chapman B. Impact of nutritional status/risk and post-operative nutritional management on clinical outcomes in patients undergoing gastrointestinal surgery: a prospective observational study. J Hum Nutr Diet. 2020;33(4):587–97.
27. Burden ST, Stamataki Z, Hill J, Molasiotis A, Todd C. An exploration of food and the lived experience of individuals after treatment for colorectal cancer using a phenomenological approach. J Hum Nutr Diet. 2016;29(2):137–45.
28. Byrnes A, Mudge A, Young A, Banks M, Bauer J. Use of hand grip strength in nutrition risk screening of older patients admitted to general surgical wards. Nutrition & Dietetics. 2018;75(5):520–6.
29. Ramsey KA, Meskers CGM, Trappenburg MC, Verlaan S, Reijnierse EM, Whittaker AC, et al. Malnutrition is associated with dynamic physical performance. Aging Clin Exp Res. 2020;32(6):1085–92.
30. Yee XS, Ng YS, Allen JC, Latib A, Tay EL, Abu Bakar HM, et al. Performance on sit-to-stand tests in relation to measures of functional fitness and sarcopenia diagnosis in community-dwelling older adults. Eur Rev Aging Phys Act. 2021;18(1):1.
31. Moore J, Merchant Z, Rowlinson K, McEwan K, Evison M, Faulkner G, et al. Implementing a system-wide cancer prehabilitation programme: The journey of Greater Manchester's 'Prehab4cancer'. Eur J Surg Oncol. 2021;47(3 Pt A):524–32.
32. I C. IBM SPSS Statistics for Windows.Armonk, NY: IBM Corp2017. 2017.
33. Team R RStudio: Integrated Development for R. RStudio, PBC Boston, MA URL 2020.
34. Vaid S, Bell T, Grim R, Ahuja V. Predicting risk of death in general surgery patients on the basis of preoperative variables using American College of Surgeons National Surgical Quality Improvement Program data. Perm J. 2012;16(4):10–7.

35. Gillis C, Wischmeyer PE. Pre-operative nutrition and the elective surgical patient: why, how and what? Anaesthesia. 2019;74(Suppl 1):27–35.
36. Stamataki Z, Burden S, Molassiotis A. Weight changes in oncology patients during the first year after diagnosis: a qualitative investigation of the patients' experiences. Cancer Nurs. 2011;34(5):401–9.
37. Burden S, Todd C, Hill J, Lal S. Pre-operative Nutrition Support in Patients Undergoing Gastrointestinal Surgery. Cochrane Database Syst Rev. 2012;11:008879.
38. Murphy JL, Aburrow A, Guestini A, Brown R, Parsons E, Wallis K. Identifying older people at risk of malnutrition and treatment in the community: prevalence and concurrent validation of the Patients Association Nutrition Checklist with 'MUST'. J Hum Nutr Diet. 2020;33(1):31–7.
39. Edwards S, Farrer K, Rose E, Haynes D, McLaughlin J. Brief intervention using the PaperWeight Armband to identify older people at risk of undernutrition in the community: a preliminary evaluation. J Epidemiol Community Health. 2022;76(1):32–7.
40. Jones DJ, Baldwin C, Lal S, Stanmore E, Farrer K, Connolly E, et al. Priority setting for adult malnutrition and nutritional screening in healthcare: a James Lind Alliance. J Hum Nutr Diet. 2020;33(2):274–83.
41. Grace EM, Shaw C, Lalji A, Mohammed K, Andreyev HJN, Whelan K. Nutritional status, the development and persistence of malnutrition and dietary intake in oesophago-gastric cancer: a longitudinal cohort study. J Hum Nutr Diet. 2018;31(6):785–92.
42. Reece L, Hogan S, Allman-Farinelli M, Carey S. Oral nutrition interventions in patients undergoing gastrointestinal surgery for cancer: A systematic literature review. Supp Care Cancer. 2020;28(12):5673–91.
43. Kubrak C, Jensen L. Critical evaluation of nutrition screening tools recommended for oncology patients. Cancer Nurs. 2007;30(5):E1–6.
44. Frazelle ML, Friend PJ. Optimizing the Teachable Moment for Health Promotion for Cancer Survivors and Their Families. J Adv Pract Oncol. 2016;7(4):422–33.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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Editorial

Prehabilitation and preparation for surgery: has the digital revolution arrived?

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The COVID-19 pandemic has profoundly disrupted global elective surgical care [1]. There are presently 5 million people in the UK on an elective surgical waiting list, a number expected to grow in the coming months [2]. The capacity of peri-operative services is finite. Increasing this to address the backlog is a substantial challenge and expected to be the rate-limiting step [3]. Restoration of elective surgical pathways will be complicated by the need to mitigate the risk of peri-operative COVID-19 infection and its significant implications for patients and staff [4]. This situation has effectively created a generation of patients waiting longer for treatment, with reduced pre-operative support driving increased levels of patient anxiety and reduced 'preparedness' for surgery. Given the major continued burden on front-line NHS staff [5], a co-ordinated national response comprising innovative solutions is required to address this problem.

Waiting better

The series of national lockdowns in the UK over the last 18 months may have significantly undermined the nation's health, increasing the rates of health risk behaviours that elevate peri-operative risk. The rates of physical inactivity, alcohol consumption and smoking may have increased, with further negative effects on diet and mental health [6, 7]. A recent concern highlighted is the association between pre-operative patient isolation and adverse postoperative outcomes [8]. Crucially, existing health inequalities mean these effects may not be evenly distributed across the population [9]. The association between high levels of social deprivation, increased prevalence of health risk behaviours and associated chronic ill-health leading to adverse peri-operative outcomes was already well established. Unfortunately, the pandemic appears to have disproportionately affected the health of this patient group [10], acutely exacerbating the problem. Supporting patients to tackle these health risk behaviours and improve their physical and mental readiness for surgery is increasingly recognised by national bodies as an important step forward in addressing this situation and has been the focus of several prehabilitation services in the UK [11, 12]. Capturing the shared learning and experience gathered over the last 3–4 years will now be crucial in seizing the opportunity which the current national situation presents.

In a national briefing from the UK Centre for Peri-operative Care [13], the need to redesign peri-operative

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pathways for the COVID-19 era was emphasised. A 'smart reset' of elective surgery is intended to not only mitigate the immediate issues of the pandemic but re-engineer peri-operative pathways for the long term. Two of the key messages relate directly to the reframing of waiting lists as preparation lists: 1. The need to develop peri-operative care as a model to promote healthy living and prevention of future ill health; and 2. The need to develop effective, virtual patient solutions. This drive has been reflected in the establishment of cross-sector 'waiting well' initiatives within regional integrated care systems seeking to understand the needs of, and support required for, patients to improve their readiness for surgery.

The unplanned shift to digital prehabilitation

Before the COVID-19 pandemic, the majority of prehabilitation services were operating as face-to-face multi-behavioural health promotion programmes. In April 2020, all NHS services were required to rapidly reconfigure their delivery because face-to-face patient contact was minimised. This had a major impact on prehabilitation support due to the lack of evidence-based remotely supervised ('home-based') prehabilitation options to match and complement face-to-face offers. Pre-pandemic work by the authors had already highlighted this unmet patient need. In one service based in the north of England and serving a tertiary geographical population, approximately 50% of patients approached for face-to-face prehabilitation participation before surgery declined [12]. Reasons cited by patients included: travel distance and cost; lack of transport; inflexibility of timing related to working and other life commitments; cost; discomfort in group environments; and preference for home-based support. The need for a wider menu of options to maximise patient engagement and reduce inequality of access was therefore already evident and brought acutely into focus by the changes in healthcare delivery enforced by the pandemic.

Existing prehabilitation services around the UK responded rapidly to this challenge through a period of innovation, development and delivery of virtual alternatives to enable continued support of patients awaiting urgent surgery or other treatments. Examples included: Conversion of patient information materials to multimedia online formats; introduction of live virtual classes using teleconferencing programmes; structured web and app-based health promotion programmes; and digital health coaching. A range of road-tested virtual options now support the initial development of 'hybrid prehabilitation' with a combination of digital and face-to-face offers.

Further successful peri-operative digital interventions have taken place, including 'digital joint school'. Although as yet unpublished, compelling results from this digital innovation have driven a major change in the peri-operative orthopaedic pathway at South Tees Hospitals. Between 2017 and 2020, digital joint school showed excellent patient engagement and significant improvements in quality of life, with associated improvement in Oxford hip and knee scores and reductions in hospital duration of stay [14]. Manchester's surgery school has also produced a virtual version to support group education in major surgical pathways [15]. As peri-operative care pathways seek to make digitally facilitated prehabilitation and preparation options available, valuable groundwork has been laid.

The case for digital?

Digitally facilitated interventions to support health behaviour change are established in several clinical settings. Perhaps the nearest aligned healthcare setting is in cardiac rehabilitation where multi-behavioural digital platforms have demonstrated comparable efficacy in behaviour change to face-to-face programmes, with excellent rates of patient engagement and adherence [16]. Other successful interventions have demonstrated improved glycaemic control in patients with type-2 diabetes through increased physical activity and dietary change [17], and reduced alcohol consumption [18].

These interventions align with NHS priorities to adopt technology in healthcare delivery closer to home. They confer several potential advantages over face-to-face and paper-based remote models, including flexibility for patients and staff. Potential cost effectiveness is supported by the capacity for comparatively fewer team members to monitor and support multiple patients simultaneously, alongside reduced space and equipment requirements. Developments in audiovisual and communication technology increasingly allow some of the unique benefits of a face-to-face interaction with a healthcare professional to be obtained remotely. Wearable devices capable of increasingly sophisticated continuous and detailed biometric monitoring can be integrated to enhance intervention fidelity, providing continuous feedback to patients and insight into the physiological effects of their peri-operative journey.

Digital solutions also have the capability to be scaled rapidly geographically to support large numbers of patients at minimal additional expense creating a potentially attractive return on investment solution. Platforms can also be designed to integrate with existing electronic record systems with the potential to streamline and digitalise complete peri-operative care pathways.

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A digital prehabilitation framework

Figure 1 presents a potential framework for discussing the range of digital prehabilitation options now available. The 'tiered offer' for prehabilitation support more broadly introduced in national guidance for prehabilitation of people with cancer [19] was used as a basis for this, with the framework aiming to help rationalise which resources are offered. The wide range in patient need across the surgical population must be balanced against the intensity of support and resources required. Universal offers are applicable to most patients preparing for surgery providing generic support with minimal healthcare staff input. 'Targeted' offers provide more structured support, tailored to patient needs and introduction of remote supervision by a healthcare professional. Finally, 'specialist' offers are intended to support patients requiring the most intensive support for complex needs, providing the elements of targeted interventions with more intensive staff supervision and support.

Challenges and potential pitfalls

The range of digital options now becoming available could revolutionise prehabilitation and peri-operative support in the UK, with the potential for rapid dissemination and uptake. However, it is critical not to lose sight of the fact that despite use of cutting-edge technology, these solutions are fundamentally health behaviour change interventions. It is also important to acknowledge that although many of the available digital solutions have undergone 'live' preliminary road testing with encouraging results, rigorous evaluations are not yet available. This situation reflects the tension between choosing rapid resource creation with a contemporaneous live evaluation process or a slower, systematic design and development process leading to formal testing.

Learning from the longer term use of similar interventions in wider healthcare contexts supports the latter approach. The importance of applying this learning from wider healthcare to prehabilitation interventions has been shown [20]. Employing established, systematic methods for iterative intervention development, grounded in health behaviour change theory, facilitates a clear understanding of intervention function and why specific behaviour change techniques were chosen and incorporated. Involving patients at the earliest possible opportunity in this process (co-design) is crucial to later success. A robust intervention development process supports subsequent evaluation and the understanding of why a given intervention does (or does not) perform well [21]. If an evidence base for digital solutions is to be built, we must use this to capitalise on the efforts already made and further develop those interventions now available to

Figure 1 Framework for digitally facilitated prehabilitation support. PROM, patient-reported outcome measure; PREM, patient-reported experience measure. Adapted with permission from [24].

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provide the best chance of real-world durable success and ensure a return on resource investment. A time-efficient combined approach may be possible; however, close synergy will be required between industry and NHS partners in achieving this. The authors are aware of several examples in the UK where this type of collaboration is already underway.

One particular concern that is widely discussed is the concept of 'digital exclusion'. For many of the patients who stand to benefit most, the offer of a digital prehabilitation intervention may be unappealing, anxiety provoking or completely inaccessible. Digital exclusion is strongly associated with wider health inequality. It is estimated that 20% of the UK population (11.6 million people) lack basic digital skills, or do not use digital technology at all. This group is likely to predominantly comprise people who are older or from a poorer socio-economic background (and therefore lacked opportunity), both of which are associated with an increased risk of chronic ill-health and utilisation of healthcare services. In a move towards digital, without a plan to proactively address this, we run the risk of worsening the situation we aimed to improve. In the *Digital Inclusion Guide for Health and Social Care* [22], NHS digital identifies several key barriers, including:

(i) Confidence and skills - patients may lack the information technology literacy necessary or fear risks such as online crime. Interventions must be co-designed with intended users with this in mind.
(ii) Opportunity and access - 20% of households with an adult >65 years of age may lack an internet connection or have variable device access. For example, learning from Digital Joint School identified that older patients may be more comfortable using desktop devices over mobile alternatives [14].
(iii) Motivation, awareness, and staff capability and capacity - patients may be unaware of resources available or the potential benefits to them. Staff involvement in the design process is critical to build confidence in recommending digital interventions to patients and supporting their usage.

NHS Digital recommends a holistic series of cross-sector measures that can be undertaken to address these barriers based upon local needs and barriers, adopting learning from the NHS widening digital participation programme [23] that demonstrated a £6.40 return on investment for every £1 spent on inclusion support (see Box 1).

Clearly, active input and collaboration across several agencies, including healthcare and industry partners, will be required to meet this challenge.

Box 1

- Community digital skills training: community online centres can provide support to patients, delivered in partnership between public, private and voluntary sector organisations.
- Digital champions: designated patient volunteers and staff can access training to support others in enhancing their skills and understand the potential benefits of getting online. Enhancing the digital skills of staff to act in this role is a focus of the Health Education England (HEE) digital capabilities framework [24].
- Intergenerational mentoring: digitally enabled family members and friends are a powerful resource to introduce and support older patients in utilising available resources.
- Assistive technologies: patients facing physical barriers to inclusion, for example poor eyesight preventing keyboard usage can be supported by dedicated technologies such as voice activated systems.
- Signposting to free public Wi-Fi: patients can be signposted and supported to safely access freely available Wi-Fi including at most NHS GP practices.
- Social prescribing: social prescribing initiatives are now embedded within NHS primary care and ideally placed to connect patients to locally available digital support.

In conclusion, the marked shift to digital prehabilitation delivery holds enormous potential to produce rapidly scalable solutions that can support patients facing extended waits for surgery. Realising this potential will require thoughtful intervention development that places patients at the centre, minimises the risk of increasing inequalities and supports creation of an evidence base. Finally, despite efforts to deliver inclusive digital solutions that meet patient and service needs, demand will continue for equally robustly developed face-to-face and 'paper-based' remote options. If our aim is to engage the fullest range of patients in prehabilitation activity, a menu of options will be required as one size cannot fit all.

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References

1. COVIDsurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. *British Journal of Surgery* 2020; **107**: 1440–9.
2. Royal College of Surgeons of England. Press Release: Surgeons call for investment in surgical hubs as NHS waiting list hits record 5.3 million. 2021. https://www.rcseng.ac.uk/news-and-events/media-centre/press-releases/waiting-times-may-2021 (accessed 21/09/2021).
3. Stoye G, Warner M, Zaranko B. Could NHS waiting lists really reach 13 million? Institute for Fiscal Studies. 2021. https://ifs.org.uk/publications/15557 (accessed 21/09/2021).
4. El-Boghdadly K, Cook TM, Goodacre T, et al. SARS-CoV-2 infection, COVID-19 and timing of elective surgery: a multidisciplinary consensus statement on behalf of the Association of Anaesthetists, the Centre for Peri-operative Care, the Federation of Surgical Specialty Associations, the Royal College of Anaesthetists and the Royal College of Surgeons of England. *Anaesthesia* 2021; **76**: 940–6.
5. Wong DJ, Bailey CR, El-Boghdadly K. Staff: our most valuable asset. *Anaesthesia* 2021; **76**: 1151–4.
6. Naughton F, Ward E, Khondoker M, et al. Health behaviour change during the UK COVID-19 lockdown: findings from the first wave of the C-19 health behaviour and well-being daily tracker study. *British Journal of Health Psychology* 2021; **26**: 624–43.
7. Niedzwiedz CL, Green MJ, Benzeval M, et al. Mental health and health behaviours before and during the initial phase of the COVID-19 lockdown: longitudinal analyses of the UK Household Longitudinal Study. *Journal of Epidemiology and Community Health* 2021; **75**: 224–31.
8. COVIDSurg Collaborative, GlobalSurg Collaborative. Effects of pre-operative isolation on postoperative pulmonary complications after elective surgery: an international prospective cohort study. *Anaesthesia* 2021; **76**: 1454–64.
9. Bann D, Villadsen A, Maddock J, et al. Changes in the behavioural determinants of health during the COVID-19 pandemic: gender, socioeconomic and ethnic inequalities in five British cohort studies. *Journal of Epidemiology and Community Health* 2021. Epub 26 May. https://doi.org/10.1136/jech-2020-215664
10. Bibby J, Everest G, Abbs I. Will COVID-19 be a watershed moment for health inequalities. The Health Foundation 2020. https://www.health.org.uk/publications/long-reads/will-covid-19-be-a-watershed-moment-for-health-inequalities (accessed 10/10/2021).
11. Moore J, Merchant Z, Rowlinson K, et al. Implementing a system-wide cancer prehabilitation programme: the journey of greater Manchester's 'Prehab4cancer'. *European Journal of Surgical Oncology* 2021; **47**: 524–32.
12. Tew GA, Bedford R, Carr E, et al. Community-based prehabilitation before elective major surgery: the PREP-WELL quality improvement project. *British Medical Journal Open Quality* 2020; **9**: e000898.
13. Centre for Perioperative Care. Delivering on Opportunities for Better Health and Peri-operative Care in the Covid-19 Era. 2020. https://cpoc.org.uk/cpoc-publishes-delivering-opportunities-better-health-and-peri-operative-care-covid-19-era (accessed 21/09/2021).
14. Centre for Perioperative Care. Development and impact of a 'digital joint school' within an orthopaedic pathway surgery pathway (South Tees Hospitals NHS Foundatoin Trust). 2021. https://cpoc.org.uk/case-studies-preoperative-optimisation (accessed 07/10/2021).
15. Centre for Perioperative Care. Preoperative Assessment and Optimisation for Adult Surgery. 2021. https://www.cpoc.org.uk/sites/cpoc/files/documents/2021-06/Preoperative%20assessment%20and%20optimisation%20guidance.pdf (accessed 21/09/2021).
16. Houchen-Wolloff L, Gardiner N, Devi R, et al. Web-based cardiac REhabilitatioN alternative for those declining or dropping out of conventional rehabilitation: results of the WREN feasibility randomised controlled trial. *Open Heart* 2018; **5**: e000860.
17. Kebede MM, Zeeb H, Peters M, Heise TL, Pischke CR. Effectiveness of digital interventions for improving glycemic control in persons with poorly controlled type 2 diabetes: a systematic review, meta-analysis, and meta-regression analysis. *Diabetes Technology and Therapeutics* 2018; **20**: 767–82.
18. Kaner EFS, Beyer FR, Garnett C, et al. Personalised digital interventions for reducing hazardous and harmful alcohol consumption in community-dwelling populations. *Cochrane Database of Systematic Reviews* 2017; **9**: CD011479.
19. Macmillan Cancer Support, Royal College of Anaesthetists, National Institute for Health Research. Prehabilitation for people with cancer. 2019. https://www.macmillan.org.uk/healthcare-professionals/news-and-resources/guides/principles-and-guidance-for-prehabilitation (accessed 10/10/2021).
20. Grimmett C, Bradbury K, Dalton SO, et al. The role of behavioral science in personalized multimodal prehabilitation in cancer. *Frontiers in Psychology* 2021; **16**: 634223.
21. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science* 2011; **23**: 42.
22. Digital NHS. Digital inclusion guide for health and social care. 2019. https://digital.nhs.uk/about-nhs-digital/our-work/digital-inclusion (accessed 19/10/2021).
23. Good Things Foundation. Digital inclusion in Health and Care: Lessons Learned During the NHS Widening Digital Participation Programme (2017-2020). 2020. https://www.goodthingsfoundation.org/insights/digital-participation-lessons-learned (accessed 19/10/2021).
24. Health Education England. A Health and Care Digital Capabilities Framework. 2018. https://www.hee.nhs.uk/sites/default/files/documents/Digital%20Literacy%20Capability%20Framework%202018.pdf (accessed 19/20/2021).

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Chapter 9
Prehabilitation and Rehabilitation in Older Adults with Cancer and Frailty

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Introduction

It is well-accepted that the adverse effects of cancer and associated treatment(s) are essentially ubiquitous across disease types and can be highly deleterious to quality of life (QoL). For many people with cancer, the significant physical and psychosocial morbidity associated with the cancer compromise functional ability across these domains. Functional impairments are highly prevalent and can be due to the disease or treatment, such as the new onset or exacerbation of fatigue, pain, neuropathy, lymphoedema, urinary or bowel dysfunction, difficulty with speech or eating, aerobic and musculoskeletal deconditioning, sexual dysfunction, distress, anxiety, depression and cognitive deficits [1, 2]. Screening, assessment, and intervention approaches that aim to identify and prevent dysfunction, as well as maintain or recover pre-diagnosis levels of function, are recommended. Such services and practices are classified as prehabilitation (prior to treatment) or rehabilitation (during or after treatment). The goals of prehabilitation (prehab) and rehabilitation (rehab) are to manage functional changes associated with cancer and optimise health across the cancer continuum.

Recommendations for referral to prehab and rehab, as well as evidence-based clinical practice guidelines that direct such care, have grown rapidly in recent years [3, 4]. However, only a few have specifically focused on the needs of older adults with cancer [5, 6]. This subset of cancer survivors has been historically unaccounted for in research and in tailored clinical programmes, despite their growing prevalence and their complex needs, from age-related changes to physiology, function, cognition and concomitant comorbidities [4, 7–10]. For example, Pergolotti and colleagues found that approximately two-thirds of older adults with cancer report functional limitations [11], and in a systematic review of 20 studies and nearly 3000 older patients by Handforth et al, over 40% were identified as frail or prefrail [12]. Moreover, when combined with disease and treatment-related adverse effects, frail older adults with cancer and functional limitations are more likely to have surgical complications, treatment intolerance, chronic disability and hastened mortality [12–14]. In light of the prevalence of dysfunction and frailty in older adults with cancer, combined with their associated increased risk for poor health outcomes, there is a compelling need for prehab and rehab to optimise health and prevent, mitigate or ameliorate loss of function throughout the cancer continuum. Older adults with functional impairments are historically not referred to rehab [15], although it is understood that referral behaviour varies internationally.

This chapter aims to provide considerations for the integration of prehab and rehab delivery for frail older adults with cancer into clinical care plans citing examples from the scientific literature. The Dietz's phases of rehabilitation [16] are used to structure chapter sections given their nuanced considerations across the cancer continuum. The chapter concludes with recommendations highlighting priorities in advancing prehab and rehab care and research for older cancer patients with frailty.

Prehabilitation, Rehabilitation and Frailty

A commonly used definition for cancer rehabilitation is '[a care strategy] that aims to allow the patient to achieve optimal physical, social, physiological and vocational functioning within the limits imposed by the disease and its treatment [17]'. The essence of this definition was subsequently applied to distinct contexts related to patients' circumstances and needs [16] (Box 9.1). Importantly, early cancer rehabilitation conceptualisations acknowledged the importance of preventing or minimising the adverse effects of cancer treatment with interventions implemented prior to treatment—a strategy now referred to as 'prehab'.

Box 9.1. Dietz Phases of Cancer Rehabilitation

- *Preventative phase*: Limiting the impact of potential complications and morbidity which could be acquired as the result of treatment.
- *Restorative phase*: A person being facilitated to resume their pre-morbid level of functional ability.
- *Supportive phase*: Where continued treatment is needed, the aim is to maximise independence and functional ability whilst also ensuring the necessary support is in place.
- *Palliative phase*: Symptom management as a person is expected to deteriorate in response to the disease progression, maximising quality of life where possible.

Cancer prehab is defined as a 'process on the cancer continuum of care that occurs between the time of cancer diagnosis and the beginning of acute treatment and includes physical and psychological assessments that establish a baseline functional level, identify impairments, and provide interventions that promote physical and psychological health to reduce the incidence and/or severity of future impairments [1]'. Contemporary approaches to prehab and rehab for people with cancer emphasise individualisation of programming for person-centred, goal-directed care, whilst discouraging a 'one-size-fits-all' approach [2]. Accordingly, prehab and rehab are often 'multimodal' and incorporate two or more intervention components specifically selected for their potential cumulative or synergistic effects on health outcomes for a given patient. Multimodal care is inherently inter-professional, requiring the coordinated efforts of a variety of professions (Fig. 9.1).

Following a cancer diagnosis, resilience to the inherent stressors of treatment and lifestyle changes is needed to preserve health and QoL. For patients who are older and frail, prehab and rehab can target resiliency to support adaptive capacity as depicted in the schematic of frailty and its relationship with stress and treatment outcomes (Fig. 9.2). Whilst adaptive capacity may be commonly interpreted as resilience to physiological stressors, the importance of psychosocial and cognitive resilience may be particularly relevant to the older adult with cancer given the

Fig. 9.1 The interdisciplinary team. *Exercise Professionals: Including but not limited to exercise physiologists, kinesiologists, fitness instructors and sport rehabilitators

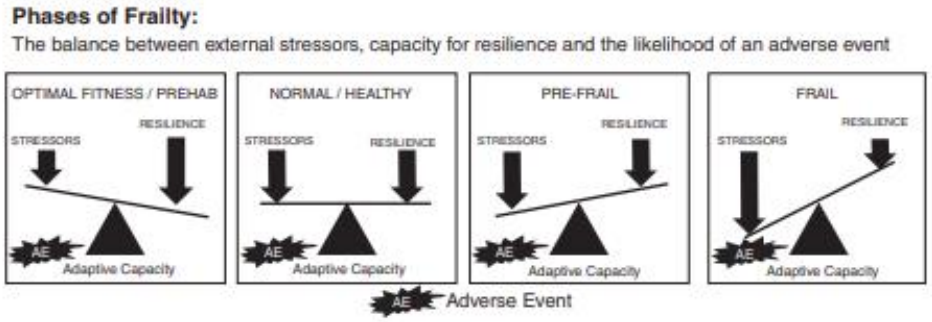

Fig. 9.2 Phases of frailty and the correlation with an older persons' adaptive capacity to be resilient to adverse events (Adapted from [24])

likelihood for social isolation and age/co-morbid or treatment-related cognitive decline [18–21]. Accordingly, assessments must be multidimensional to capture the breadth of health, psychosocial and functional factors, to appropriately design prehab and rehab interventions in this population. The National Comprehensive Cancer Network (NCCN) and the American Society of Clinical Oncology (ASCO) specifically recommend geriatric screening and assessment tools to appraise functional status across physical, cognitive, medical and social domains [5, 6]. Frailty screening, as a minimum, is recommended when older adults are diagnosed with cancer and also when a referral to prehab/rehab is being considered. These evaluations, including determining the support a patient needs, aids to avoid over- or

under-treatment of cancer, a well-known problem in geriatric oncology [22]. In particular, the Comprehensive Geriatric Assessment (CGA) is recommended as standard of care in this population to identify vulnerabilities beyond usual oncological assessments [5]; however, due to potential time requirements of the CGA and the balance of overall data, clinicians are recommended to prioritise the assessment of function, comorbidity, falls, mood, cognition and nutrition [5]. CGA is a key component in the identification of patients for referral to prehab and rehab and an important assessment tool within prehab and rehab programmes. Therefore, it is unsurprising that referrals to physiotherapy, occupational therapy, nutrition or dietetics and speech-language pathology or speech and language therapy (grouped as 'Allied Health Professionals—AHPs') are commonly advised for patients with functional deficits identified during geriatric assessments [23].

Ultimately, when managing cancer patients, particularly if older and with frailty, both the patient and the family/carers should be involved in discussions around treatment planning, adopting the mantra of 'no decision without me, about me' as suggested by Cancer Research UK [25]. The findings from the CGA better identify the risks and the unmet needs for patients, such as additional support required in order to undergo specific treatments, which aids treatment-related decisions. Overall, important considerations for frail or pre-frail older adults with cancer include: (a) their capacity for decision-making [26]; (b) the need for a patient-centred approach assessing the person holistically (not just their needs, but also their wishes and goals) and (c) the focus on functional independence and QoL which are often more important than length of survival for this group of patients [27].

Preventative Phase of Cancer Rehabilitation (Prehab)

The aim of prehab is to improve and or prevent physical, mental wellbeing and nutritional dysfunction, increase the likelihood of a return to functional baseline and optimise the patient's ability to undergo additional oncology treatments [20, 21, 27].

Prehab should be multimodal and incorporate aerobic and resistance exercise, nutritional support and mental wellbeing interventions (to support anxiety and mood disturbance), as well as behaviour change strategies to promote adherence and longer-term lifestyle changes [10]. For healthy lifestyle modification smoking cessation and alcohol intake management [28] where applicable should be included, and medical optimisation of other health conditions. Prehab for older cancer patients with frailty should be guided by the CGA, with programmes starting as early as possible in the cancer pathway to ameliorate the often quick decline between the onset of symptoms, diagnosis and eventual treatment [29]. Prehab interventions should be routinely assessed and adapted based upon the findings of additional dynamic risk assessments, re-considered at the start of each patient contact using pre-agreed risk criteria such as changes in symptoms, medication etc., to ensure optimal programme effects and to prevent harm [29].

Exercise interventions and advice within the context of prehab require several considerations and adaptations for the frail older adult with cancer. Traditionally, there has been a dominance for cardiovascular-based aerobic exercise (walking, cycling) interventions. However, with the increasingly recognised prevalence of sarcopenia in older patients with cancer, an equal focus on resistance training combined with nutritional protein supplements is recommended to improve muscle function and potentially reverse frailty [29, 30]. Prehab programmes may be outpatient, community or home-based, and safety guidelines are important so as to ascertain potential cautions or contraindications [29]. For those prescribing or delivering the exercise programme, relevant physiological parameters (blood pressure, heart rate, oxygen saturation (SaO2)) should be specified as part of local standard operating procedures with attention to potential changes in the patients' condition and screening for agreed 'red flags' which might escalate the patient back to the clinical team and temporarily suspend them from the programme. Where a prehab programme does not currently exist, 'home based exercises' for older people with a focus on achievable goals based on their CGA is still valuable. These may range from a simple exercise prescription inclusive of ascending stairs at home a set number of times daily, to asking a patient to increase their completion of physically challenging Instrumental Activities of Daily Living (IADLs), which may enhance their level of independence in the community, such as walking to the local shops. Similarly, comprehensive prehab services may incorporate such occupation-based 'physical activities' as a method to effectively engage and achieve programme aims for older adults experiencing frailty. Other obstacles to prehab may be identified in the holistic needs assessment within a CGA such as financial burden, reliance on family members and reduced volition, all of which could present as potential blocks to engagement for this vulnerable group [12, 31].

Sequencing difficulties are a common deficit component experienced by patients with cognitive impairment and new activities such as prehab may be difficult to 'initiate' if they are unfamiliar to the patient. Thus, it may be necessary to 'activate' the patient to engage in interventions, through verbal and physical prompting and demonstration from another person. A trial of a digital solution 'Fit4Surgery TV' has been successful in actively prompting older colorectal cancer patients with frailty to complete prehab tasks [30]. Similarly, wearable activity tracker trials have been shown to be a motivating factor for increased physical activity [32]. These studies are small but show an emerging technology-driven methodology to support prehab and rehab in older patients [33].

Nutrition is an important consideration in older adults with cancer undergoing either prehab or rehab, and there are several important considerations regarding this topic. First, malnutrition is common in older adults with cancer [34, 35], and is a major risk factor for frailty [36]. Second, malnutrition is associated with multiple adverse outcomes, including post-operative outcomes, reduced tolerance to and greater adverse events from chemotherapy, functional decline and worse QoL [34]. Third, malnutrition is more common in advanced cancer, and is sometimes

difficult to separate from the cancer anorexia and cachexia syndrome [35]. Finally, there are major gaps in knowledge of how to optimise nutrition in older adults with cancer, but dietary counselling and nutritional supplementation have shown to be valuable [34]. Moreover, evidence in other settings, particularly inpatient acute care and rehabilitation settings, has shown the importance of systematically identifying undernutrition and targeting it with protein-calorie supplementation, which can improve functional recovery, QoL and survival in specific settings [37, 38].

'Social frailty', the concept of losing one's resources required for social requirements such as engagement in social activities [39], needs to be addressed as it may indeed precede and be implicated in the development of physical and/or cognitive frailty. Depression and social isolation lead to apathy, reduced self-management and self-neglect with compromised adherence to medication and other advice. Additional considerations important for older adults include health literacy and education, digital exclusion, management of social communication, nutritional and swallowing difficulties and adapting assessments and interventions to account for hearing and vision loss [25]. By addressing these potential 'barriers to engagement' for this cohort, there will be greater likelihood of goal achievement and subsequent improved clinical outcomes and QoL.

In Europe, in-patient and community programmes for both prehab and rehab exist, whereas in Australia these are predominately out-patient. Some examples of prehabilitation programmes can be found in Table 9.1. Unfortunately, there are too few programmes to meet the increasing demand in oncology [40]. The environmental setting is an important consideration for the successful delivery of prehab (and rehab) for older cancer patients, with and without frailty, as clinicians and administrators aim to support high adherence whilst still delivering the most effective programme. This is traditionally felt to be optimal within face-to-face programmes, where group activities, often based in community settings, bring a number of additional benefits including better social interaction, peer support and the promotion of self-management skills. If travel is a barrier to attendance at community-based prehab or patient preference, which can often be the case for this population, then a home-based programme with phone and digital options can be considered. Achieving intervention and adherence targets is more challenging in home-based (unsupervised) programmes, however, home-based rehab has been shown to achieve improved outcomes in patients with lung cancer [41]. There is minimal research that compares efficacy between out-patient, community and home-based prehab or rehab [42]. For patients who are frail, it would seem that, given their higher risk already discussed, that outpatient or community-based programmes may be preferred to rapidly identify and manage risk [43] and to maximise their engagement and exercise dose safely. Reports from research in non-frail patients demonstrate prehab is generally safe, with adverse events mostly relating to musculoskeletal injury, with a smaller number of serious adverse events such as falls [44]. In frail patients, caution is warranted since the few studies completed have not discussed the rate of adverse events [45].

Table 9.1 Examples of prehabilitation programmes

Country and leads(s)	UK; Moore, J and Merchant, Z	Australia; Crowe, J and Denehy, L
Programme name and patient cohorts	Prehab4Cancer and recovery service Colorectal, Lung and Oesophago-Gastric surgery with curative intent; Lung alternative curative intent treatment incl. SABR, radical radiotherapy and concurrent chemo/radiotherapy. Age 17 years and above. Registered with a Greater Manchester GP	Fit4surgery and Fit4transplant Adults having pelvic exenteration, Oesophago-Gastric surgery, hepatectomy, colorectal, retroperitoneal sarcoma, Autologous stem cell transplants (lymphoma, multiple myeloma)
Workforce	Exercise Specialist Instructors (Level 4 Cancer Rehabilitation qualified) Co-designed and supported by Anaesthetist, EP, OT, PT, GP, Dietitians, Oncology Psychologist, Surgeons, Respiratory Physician, CNSs, ERAS nurses, and other members of cancer MDTs	The interdisciplinary team includes Anaesthetists, Oncologists, Surgeons, pain specialists, Haematologists, PT, EP, Oncology Dietitians, and clinical Psychologists, ERAS nurses, nurse/coordinators and nurse consultants
Referral source	Single Point of Access via https://prehab4cancer.co.uk/how-to-refer/ Clinical MDTs from 10 different acute hospitals in Greater Manchester Named referrer normally patients' keyworker (CNS or equivalent)	Surgical to allied health through Fit4surgery email: More broadly Anaesthetists, surgical liaison nurses, Preoperative and tumour stream nurse coordinators and consultants including CPET and PAC clinic, Fit4transplant referrals from Haematologists and AuSCT nurse consultant All from the tertiary hospital
Setting, frequency and stratified patient pathways	Delivered in local leisure facility close to participants' residential postcode. Available in 87+ leisure facilities in Greater Manchester conurbation. Free gym membership for prehab phase (from referral to break for treatment) and rehab phase (12 weeks) Recommended 2–3 sessions/week for all participants Targeted pathway—supervised, 3× sessions/week F2F Universal pathway—self-managed, independent exercise sessions with regular (at least weekly) contact with an exercise specialist, which can include F2F	Tertiary hospital OP, and/or group programme; 60 min; 2–3 sessions/week OR telehealth service; Patients reviewed weekly if high risk unless attending F2F supervised sessions If a surgical patient, they also attend 'Surgery School' which involves group sessions by webinar or face to face where individual members of the MDT provide education about the upcoming surgery and perioperative care process by video or face to face
Objective physiological outcome measures	CPET ISWT or 6MWT (ISWT preferential but can be contraindicated for patients with musculoskeletal injury/weakness, reduced baseline fitness levels and other co-morbidities). 60 s STS. Handgrip strength Rockwood Clinical Frailty Scale, PG-SGA	CPET (surgical—VO_2 peak, AT), 30 s STS, 6MWT, handgrip strength, post-operative complications, weight, height, clinical frailty scale, DASI, PG-SGA

(continued)

Table 9.1 (continued)

Patient-reported outcomes	EQ5D-5L, IPAQ, Self-Efficacy Scale for Exercise, WHODAS 2.0, EORTCQLQ-C30, PG-SGA	EORTC-QLQ-C30, IPAQ, meeting activity guidelines (Y:N), PG-SGA GAD-7, PHQ-9
Aerobic exercise	Prehab: Either re-HIIT interval training using exercise bike (or alternative ergometer if required) or Progressive/ Continuous steady-state cardiovascular exercise, dependent upon fitness baseline Rehab: Personalised exercise prescription using a range of equipment/group sessions/PA based on patient preference, for prolonged behavioural change post-discharge	Supervised: Treadmill walking or cycling at moderate/high intensity prescribed at Borg 3–5/10 and/or 60–80% max heart rate for a total of 20 min (Continuous exercise or HIIT dependent upon fitness baseline)
Resistance exercise	Muscle groups targeted in the upper body and lower body, mainly related to functional tasks including bed, chair and toilet transfers, mobility, stairs. Resistance bands were issued and range of weights and other resistance equipment were utilised in local leisure facilities. Swimming and other PA recommended which addresses muscle strengthening	Muscle groups targeted based on individual deficits assessed using objective outcomes (see below) at first assessment session by the allied health team. In general, functional exercises in the upper and lower limb including: sit to stand, heel-raises, squats, step-ups, bench push ups, bicep curls, overhead press, shoulder abduction. Dumb-bells and resistance bands were provided for patients to take home as indicated. Commenced at 80% of the 10-repetition maximum 8–12 repetitions, 2–3 sets. 2–3 × week
Home-based instructions	Personalised Home Exercise Pack (https://prehab4cancer.co.uk/coronavirus-covid-19/) issued to each patient and adapted for participants changing exercise ability through their engagement in the service All advised to engage in daily PA walking in around exercise prescription and as medical treatment regime, i.e. radiotherapy allows	Home based: progressive increase to 150 min of continuous moderate intensity BORG 3–4/10 per week. Walking, exercise bike, swimming, jogging based on patient equipment and preference. Start level based upon assessment Individual resistance programme prescribed as above: in general functional exercises of the UL and LL. Commenced at 80% of the 10-repetition maximum. 8–12 repetitions, 2–3 sets. 2–3 × week

(continued)

Table 9.1 (continued)

Nutrition	PG-SGA and 'traffic light system': Green—Provide low-risk nutritional advice sheet as per https://prehab4cancer.co.uk/nutrition-2/, continue to monitor weight regularly and PG-SGA at regular time points Amber—Provide 'Eating Help Yourself' diet booklet, contact named referrer to escalate concern Red—As above, request a dietetic referral or make this directly All patients all receive 1:1 advice verbally re. diet and exercise	1:1 advice from a registered oncology dietician for 1–4 sessions based on need Dietetics OP clinic or telehealth; 20 min sessions then follow up as needed
Psychosocial and mental well-being	All exercise specialists completed level 1 psychological communication training, able to notice distress, listen, be empathetic, signpost to appropriate service or escalate back to named referrer based on unmet need identified. Utilise exercise, group support and relaxation PA to address mental well-being Staff receives reflective sessions with psychologist and OT bimonthly for CPD and their emotional well-being includes case study discussion	1:1 advice and strategies if PHQ4 score > 2 at screening from a registered clinical Psychologist. Initial 60 min session then follow up as needed. All patients preparing for a Pelvic exenteration automatically qualify for initial clinical psychology assessment. 1–5 sessions based on needs

BMT, bone marrow transplant; PT, physiotherapist; EP, exercise physiologist; PA, physical activity; PHQ4, Patient Health Questionnaire (4-item) measure anxiety and depression; CPET, cardiopulmonary exercise test; VO_2 peak, peak oxygen uptake; AT, anaerobic threshold; 6MWT, six-minute walk test; PG-SGA, patient-generated subjective global assessment (nutrition assessment); EORTC, European Organization for Research and Treatment of Cancer quality of life questionnaire; IPAQ, international physical activity questionnaire; SABR, stereotactic ablative radiotherapy; CNS, cancer nurse specialists; ERAS nurse, enhanced recovery after surgery nurse; ISWT, Incremental Shuttle Walk Test; STS, Sit to Stand test; EQ-5D-5L, EuroQoL outcome measure; IPAQ, International Physical Activity Questionnaires; WHODAS 2.0, World Health Organisation Disability Assessment Schedule version 2

Prehab Considerations Regarding Surgical Cancer Treatments

Cancer surgery for older patients benefits from integrating assessment and care [46]. A meta-analysis found that perioperative pathways in older patients (>60 years), specifically those with elements of prehab and enhanced recovery programmes in multicomponent interventions, reduced hospital stay for elective surgery by an average of 1.5 days amongst people having colorectal surgery and an average of 5 days in those having upper abdominal surgery [47].

The evidence base for the benefits of prehab is growing [48], particularly for colorectal, lung and oesophageal surgical patients but also in haematologic and prostate cancers. Preoperative frailty is associated with 2.5 times the risk of postoperative complications and increased length of hospital stay after abdominal

surgery [49]. In a recent systematic review examining prehab prior to abdominal surgery, the authors suggest that high-risk patients should be targeted for prehab as those are most likely to benefit [50]. The complex presentation and often inherent co-morbidities present in older people experiencing frailty place them in a high-risk group leading to a greater likelihood of complications or side effects of aggressive cancer treatment (including major surgery, radical radiotherapy and other systemic cancer therapies).

There are currently limited research studies that include older patients with frailty in prehabilitation for cancer surgery, and even less feature in trials for patients receiving prehab as part of chemo-, radio- or immunotherapy. A recent randomised controlled trial by Carli et al examined prehabilitation in a frailty cohort undergoing predominantly minimally invasive colorectal resection surgery. Patients identified as frail (using Fried Frailty Index) were randomised to receive a multimodal prehabilitation intervention delivered pre-op versus no-prehab. The no-prehab group was offered the same intervention delivered post-op as a rehabilitation package. Although there was a physical improvement in 6MWT in the prehab group, in this study this did not translate into a reduction in post-operative complications or length of stay (4 days in both groups), which were used as primary outcome measures. The authors considered that the use of minimally invasive surgery within enhanced recovery pathways mitigated the effect of the prehabilitation programme on the primary endpoints in this group [45]. There was a tendency to a reduction in hospital readmissions within the prehab group and it is important to consider what the endpoints of rehabilitation should be with a focus on longer patient impact. Despite the limitations to the current body of evidence, clinicians are increasingly supportive of prehab for older patients. This is exemplified in a Delphi survey, 80% of colorectal surgeons recommended exercise prehabilitation be included for patients from 40 years of age to > 80 years and should include aerobic training [51].

Furthermore, all patients should be offered Enhanced Recovery programmes when undergoing major cancer resection [52], which should dovetail with prehab to optimise surgical preparation [53]. They offer in-hospital, stepped recovery for patients with a focus on daily goal setting around early mobilisation, early nutrition and chest recovery in an attempt to reduce perioperative complications and support early discharge [54]. Enhanced recovery programmes have been shown to be safe when applied to older frail patients and demonstrated to reduce post-operative complications and shorten the length of hospital stay [55].

Detecting higher risk older surgical patients, using previously described methods such as cardiopulmonary exercise testing, clinical frailty tools and performance scores [56], will determine which patients will benefit most from the involvement of a geriatrician within their perioperative care alongside a more standard Enhanced Recovery programme. Various models incorporating geriatrician involvement exist, including additional ward level care, daily board round, weekly interdisciplinary meeting, targeted geriatrician-led ward rounds and a geriatric surgery checklist. These models have been associated with reduced post-operative complications and hospital length of inpatient stay [57].

Post-operative delirium is an extremely common complication in older patients following all types of cancer and non-cancer anaesthesia and surgery, with an incidence as high as 65% in patients aged 65 years and older [58]. Delirium in the post-op periods increases hospital length of stay, induces functional decline [58] and can increase the incidence of long-term cognitive impairment and dementia [59]. Perioperative interventions to reduce delirium encompass support for cognitive and sensory domains (e.g. orientation and hearing aids), enhanced recovery after surgery principles including patient and family information, reducing medication load, improving pain management, sleep and circadian rhythm maintenance. Further, in older patients (70 years or greater) prehab has been shown to improve post-operative delirium [45].

Prehab Considerations Regarding Non-surgical Cancer Treatments

It is acknowledged within cancer clinical practice that older adults experiencing frailty and diagnosed with cancer are less likely to be able to be offered curative surgical options due to their presenting performance status and high risk of post-operative complications. Thus this cohort is more likely to be treated using oncological treatment such as chemotherapy, immunotherapy and radiotherapy. The aims of prehab prior to such treatment modalities include improving tolerance and adherence to oncological treatments with subsequent longer-term survival, maintaining optimised QoL through treatment due to the reduction in the experience of side effects and ultimately reducing the risk of toxicity and other harmful treatment complications. Whilst the aims of prehab for people undergoing non-surgical cancer treatments might be different to the surgical cohort the interventions are similar, maintained where possible during the same time period as whilst the cancer patient is undergoing chemotherapy and radiotherapy treatment. However, evidence from prehab programmes is still very limited in the non-surgical setting.

The cohort of patients in this non-surgical pathway is often older and more frail, which may limit some of the more standard prehab approaches. Therefore, often there will need to be some adjustment within the patient's programme particularly in the physical training aspects of prehab and rehab. Moreover, treatments such as chemotherapy are delivered over prolonged periods of time, which is different from surgery for example. Therefore, components of both prehab and rehab are often merged in this setting and they should be further tailored according to the patient's response to treatment and the ability for the participant to remain engaged dependent on emerging treatment-related side-effects (Fig. 9.3) [29]. For patients entering non-surgical cancer treatment including radiotherapy and chemotherapy, one should aim for interventions to be maintained for as long as possible, with close monitoring during this period. It may also become less feasible and acceptable for patients to maintain engaging in community-based interventions whilst also having to travel for daily radiation doses for several weeks or more.

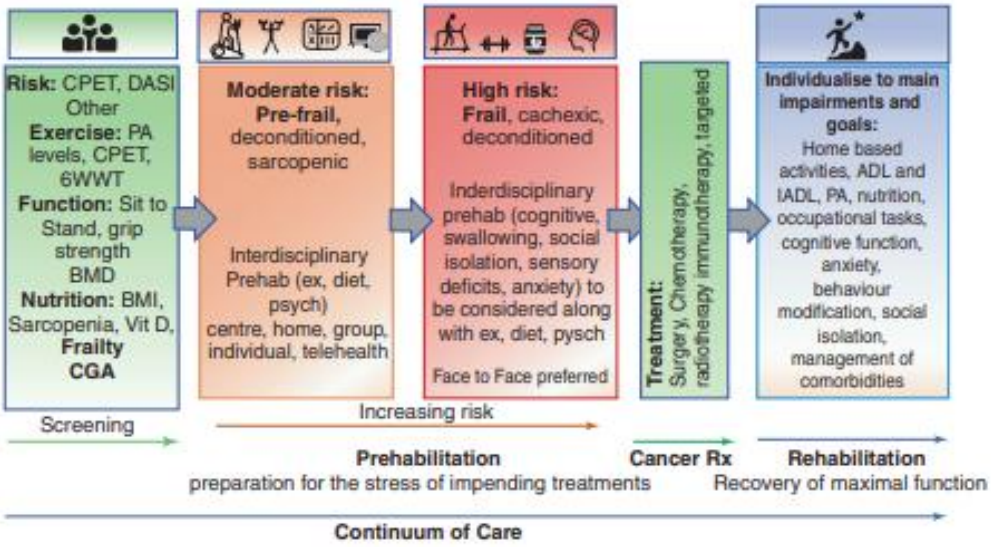

Fig. 9.3 Suggested model for prehab and rehab assessments and interventions. CPET, cardiopulmonary exercise testing; DASI, Dike activity status index; PA, physical activity; 6MWT, six minutes' walk test; BMD, bone mineral density; CGA, comprehensive geriatric assessment; ex, exercise; psych, psychology; ADL, activities of daily living; IADL, instrumental activities of daily living; Rx, treatment

Personalisation of prehab and rehab for the older patients with frailty particularly will support their ongoing participation. Where possible this should be led by an interdisciplinary team approach as described above in close liaison with the patient, cancer care delivery team and the patient's care network to support realistic goal setting. Continued prehab may further promote a greater sense of wellbeing, self-control, with reduced experience of anxiety and mood disturbance, and better tolerance of common cancer treatment symptoms including cancer-related fatigue, nausea, peripheral neuropathy, pain and in general a patient's tolerance to treatment [35]. Another potential benefit is the patient being able to complete a chemo or radiotherapy treatment sequence if they are fitter and less fatigued although this remains to be robustly established in trials.

Ongoing dynamic risk assessment continues to be essential to ensure that if prehab interventions are maintained by an individual, that they are done so safely, taking into consideration risk of cardiac toxicity and other potential significant complications of cancer treatment [29].

Restorative Phase of Cancer Rehabilitation

Rehab is widely evidenced to be positive for people with cardiac, pulmonary, heart failure, and neurological conditions [50, 60]. Geriatric patients mobilising as soon as possible in hospitals is supported from studies examining 'pyjama paralysis'

where patients are dressed in 'street' clothes and sat out of bed rather than staying in bed in their pyjamas [61]. Promoting the achievement of generic older adult physical activity recommendations coupled with targeted additions such as reducing sedentary behaviour improving cognition and improving strength and balance to prevent falls is a reasonable approach [62] utilised in many rehab programmes.

Once the patient has completed their medical treatment they should be reassessed including reviewing pre-treatment function and QoL goals to clarify whether these are still relevant, or whether goal-adjustment is required [63]. For older patients with a more complicated recovery from surgery, in-patient rehabilitation led by AHPs will be necessary, supported ideally by a geriatrician as part of a co-ordinated pathway. This team will then support patient recovery and the transition to home or residential/nursing care facility. The subsequent 'seamless transfer of care' with a community-based prehab–rehab team will benefit from a close handover from hospital-based services as the patient aims to step back into facilitated community-based rehab. Restorative and adaptive principles may be needed to enable a patient to resume basic ADLs. It should be expected that a patient's lowest functional ability will be immediately post-treatment [64]. Short- and longer-term agreed goals can set expectations for the patient [63] and motivate them as they make progress in a graded fashion. They will also help dictate which member(s) of the interdisciplinary team should be involved at this stage and the interventions required.

Restorative rehabilitation may focus on the impact on function of the common cancer-specific side effects already listed. As such, healthcare and exercise professionals should have a heightened awareness of cancer-related fatigue, peripheral neuropathy and pain, especially given the greater probability of these being experienced by a frail, older adult post-treatment [31]. There needs to be understanding that such symptoms may signal disease progression, and may delay patients' safely resuming activities such as exercise. Fatigue and anxiety management are likely additional interventions required during this phase [10].

Supportive Phase of Cancer Rehabilitation

Behavioural change is a psychological feature of prehab/rehab (probably even more so for rehab as the expectation is long-term adherence, well beyond the acute phase) programmes, with the engagement in healthy lifestyle activities enabling the added wider goal of secondary prevention of other long-term health conditions or comorbidities [10] and even the aspiration to reduce the reoccurrence of cancers. The patient may prefer to adapt how they exercise so this fits within their daily and weekly routine. Indeed within the Prehab4Cancer and recovery programme, although patients resume exercise in a leisure facility for 12 weeks prior to discharge during their rehab phase, they are then encouraged to engage in physical activities which suits their preferences both habitually and volitionally [53] (e.g. joining a local walking group). Through change in a patient's behaviour they are

encouraged to be independent exercisers, with as little support as is required for this cohort, and less involvement, if any, from healthcare services.

As the patient achieves their newly adjusted rehabilitation goals and is on the verge of discharge then it will be important to re-assess their holistic unmet needs and agree on an 'exit' strategy, identifying what further support the patient may require and how they will receive this. This is where social prescribing, support from voluntary and charitable organisations, from existing family and friends' networks and potentially even ongoing digital support could be what is required for maintenance purposes and to address any outstanding needs for the patient. In the UK there is a focus on improved self-management for patients, through the personalised care agenda [10]. In some situations, where a patient is experiencing pronounced frailty, a carer or family member may be involved in rehabilitation sessions as the patient learns to adapt their completion of ADLs, either with dependence on someone else's assistance or adaptive equipment for optimised self-management.

Importantly at this stage in a patient's care, they may no longer have oncological treatment options, likely in part due to their frailty and reduced fitness, but this does not mean that they do not have rehabilitation potential. A patient may still be able to engage in some interventions such as the rehab elements of exercise, nutrition and psychological support, which will achieve their functional goals and maximise their QoL, in advance of the palliative phase. Anecdotally, it has been observed that patients are often not referred for rehabilitation in this phase, when they should be.

Palliative Phase of Cancer Rehabilitation

In most cases, older people experiencing non-curative cancer and combined frailty, approaching the end of their life, will significantly deteriorate in their functional ability as they transition into palliative care. At this stage specialist rehabilitation may be beneficial to ameliorate the symptoms of cancer progression and the cumulative side effects of treatment (if being offered) [23], with the overarching short-term goal of optimal QoL. Complex management is required including applying orthopaedic, respiratory, neurological and lymphoedema expertise as indicated by the patient's prognosis, adverse effect profile and tolerance [23].

Family members may require additional support at this time also and once again it is important to understand their and the patient's wishes including end-of-life planning and the role of hospice care. In the United Kingdom, hospices can offer patients the opportunity to attend during the day and many have rehabilitation teams with a mixture of nursing staff and AHPs available to address needs that become present during this cancer stage, as well as complimentary therapeutic provision such as music therapy. Additional referrals may be needed for dietetic or speech and language therapy input if a patient becomes unable to swallow or if their communication deteriorates. Social work professionals are often pivotal at this point, whether to facilitate practical assistance or in some countries provide emotional and spiritual support. The rehabilitation offered to patients at this stage should still be goal based,

although it is likely these will be focused on immediate needs such as reducing pain, managing anxiety and maximising time spent with family members. In-depth interviews with patients with advanced cancer concluded that symptom control and palliation should be viewed as mechanisms to optimise active participation in essential and valued activities. Participants in this qualitative study were adamant they did not want to languish and wanted to be able to do '… the everyday things….' [65]. Low-level physical activity or exercise can still be a method to achieve these short-term ADL goals, such as chair-based exercise [58]. Risk assessment is paramount, with consideration being paid to potential metastatic spinal cord compression and other bone fractures, which could exacerbate pain and other associated symptoms during this phase.

Research Needs

More evidence needs to be accrued detailing which intervention or combination of interventions is most feasible, efficacious and cost effective, and crucially, which are most important to older patients [66]. Beyond specific interventions, the measurement of important outcomes (i.e. what to measure and how to measure it) is controversial. Indeed, for all prehab populations the development of a patient facing common core outcome dataset is long overdue. Similarly, in frail populations, agreement in screening instruments and longer-term outcomes that have high clinical utility are needed. Further, longitudinal research in frailty is important, since patients may dynamically transition between frailty and pre-frail states [66] and prehab and rehab strategies should be intuitive and personalised across the continuum of frailty and cancer.

Whilst recent systematic reviews and meta-analyses support the role of interdisciplinary prehab and rehab in several tumour sites, there are many aspects of this care that require further research. In particular; the impact of prehab and rehab for older and /or frail patient subgroups, the fidelity of individual components of the treatments, the most patient-centred and effective implementation strategies, the growing role of technology in delivering such services, and their effectiveness across the range of tumour sites and treatments. Improvements in outcomes need to be sustained across different stages of cancer survivorship and aligned with patient goals. Figure 9.4 summarises a list of research unmet needs that will help close the evidence–practice gap across prehab, particularly in the setting of frailty.

Multiple prehab randomised clinical trials for patients with frailty are currently recruiting including McIsaac et al. [67] using a single centre, parallel-arm randomised clinical trial to test the efficacy of home-based exercise prehab for older people undergoing intra-abdominal or intrathoracic cancer at The Ottawa Hospital [67] and Wang et al investigating the impact of nutritional optimisation and exercise training on the early and long-term outcomes on older patients undergoing 'digestive' surgery [68]. The majority of existing trials are limited to cancer surgery and whilst we await their findings with interest it is further recommended for

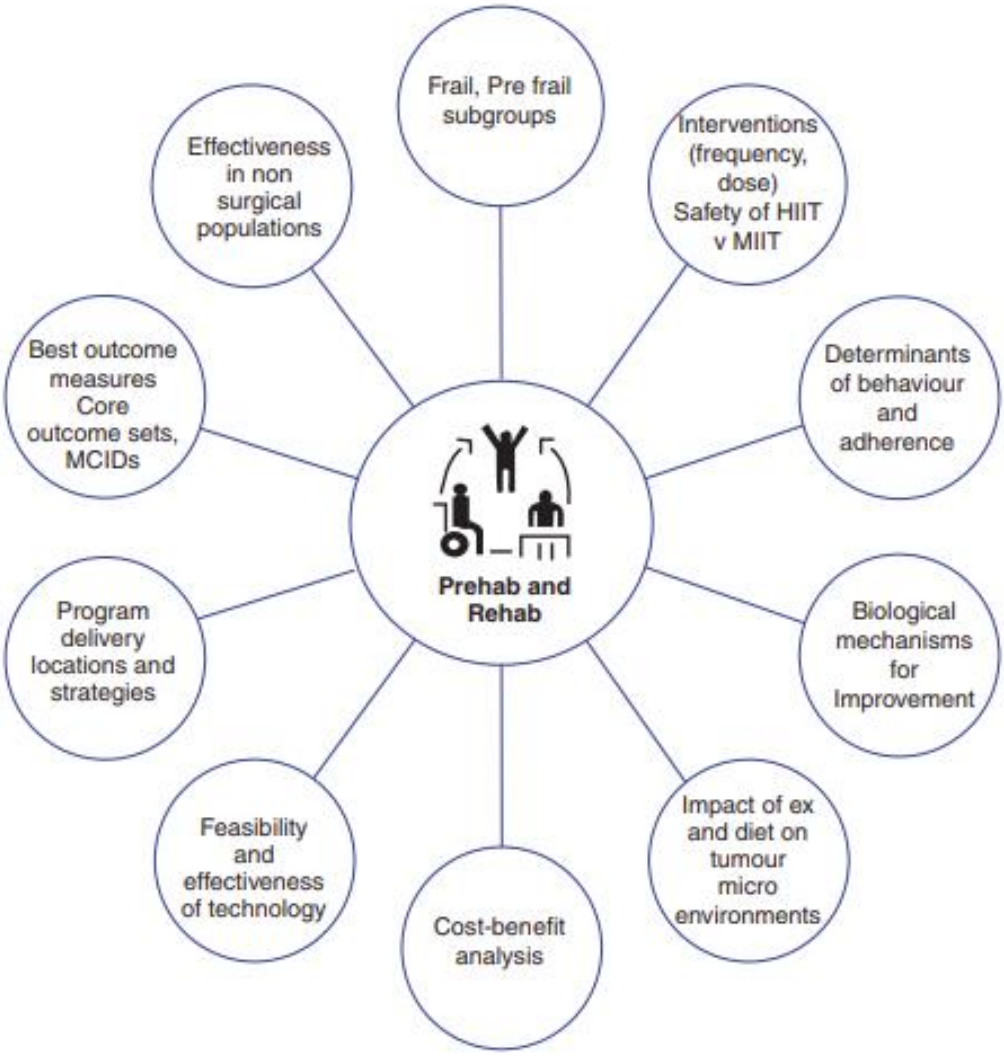

Fig. 9.4 Suggested research areas for prehab and rehab

frailty-focused prehab (and rehab) randomised clinical trials to be completed within other cancer treatment modalities.

Conclusion

Older adults with cancer are commonly frail with reduced resilience and adaptive capacity to stressors and seem to be an ideal group to benefit from prehab and rehab. Identifying and optimising the management of comorbidities and their associated medications, promoting the achievement of generic older adult physical activity recommendations coupled with targeted additions are important in the management of this cohort of cancer patients [62].

Use of CGA and frailty screening is recommended in the prescription of prehab and rehab, prioritising the assessment of function, comorbidity, falls, depression, cognition and nutrition [5], in addition to other more standard risk assessment tools.

Personalised therapy is perhaps the most important aspect of maximising functional outcomes for people in any programme, but especially in frail patients, to target the main impairments aligned with the individual's goals. As above-described, frailty is multidimensional including physical, social, environmental, and psychological factors. Some risks for frailty may be preventable, treatable and/or reversible. However, the current provision of rehab often does not specifically address frailty factors, instead of being delivered by a large team often not able to provide frailty-focused individualised care. Growing evidence recommends to improve effectiveness, prehab or rehab programmes for older people should identify and target specific factors for frailty [69].

It is acknowledged that the above-described models of prehab and rehab may not be available globally, despite this being an aim of worldwide initiatives, such as the World Health Organisation rehab recommendations [70]. In the absence of established 'prehab' and 'rehab' services available locally there can still be an aspiration for good care for cancer patients, particularly those older with (or at high risk) of frailty. This can include successful secondary care initiatives such as 'Making Every Contact Count' which obligate healthcare professionals working within hospital settings to focus on improved independence and the adoption of healthy behaviours. Furthermore, there are digital resources available which patients and family members/carers can be signposted to (Prehab4Cancer website [71]), as well as websites designed to upskill and give confidence to healthcare providers to empower them to give basic exercise advice applicable to the patients they are treating, such as the Moving Medicine website [72].

References

1. Silver JK, Baima J, Mayer RS. Impairment-driven cancer rehabilitation: an essential component of quality care and survivorship. CA Cancer J Clin. 2013;63(5):295–317.
2. Alfano CM, Pergolotti M. Next-generation cancer rehabilitation: a giant step forward for patient care. Rehabil Nurs. 2018;43(4):186–94.
3. Stout NL, Santa Mina D, Lyons KD, Robb KA, Silver JK. A systematic review of rehabilitation and exercise recommendations in oncology guidelines. CA J Cancer Clin. 2020. https://doi.org/10.3322/caac.21639
4. Introduction—delivering high-quality cancer care—NCBI Bookshelf [Internet]. [cited 30 Sept 2020]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK202150/
5. Mohile SG, Dale W, Somerfield MR, Schonberg MA, Boyd CM, Burhenn PS, et al. Practical assessment and management of vulnerabilities in older patients receiving chemotherapy: ASCO guideline for geriatric oncology. J Clin Oncol. [Internet] 2018;36(22):2326–47 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/29782209/
6. NCCN clinical practice guidelines in oncology [Internet] [cited 4 Oct 2020]. Available from: https://www.nccn.org/professionals/physician_gls/default.aspx
7. Talarico L, Chen G, Pazdur R. Enrollment of elderly patients in clinical trials for cancer drug registration: a 7-year experience by the US Food and Drug Administration. J Clin Oncol.

[Internet] 2004;22(22):4626–31 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/15542812/
8. Quaglia A, Tavilla A, Shack L, Brenner H, Janssen-Heijnen M, Allemani C, et al. The cancer survival gap between elderly and middle-aged patients in Europe is widening. Eur J Cancer. [Internet] 2009;45(6):1006–16 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/19121578/
9. Hutchins LF, Unger JM, Crowley JJ, Coltman CA, Albain KS. Underrepresentation of patients 65 years of age or older in cancer-treatment trials. N Engl J Med. [Internet] 1999;341(27):2061–7 [cited 30 Sept 2020]. Available from: http://www.nejm.org/doi/abs/10.1056/NEJM199912303412706
10. Internet [cited 30 Sept 2020]. Available from: https://www.macmillan.org.uk/documents/getinvolved/campaigns/ageoldexcuse/ageoldexcusereport-macmillancancersupport.pdf
11. Pergolotti M, Deal AM, Lavery J, Reeve BB, Muss HB. The prevalence of potentially modifiable functional deficits and the subsequent use of occupational and physical therapy by older adults with cancer. J Geriatr Oncol. [Internet] 2015;6(3):194–201 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/25614296/
12. Handforth C, Clegg A, Young C, Simpkins S, Seymour MT, Selby PJ, et al. The prevalence and outcomes of frailty in older cancer patients: a systematic review. Ann Oncol. [Internet] 2015;26(6):1091–101 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/25403592/
13. Clough-Gorr KM, Stuck AE, Thwin SS, Silliman RA. Older breast cancer survivors: geriatric assessment domains are associated with poor tolerance of treatment adverse effects and predict mortality over 7 years of follow-up. J Clin Oncol. [Internet] 2010;28(3):380–6 [cited 30 Sept 2020]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2815700/?report=abstract
14. Kenis C, Milisen K, Flamaing J, Wildiers H, Decoster L, Van Puyvelde K, et al. Performance of two geriatric screening tools in older patients with cancer. J Clin Oncol. [Internet] 2014;32(1):19–26 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/24276775/
15. Mariano C, Williams G, Deal A, Alston S, Bryant AL, Jolly T, et al. Geriatric assessment of older adults with cancer during unplanned hospitalizations: an opportunity in disguise. Oncologist. [Internet] 2015;20(7):767–72 [cited 4 Oct 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/26032136/
16. Dietz JH. Rehabilitation oncology. Wiley; 1981 (Wiley medical publication).
17. Cromes GFJ. Implementation of interdisciplinary cancer rehabilitation. Rehabil Couns Bull. 1978;21(3):230–7.
18. Hshieh TT, Jung WF, Grande LJ, Chen J, Stone RM, Soiffer RJ, et al. Prevalence of cognitive impairment and association with survival among older patients with hematologic cancers. JAMA Oncol. [Internet] 2018;4(5):686–93 [cited 30 Sept 2020]. Available from: https://jamanetwork.com/
19. Magnuson A, Mohile S, Janelsins M. Cognition and cognitive impairment in older adults with cancer. Curr Geriatr Rep. [Internet] 2016;5:213–9 [cited 30 Sept 2020]. New York: Springer. Available from: https://link.springer.com/article/10.1007/s13670-016-0182-9
20. Kumar Pal S, Katheria V, Hurria A. Evaluating the older patient with cancer: understanding frailty and the geriatric assessment. CA Cancer J Clin. [Internet] 2010;60(2):120–32 [cited 30 Sept 2020]. Available from: http://doi.wiley.com/10.3322/caac.20059
21. Nicholson NR. A review of social isolation: an important but underassessed condition in older adults. J Prim Prev. [Internet] 2012;33:137–52 [cited 30 Sept 2020]. Springer. Available from: https://link.springer.com/article/10.1007/s10935-012-0271-2
22. DuMontier C, Poh Loh K, Bain PA, Silliman RA, Hshieh T, Abel GA, et al. Defining undertreatment and overtreatment in older adults with cancer: a scoping literature review. J Clin Oncol. [Internet] 2020;38:2558–69 [cited 4 Oct 2020]. American Society of Clinical Oncology. Available from: https://pubmed.ncbi.nlm.nih.gov/32250717/

23. Rankin J, Gracey J. Rehabilitation in oncology and palliative care. In: Rankin J, Robb K, Murtagh N, Cooper J, Lewis S, editors. Rehabilitation in cancer care. 1st ed. Oxford: Blackwell; 2008. p. 24–43.
24. Ethun CG, Bilen MA, Jani AB, Maithel SK, Ogan K, Master VA. Frailty and cancer: implications for oncology surgery, medical oncology, and radiation oncology. CA Cancer J Clin. [Internet] 2017;67(5):362–77 [cited 4 Oct 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/28731537/
25. Cancer Research UK. Advancing care, advancing years: improving cancer treatment and care for and ageing population. 2018;(1089464):19. Available from: https://www.cancerresearchuk.org/sites/default/files/advancing_care_advancing_years_briefing.pdf
26. Mental Capacity Act 2005 [Internet] [cited 30 Sept 2020]. Available from: https://www.legislation.gov.uk/ukpga/2005/9/contents
27. Rønning B, Wyller TB, Nesbakken A, Skovlund E, Jordhøy MS, Bakka A, et al. Quality of life in older and frail patients after surgery for colorectal cancer-A follow-up study. J Geriatr Oncol. [Internet] 2016;7(3):195–200. Available from: https://doi.org/10.1016/j.jgo.2016.03.002
28. Hayes SC, Newton RU, Spence RR, Galvão DA. The Exercise and Sports Science Australia position statement: exercise medicine in cancer management. J Sci Med Sport. 2019;22:1175–99. Elsevier
29. Santa Mina D, Alibhai SMH. Prehabilitation in geriatric oncology. J Geriatr Oncol. 2020;11(4):731–4.
30. Bruns ERJ, Argillander TE, Schuijt HJ, Van Duijvendijk P, Van Der Zaag ES, Wassenaar EB, et al. Fit4SurgeryTV at-home prehabilitation for frail older patients planned for colorectal cancer surgery: a pilot study. Am J Phys Med Rehabil. 2019;98(5):399–406.
31. Overcash J, Cope DG, Van Cleave JH. Frailty in older adults. Clin J Oncol Nurs. 2018;22(6):8–17.
32. Richards S, Jerram P, Brett C, Falloon M, Frizelle F. The association between low pre-operative step count and adverse post-operative outcomes in older patients undergoing colorectal cancer surgery. Perioper Med. 2020;9(1):1–10.
33. Steffens D, Delbaere K, Young J, Solomon M, Denehy L. Evidence on technology-driven preoperative exercise interventions: are we there yet? Br J Anaesth. 2020;125(5):646–9. Elsevier.
34. Hamaker ME, Oosterlaan F, van Huis LH, Thielen N, Vondeling A, van den Bos F. Nutritional status and interventions for patients with cancer—a systematic review. J Geriatr Oncol. [Internet] 2020 [cited 4 Oct 2020]. Elsevier. Available from: https://pubmed.ncbi.nlm.nih.gov/32616384/
35. Presley CJ, Dotan E, Soto-Perez-de-Celis E, Jatoi A, Mohile SG, Won E, et al. Gaps in nutritional research among older adults with cancer. J Geriatr Oncol. [Internet] 2016;7:281–92 [cited 4 Oct 2020]. Elsevier. Available from: https://pubmed.ncbi.nlm.nih.gov/27197919/
36. Lorenzo-López L, Maseda A, De Labra C, Regueiro-Folgueira L, Rodríguez-Villamil JL, Millán-Calenti JC. Nutritional determinants of frailty in older adults: a systematic review. BMC Geriatr. [Internet] 2017;17(1) [cited 4 Oct 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/28506216/
37. Milne AC, Potter J, Vivanti A, Avenell A. Protein and energy supplementation in elderly people at risk from malnutrition. Cochrane Database Syst Rev. [Internet] 2009 [cited 4 Oct 2020]. Wiley. Available from: https://pubmed.ncbi.nlm.nih.gov/19370584/
38. Kou K, Momosaki R, Miyazaki S, Wakabayashi H, Shamoto H. Impact of nutrition therapy and rehabilitation on acute and critical illness: a systematic review. J UOEH. [Internet] 2019;41:303–15 [cited 4 Oct 2020]. University of Occupational and Environmental Health. Available from: https://pubmed.ncbi.nlm.nih.gov/31548485/
39. Bunt S, Steverink N, Olthof J, van der Schans CP, Hobbelen JSM. Social frailty in older adults: a scoping review. Eur J Ageing. [Internet] 2017;14:323–34 [cited 6 Apr 2021]. Springer. Available from: https://pubmed.ncbi.nlm.nih.gov/28936141/
40. Dennett AM, Peiris CL, Shields N, Morgan D, Taylor NF. Exercise therapy in oncology rehabilitation in Australia: a mixed-methods study. Asia Pac J Clin Oncol. 2017;13(5):e515–27.

41. Edbrooke L, Aranda S, Granger CL, Mcdonald CF, Krishnasamy M, Mileshkin L, et al. Multidisciplinary home-based rehabilitation in inoperable lung cancer: a randomised controlled trial. Thorax. 2019;74(8).
42. Alibhai SMH, Santa Mina D, Ritvo P, Tomlinson G, Sabiston C, Krahn M, et al. A phase II randomized controlled trial of three exercise delivery methods in men with prostate cancer on androgen deprivation therapy. BMC Cancer. 2019;19(1):2.
43. Lopez C, Jones J, Alibhai SMH, Mina DS. What is the "home" in home-based exercise? The need to define independent exercise for survivors of cancer. J Clin Oncol. 2018;36:928–9. American Society of Clinical Oncology.
44. Santa Mina D, Au D, Auger LE, Alibhai SMH, Matthew AG, Sabiston CM, et al. Development, implementation, and effects of a cancer center's exercise-oncology program. Cancer. 2019;125(19):3437–47.
45. Carli F, Bousquet-Dion G, Awasthi R, Elsherbini N, Liberman S, Boutros M, et al. Effect of multimodal prehabilitation vs postoperative rehabilitation on 30-day postoperative complications for frail patients undergoing resection of colorectal cancer: a randomized clinical trial. JAMA Surg. 2020;155(3):233–42.
46. Harari D, Hopper A, Dhesi J, Babic-Illman G, Lockwood L, Martin F. Proactive care of older people undergoing surgery ('POPS'): designing, embedding, evaluating and funding a comprehensive geriatric assessment service for older elective surgical patients. Age Ageing. [Internet] 2007;36(2):190–6 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/17259638/
47. Nunns M, Shaw L, Briscoe S, Thompson Coon J, Hemsley A, McGrath JS, et al. Multicomponent hospital-led interventions to reduce hospital stay for older adults following elective surgery: a systematic review. Heal Serv Deliv Res. 2019;7(40):1–178.
48. Waterland JL, McCourt O, Edbrooke L, Granger CL, Ismail H, Riedel B, et al. Efficacy of prehabilitation including exercise on postoperative outcomes following abdominal cancer surgery: a systematic review and meta-analysis. Front Surg. [Internet] 2021;8:628848 [cited 2 Apr 2021]. Available from: https://www.frontiersin.org/articles/10.3389/fsurg.2021.628848/full
49. Makary MA, Segev DL, Pronovost PJ, Syin D, Bandeen-Roche K, Patel P, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210(6):901–8.
50. Thomas G, Tahir MR, Bongers BC, Kallen VL, Slooter GD, van Meeteren NL. Prehabilitation before major intra-abdominal cancer surgery. Eur J Anaesthesiol. 2019;36(12):933–45.
51. Boereboom CL, Williams JP, Leighton P, Lund JN. Forming a consensus opinion on exercise prehabilitation in elderly colorectal cancer patients: a Delphi study. Tech Coloproctol. 2015;19(6):347–54.
52. Overview | Perioperative care in adults | Guidance | NICE [Internet] [cited 4 Oct 2020]. Available from: https://www.nice.org.uk/guidance/ng180
53. Moore J, Merchant Z, Rowlinson K, McEwan K, Evison M, Faulkner G, et al. Implementing a system-wide cancer prehabilitation programme: the journey of Greater Manchester's 'Prehab4cancer'. Eur J Surg Oncol. 2021;47(3):524–32.
54. Moore JA, Conway DH, Thomas N, Cummings D, Atkinson D. Impact of a peri-operative quality improvement programme on postoperative pulmonary complications. Anaesthesia. [Internet] 2017;72(3):317–27 [cited 30 Sept 2020]. Available from: http://doi.wiley.com/10.1111/anae.13763
55. Bagnall NM, Malietzis G, Kennedy RH, Athanasiou T, Faiz O, Darzi A. A systematic review of enhanced recovery care after colorectal surgery in elderly patients. Colorectal Dis. [Internet] 2014;16:947–56 [cited 30 Sept 2020]. Blackwell. Available from: https://pubmed.ncbi.nlm.nih.gov/25039965/
56. Kalsi T, Harari D. Assessment methods and services for older people with cancer in the United Kingdom. World J Clin Oncol. [Internet] 2020;11(3):152–61 [cited 4 Oct 2020]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7103526/?report=abstract
57. Braude P, Goodman A, Elias T, Babic-Illman G, Challacombe B, Harari D, et al. Evaluation and establishment of a ward-based geriatric liaison service for older urological surgical

patients: Proactive care of Older People undergoing Surgery (POPS)-urology. BJU Int. [Internet] 2017;120(1):123–9 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/27167854/
58. Rudolph JL, Marcantonio ER. Postoperative delirium: acute change with long-term implications. Anesth Analg. [Internet] 2011;112:1202–11 [cited 30 Sept 2020]. Lippincott Williams and Wilkins. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3090222/?report=abstract
59. Saczynski JS, Marcantonio ER, Quach L, Fong TG, Gross A, Inouye SK, et al. Cognitive trajectories after postoperative delirium. N Engl J Med. [Internet] 2012;367(1):30–9 [cited 30 Sept 2020]. Available from: http://www.nejm.org/doi/abs/10.1056/NEJMoa1112923
60. Luther A, Gabriel J, Watson RP, Francis NK. The impact of total body prehabilitation on post-operative outcomes after major abdominal surgery: a systematic review. World J Surg. [Internet] 2018;42:2781–91 [cited 4 Oct 2020]. New York: Springer. Available from: https://pubmed.ncbi.nlm.nih.gov/29546448/
61. Buchanan C, Kane C. Developing therapy services to support frail patients through an acute hospital admission. Physiotherapy. 2019;105:e131–2.
62. Dent E, Martin FC, Bergman H, Woo J, Romero-Ortuno R, Walston JD. Management of frailty: opportunities, challenges, and future directions. Lancet. [Internet] 2019;394:1376–86 [cited 30 Sept 2020]. Lancet Publishing. Available from: https://pubmed.ncbi.nlm.nih.gov/31609229/
63. Lyons KD, Newman RM, Kaufman PA, Bruce ML, Stearns DM, Lansigan F, et al. Goal attainment and goal adjustment of older adults during person-directed cancer rehabilitation. Am J Occup Ther. 2018;72(2).
64. Hunter EG, Gibson RW, Arbesman M, D'Amico M. Systematic review of occupational therapy and adult cancer rehabilitation: Part 2. Impact of multidisciplinary rehabilitation and psychosocial, sexuality, and return-to-work interventions. Am J Occup Ther. 2017;71(2).
65. Morgan DD, Currow DC, Denehy L, Aranda SA. Living actively in the face of impending death: constantly adjusting to bodily decline at the end-of-life. BMJ Support Palliat Care. [Internet] 2017;7(2):179–88 [cited 30 Sept 2020]. Available from: https://pubmed.ncbi.nlm.nih.gov/26182946/
66. Hoogendijk EO, Afilalo J, Ensrud KE, Kowal P, Onder G, Fried LP. Frailty: implications for clinical practice and public health. Lancet. 2019;394:1365–75. Lancet Publishing.
67. McIsaac DI, Saunders C, Hladkowicz E, Bryson GL, Forster AJ, Gagne S, et al. PREHAB study: a protocol for a prospective randomised clinical trial of exercise therapy for people living with frailty having cancer surgery. BMJ Open. 2018;8(6):1–8.
68. Multicomponent prehabilitation and outcomes in elderly patients with frailty—Full text view—ClinicalTrials.gov [Internet] [cited 6 Apr 2021]. Available from: https://clinicaltrials.gov/ct2/show/NCT04715581
69. Janssen TL, Mosk CA, Van Hoof-De Lepper CCHA, Wielders D, Seerden TCJ, Steyerberg EW, et al. A multicomponent prehabilitation pathway to reduce the incidence of delirium in elderly patients in need of major abdominal surgery: study protocol for a before-and-after study. BMC Geriatr. 2019;19(1):1–10.
70. WHO | World Health Organization [Internet] [cited 30 Sept 2020]. Available from: https://www.who.int/rehabilitation/rehab-2030/en/
71. Prehab4Cancer [Internet] [cited 30 Sept 2020]. Available from: https://prehab4cancer.co.uk/
72. Homepage—Moving Medicine [Internet] [cited 18 Aug 2020]. Available from: https://movingmedicine.ac.uk/

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Perioperative Medicine

RESEARCH Open Access

Surgery school—who, what, when, and how: results of a national survey of multidisciplinary teams delivering group preoperative education

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Abstract

Background: Group education is increasing in popularity as a means of preparing patients for surgery. In recent years, these 'surgery schools' have evolved from primarily informing patients of what to expect before and after surgery, to providing support and encouragement for patients to 'prehabilitate' prior to surgery, through improving physical fitness, nutrition and emotional wellbeing.

Method: A survey aimed at clinicians delivering surgery schools was employed to capture a national overview of activity to establish research and practice priorities in this area. The survey was circulated online via the Enhanced Recovery after Surgery UK Society and the Centre for Perioperative Care mailing lists as well as social media.

Results: There were 80 responses describing 28 active and 4 planned surgery schools across the UK and Ireland. Schools were designed and delivered by multidisciplinary teams, contained broadly similar content and were well attended. Most were funded by the National Health Service. The majority included aspects of prehabilitation most commonly the importance of physical fitness. Seventy five percent of teams collected patient outcome data, but less than half collected data to establish the clinical effectiveness of the school. Few describe explicit inclusion of evidence-based behavior change techniques, but collaboration and partnerships with community teams, gyms and local charities were considered important in supporting patients to make changes in health behaviors prior to surgery.

Conclusion: It is recommended that teams work with patients when designing surgery schools and use evidence-based behavior change frameworks and techniques to inform their content. There is a need for high-quality research studies to determine the clinical effectiveness of this type of education intervention.

Keywords: Preoperative education, Surgery school, Prehabilitation, Perioperative medicine

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The average person in the UK will undergo four to six surgeries during their lifetime (Nepogodiev et al., 2019). Patient education prior to surgery is an established part of the surgical pathway, traditionally undertaken within presurgical clinics and focussing on what to expect. It is generally accepted that well-prepared patients are more confident and less anxious about undergoing surgery (Dawson, 2000). Despite established programmes in the USA since the 1970s (Mezzanotte, 1970), preoperative education in a group setting is a relatively new concept in the UK and Ireland with a primary focus on educating patients within Enhanced Recovery after Surgery (ERAS) programmes, particularly within orthopaedics. Reported outcomes have included reduction in length of hospital stay, reduced preoperative anxiety and reduced postoperative pain (Giraudet-Le Quintrec et al., 2003; McGregor et al., 2004).

The last 5 years have seen an evolution of 'surgery schools' within the UK and Ireland. The schools now not only prepare patients for what to expect, but also provide advice and support on what patients can do to prepare themselves physically and mentally to reduce the risk of postoperative complications (Moore et al., 2017; Moore et al., 2020). Improving physical fitness, nutrition and emotional wellbeing prior to surgery is known as 'Prehabilitation' and has been shown to improve surgical outcomes (Li et al., 2013). To date prehabilitation interventions have primarily been limited to research trials. There is now emerging evidence that educating surgical patients in groups as part of a clinical service and using evidence-based behaviour change techniques may promote behaviour change, thus optimising physical and psychological health (Fecher-Jones et al., 2021).

Despite these 'Fit for Surgery' schools anecdotally growing in number and becoming a regular feature of perioperative conference agendas, clinical and patient-reported outcomes of these interventions remain largely unreported. As leads for surgery schools at University Hospital Southampton and Manchester Royal Infirmary, we felt it timely to capture a national overview of surgery school development and activity. The aim was to identify similarities and differences in surgery schools across the UK and Ireland, including content, outcomes measured and funding mechanisms. The results would enable greater insight into the variations of this educational intervention and allow research and practice priorities to be identified.

Methods

A bespoke survey was conducted in the summer of 2019 aimed at health care teams delivering surgery schools (See Additional File 1).

The survey was designed using 'Survey Monkey' (Survey Monkey, 2019), an online survey platform. The link to the survey was initially sent out via email to all members of the ERAS UK society as a pilot to gauge responses, and following minor amendments was disseminated by the authors through social media (Twitter and Facebook) from 13/9/2019. Response rate was reviewed, and the survey sent out again by the UK Centre for Perioperative Care to all perioperative medicine leads. The survey was open for 94 days, closing on 16/12/2019. Descriptive statistics were calculated for numeric survey items. Content analysis was used to analyse open responses and key themes identified.

Results

There were 80 responses to the survey, from 45 different hospitals. One respondent was excluded as they were from outside of the UK and Ireland and 11 others excluded as they were duplicate entries. Thirty-six respondents had significant missing data, providing job title and location only. Following exclusion of duplicated entries and missing data, there were 28 active surgery schools and four with planned start dates. For breakdown of responses see Fig. 1.

The active and planned schools were situated in 23 different National Health Service (NHS) Trusts with broad spread across England, Scotland and Wales and one in Dublin. There was no reply from colleagues in Northern Ireland. Some geographic areas such as London had more than one surgery school. One respondent who described an active school declined to enter their geographical location.

Over half of the respondents of active and planned schools were anaesthetists 24 (56%), and 12 (28%) nurses. The remaining six respondents were other members of the multidisciplinary team (MDT) including physiotherapists, occupational therapists and one surgeon.

Surgery school design

Respondents described a range of MDT members involved in the design and delivery of the 28 active and four planned schools (see Fig. 2). Most common professions involved in design were anaesthetists, nurses, physiotherapists and surgeons, with psychologists and patients in the minority. Over half of the responders (66% (n=32)) stated that their school was delivered or would be delivered by three or more members of the MDT. Most commonly, these included a nurse, physiotherapist and anaesthetist.

A small number (11% (n=4)) of surgery schools had been running for over a decade, most commonly in orthopaedics. Almost half (43% (n=12)) had started within the last 2years and reported finding it useful to visit

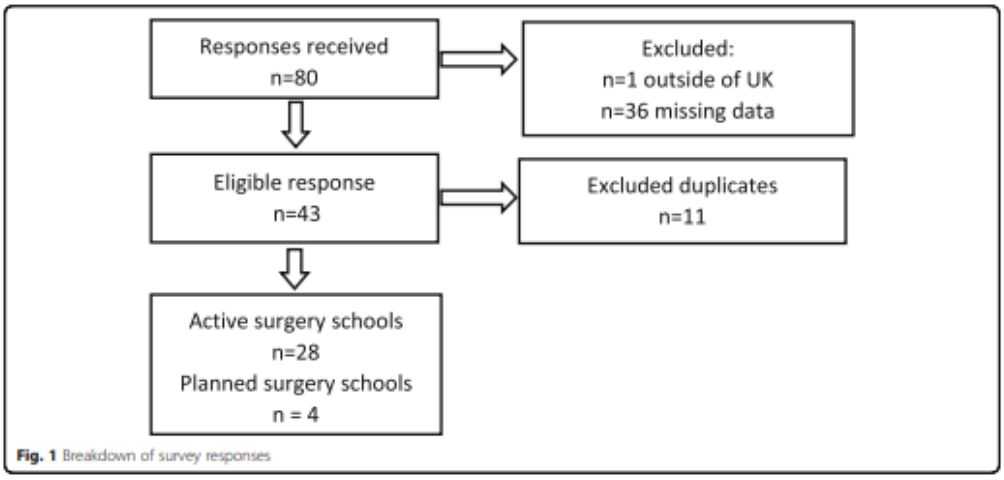

Fig. 1 Breakdown of survey responses

other hospitals running schools before setting up their own..

Most respondents (71% (*n*=23)) reported that their surgery schools were funded by their own NHS Trust. The remaining schools were funded by local partnerships, national grants and charities; two of the schools were unfunded and undertaken in staff members' own time. Almost half (46% (*n*=15)) reported that their funding was ongoing, 18% (*n*=6) reported fixed term funding and the remaining 24% (*n*=7) did not know their funding mechanism.

Surgery school structure and content

The majority of active surgery schools (71% (*n*=20)) were reported as lasting 1 to 2 h and offered as a single session per patient (85% (*n*=24)), with between 5 and 20 patients (82% (*n*=23)) attending each school event. Three respondents stated that they had more than twenty patients attend at a time. Patient attendance was reported by 82% (*n*=23) of respondents and ranged from 35 to 100% of those invited, with the majority (78% (*n*=22)) reporting very good attendance rates of 80–100%.

Active schools were being delivered to ten different surgical specialties, mostly commonly in orthopaedics, colorectal and urology (see Fig. 3). Orthopaedic schools (*n*=12) were run exclusively for orthopaedic patients. The remaining schools apart from three colorectal schools were mixed specialty.

Eleven of the hospital teams (39%) invited all their surgical patients undergoing major surgery to attend their surgery school as part of the surgical booking process, with three of those (11%) stating that school attendance

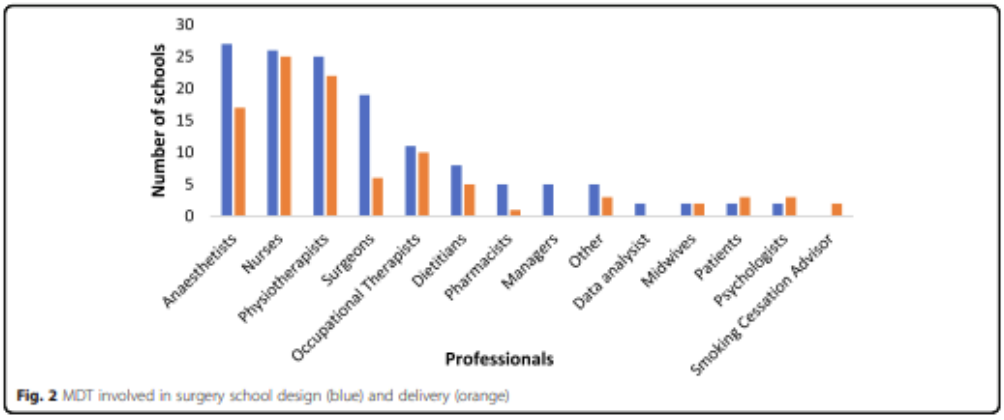

Fig. 2 MDT involved in surgery school design (blue) and delivery (orange)

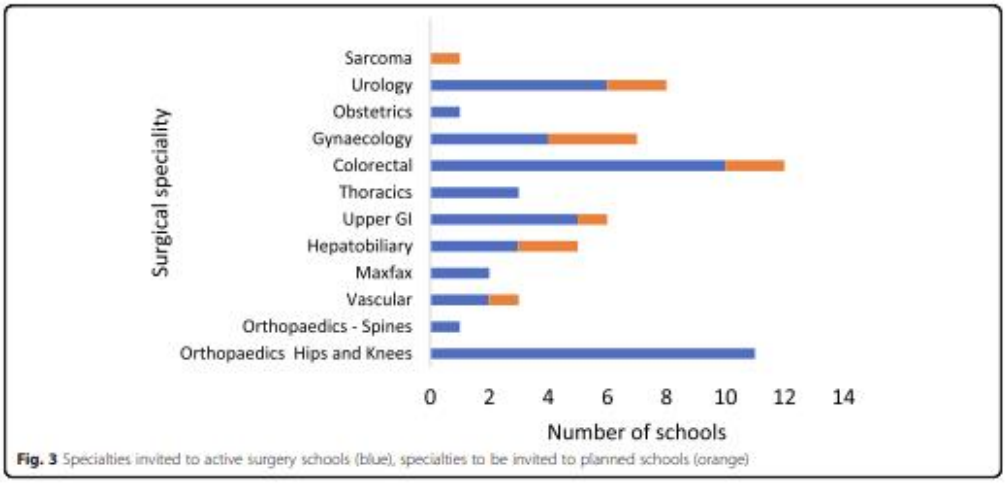

Fig. 3 Specialties invited to active surgery schools (blue), specialties to be invited to planned schools (orange)

was mandatory for patients prior to surgery. The remaining 61% (n=17) of active schools relied on case by case referrals from their surgeons, clinical nurse specialists and preoperative teams.

Taught content

The active and planned schools covered a range of topics. Most commonly taught were what to expect coming into hospital, enhanced recovery principles, increasing physical fitness, rehabilitation exercises and smoking cessation. Only half of the schools taught postoperative breathing exercises, and less than half described specific content to support emotional wellbeing (see Fig. 4). Other topics included stoma care training, pain control and the role of therapy services in recovery.

Almost all respondents (96% (n=31)) reported using supporting resources alongside their face-to-face teaching; most commonly used (75% (n=24)) were bespoke locally designed patient information leaflets; only 19% (n=6) used national written patient information. Almost half of the schools sign-posted to online resources (47% (n=15), videos and DVDS were used by 41% (n=13)), and less commonly Apps (13% (n=4)), DVDs, apps and signposting to online resources.

The majority of active and planned schools (78% (n=25)) used the patient contact opportunity to undertake further screening and assessment including screening for anaemia (28% of schools (n=9)) and recruitment for research studies (22% (n=7)). Other screening was undertaken for physical fitness (19% (n=6)), malnutrition (16%

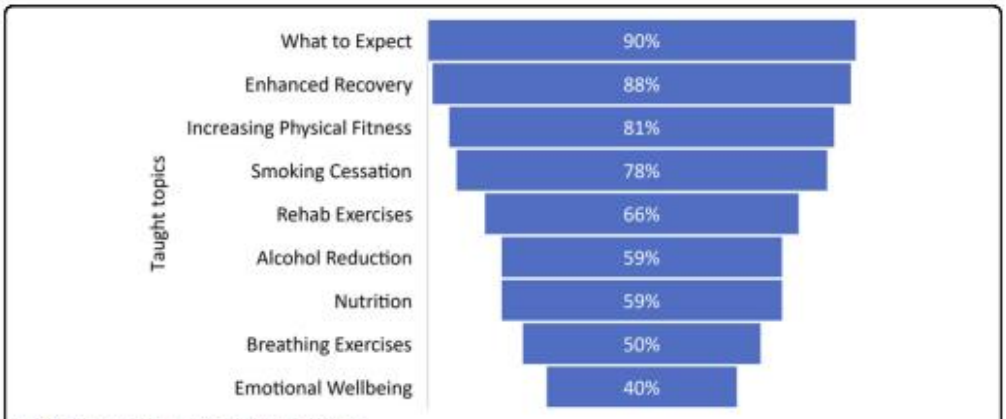

Fig. 4 Topics taught at surgery school by popularity

(*n*=5)), anxiety (9% (*n*=3)), lifestyle factors (3% (*n*=1)) and frailty (3% (*n*=1)).

Behaviour change support

Respondents were asked if they offered behaviour change support as part of their surgery school. Sixty-six percent (*n*=21) described using at least one method of support, including encouraging patients to set goals, keep diaries and use methods of communication during the session to encourage and motivate attendees.

Referral to agencies to support behavior change such as charities, gyms, council programs and smoking and alcohol cessation services was frequently described (see Fig. 5), as well as other NHS services such as dietitians, psychology and access to telephone support with session facilitators.

Just over one third of respondents of active and planned schools (*n*=12) reported developing collaborations with local organisations to support the prehabilitation of patients including local cancer charities (22% (*n*=7)) and local authority programs (16% (*n*=5)), see Table 1.

Outcome data

Patient outcome data following surgery school was collected by 75% (*n*=21) of active schools. Fourteen percent (*n*=4) did not collect any data, and 11% (*n*=3) did not know if they did. Forty-three percent of active schools (*n*=12) recorded length of hospital stay and 39% (*n*=11) postoperative morbidity and mortality. Other outcomes measured were postoperative data on time to drinking, eating and mobilising (25% (*n*=7)); patient satisfaction (21% (*n*=6)); patient-reported outcome measures (14% (*n*=4)); and behaviour change (7% (*n*=2)).

Future plans

The majority of active schools (75% (*n*=21)) reported ambitions for the future of their surgery school which included expanding to other specialties and hospitals (39% (*n*=11)), developing a complete prehabilitation service (25% (*n*=7)) and developing online support material for patients (25%). Others aimed to improve attendance (18% (*n*=5)), integrate more behaviour change interventions (18% (*n*=5)) and collect more outcome data (7% (*n*=2)).

Discussion

These novel survey results provide an insightful overview of surgery school activity across the UK and Ireland and confirm growing integration of prehabilitation.

Most respondents were anesthetists or nurses with notably only one surgeon. This may be due to survey distribution bias; although ERAS UK and Centre for Perioperative Care are both multidisciplinary organisations, the membership spread across the professions is not known and preoperative optimisation tends to be anaesthetic led. Respondents reported involvement from a wide range of the MDT in the design and delivery of their schools, predominated by anaesthetists, surgeons, nurses and physiotherapists, which concurs with the published literature regarding the design and delivery of surgery schools (Moore et al., 2017; Fecher-Jones et al., 2021; Shuldham et al., 2002).

Only two (7%) of teams involved patients in the design of their schools and 11% in the delivery. Patient

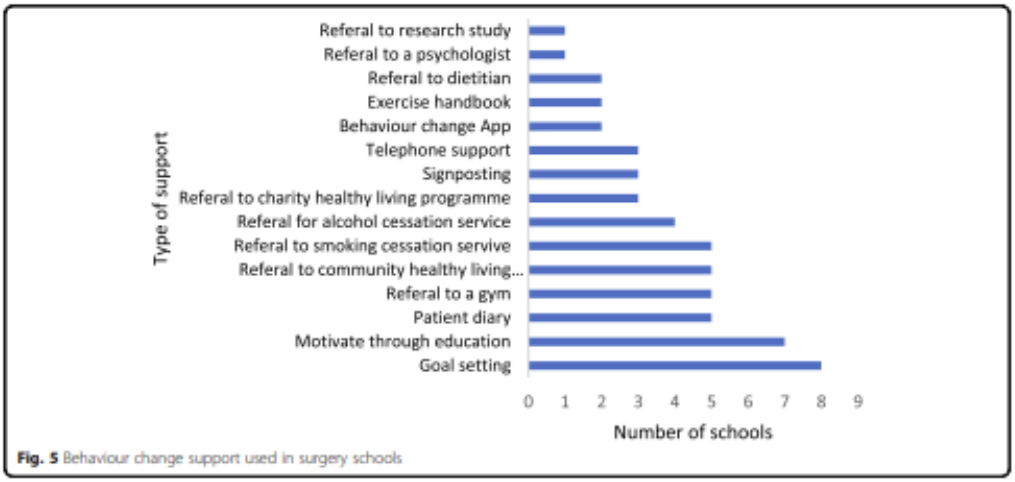

Fig. 5 Behaviour change support used in surgery schools

Table 1 Surgery school collaborations

Organisation	Number of schools
Cancer charities	7 (22%)
Local authorities	5 (16%)
Local gyms	2 (6%)
Research studies	2 (6%)
Sports charities	1 (3%)
Universities	1 (3%)

participation in the design, delivery and evaluation of new services has been found to enhance service delivery and acceptability (Bombard et al., 2018). Service users are also key stakeholders in any intervention that aims to change behavior (NICE, 2014). Surgery schools aim to empower patients and their support network to take an active role in planning and preparing for their operation (Royal College of Anaesthetists, 2017); therefore, their role in the planning and design phase of the school is important if it is to achieve its aim.

To our knowledge, there is only one example in the published literature of utilising patient and family input to support the design of surgery schools and other education-based resources (Moore et al., 2017). This concurs with the low number of respondents to the current survey describing such involvement. However, a significant number of respondents reported working with local organizations and explicitly cancer charities, which would help recognise the needs of patients and their families. Considering local patient and family participation in surgery school design and implementation is recommended for future services.

Most of the schools aimed to support patients to increase their physical activity and/or make healthful dietary changes, yet only two reported psychologist involvement, and none recount involvement of a behaviour change specialists in the design of the schools. The design of behaviour change interventions should be evidence-based, patient-focused and delivered by teams with core skills, knowledge and competence in behaviour change techniques (NICE, 2014). Over half of the respondents reported using methods to help motivate and facilitate patients' behaviour change but were unable to link these with evidenced-based behavior change techniques (Michie et al., 2013). This suggests a lack of knowledge of behavior change models and techniques and supports the case for behavior change specialists to be involved in surgery school design.

One third of the respondents reported working collaboratively with local agencies such as charities and local authorities to support patients to make lifestyle changes. Identification and signposting to support networks is critical if behaviour change is to be achieved (NICE, 2014; Grimmett et al., 2021). It is well evidenced that many people will require more than just instruction to change behaviour. More intensive personalised support may be required in order to make and sustain lifestyle behaviour changes (Grimmett et al., 2019).

The notable increase in the numbers of new schools in the last 2 years reflects the growing interest in prehabilitation particularly for cancer (Macmillan, 2019) and the ability to integrate aspects of this into surgery school curriculums as a universal intervention for all surgical patients. Respondents also reported visiting other surgery schools within the UK which they encouraged. Visiting and talking to other clinicians about their surgery school appears to promote shared learning and prevents teams from 'reinventing the wheel'. It may however have limited the development of different models of surgery school. Indeed, the schools described in this survey appear very similar, with most lasting 1 to 2 h, organised as a one-off session and attended by 5–20 patients at a time. Surgery schools were generally offered to a wide range of surgical specialties, although notably absent was cardiac surgery, which was unexpected given there are published studies demonstrating the benefit of group education on the clinical outcomes of cardiac patients (Shuldham et al., 2002; Goodman et al., 2008). It is also noted that 40% (n=11) of the active schools were Orthopaedic. These 'Joint schools' were more likely to be longer established but less likely to include elements of prehabilitation. This is supported by the literature, where joint schools are commonly described as standard care prior to joint surgery, often delivered by nurses and surgeons with more of a focus on rehabilitiation than prehabilitiation (McDonald et al., 2014).

Most schools taught similar topics, with emphasis on enhanced recovery and patient expectation management of major surgery. Prehabilitation components were also common, including increasing physical activity taught by 81% of schools and preoperative nutrition taught by 59% of schools. Support for psychological wellbeing was included in just 40% of schools, despite being a key component of trimodal prehabilitation (Li et al., 2013), and with evidence that poor preoperative psychological health is associated with poorer outcomes (Rosenberger et al., 2006; Kitagawa et al., 2011). However, research in this area is in its infancy, with an urgent need for high-quality trials investigating the impact of preoperative psychological support (Levett & Grimmett, 2019). Although preoperative nutrition was taught by two thirds of the schools, only 25% listed a dietitian as part of their design team, compared with 78% schools who listed physiotherapists. This is despite convincing evidence that preoperative malnutrition is associated with a worse postoperative outcome (Gillis & Wischmeyer, 2019).

The majority of schools supplemented teaching with additional learning resources with most offering

bespoke, locally written information. Less than 20% (n= 6) reported using nationally available patient information such as the Royal College of Anaesthetists 'Fitter Better sooner' guide (Royal College of Anaesthetists, 2017), perhaps suggesting that the national documentation does not quite fit local requirements. It has been argued that written documentation is often ineffective in communicating information due to issues with readability and accessibility (Zorn MaR, 2000). Evidence suggests that between 43 and 61% of English working age adults routinely do not understand health information due to low health literacy (Rowlands et al., 2015). In relation to prehabilitation, there is a strong association with health literacy and physical exercise; the higher the health literacy, the higher the frequency of physical exercise. It is also known that patients with lower health literacy have more difficulty in planning and adjusting their lifestyle to maintain good health (Wittink & Oosterhaven, 2018). Web- and phone-based apps have been found to be an effective way of delivering health information tailored to individuals with limited health literacy (Kim & Xie, 2015). Results from our survey found that only three respondents reported using apps, but many mentioned them in their future ambitions.

Although the majority of respondents reported their schools to be NHS funded, only 25% of these charged a tariff (an agreed price for an individual service). Some Trusts may receive 'block payments' based on an agreed payment for the provision of a service rather than individual payment per appointment or episode. Funding surgery schools is anecdotally a challenge. We found that some teams were delivering schools in their own unpaid time. Under half of respondents had secured long-term funding. Group education sessions are a cost-effective way of information giving to patients (Seesing et al., 2014) and may reduce the outpatient time needed. Given their potential for reducing surgical complications and length of stay, they may present an attractive cost improvement opportunity for organisations. However, the limited evidence base for the efficacy of surgery schools may provide an explanation as to why organisations are hesitant to commit to funding.

Seventy five percent of respondents reported collecting outcome data; however, postoperative length of stay and morbidity and mortality were collected by fewer than half of the teams, and behaviour change by only 7%. Without these as markers of clinical effectiveness, sustaining the service within the current financial climate is likely to be difficult. Given the additional staffing resources that are often needed to collect robust prospective data, there is a need for standardisation of a minimum dataset, including measures of behavior change, length of hospital stay, post-operative morbidity as well as patient-reported outcome measures. Data collection tools are also needed to facilitate this practice. Including a patient education category within national perioperative audit datasets such as The Perioperative Quality Improvement Project (Health Services Research Centre Perioperative Quality Improvement Project (PQIP), 2019) would be one way of doing this.

This survey was conducted before the COVID-19 pandemic, which resulted in face-to-face group education no longer being an option due to the risk of virus transmission. Five of the centres who took part in this survey have subsequently contacted the authors and report moving their surgery schools to online group sessions in recent months. The findings of this survey therefore remain highly relevant regarding the future of group preoperative education whether it be delivered virtually or face-to-face. The pandemic has also resulted in a backlog of patients awaiting surgery, thus creating an extended window of opportunity for patients to improve their fitness for surgery through lifestyle modification. Surgery school provides a likely cost-effective platform for perioperative clinicians to support patients to use this time proactively which should not be overlooked.

Strengths and Limitations

This survey provides the first published window of insight into surgery schools across the UK, establishes a baseline of clinical activity and identifies the similarities and differences between schools. Capturing this has enabled us to identify clear suggestions for practice and research that will underpin the future of surgery schools.

Although 80 clinicians responded to the survey only, 32 different schools were identified, which equates to 9% of 356 UK hospitals undertaking surgery having a surgery school (National Audit Project (NAP), 2021). We acknowledge that the actual number of surgery schools in the UK will likely be higher and that there may be bias in responses by nature of the fact that those with an interest surgery schools were more likely to take part. It was also noted that although responses were from across the UK and Ireland, they were most commonly from larger centres within UK cities, and almost a third were from London and the South of England. This bias may be due to those centres having more established perioperative services. The reasons for the large number of responses with missing data are also not known. It would have been useful to include within the survey a question asking whether respondents had a surgery school. A response of 'no' would have justified missing data. Responses to the open questions varied considerably in length and depth. This may have been because some respondents had more time or insight into the detail of their surgery school than others, but none the less will have influenced the overall findings.

Suggestions for practice and research

Future priority is to establish the clinical effectiveness of surgery school. This relies on teams and organisations working together to standardise their data collection and publish their outcomes. Data collection of outcomes needs to be considered within service development plans and adequately resourced. The recently completed Greater Manchester Implementation of 'ERAS+' will provide useful information about the effectiveness of surgery school (The Health Foundation, 2020).

Teams aiming to change patient behaviour should involve service users in the design of their programmes as well as evidence-based techniques for supporting behavior change.

Health literacy of participants should be considered from the outset to ensure accessibility of surgery school for all patient participants and the most appropriate supporting resources.

Conclusion

Surgery schools are a growing phenomenon in the NHS and provide education on a range of topics to patients and their families prior to major elective surgery. Schools provide a platform for introducing the elements of prehabilitation and the potential for motivating behaviour change. Inclusion of behavioral science and patients within the design of these interventions would maximise the effectiveness of schools in promoting behaviour change. Funding remains the biggest threat to the future of these schools, and without comprehensive collection of clinical effectiveness outcome measurements, and dissemination of the results, the future is uncertain. The authors challenge teams to think creatively, particularly around this time of uncertainty within the NHS, to establish collaborations with external agencies and focus on developing and sharing resources to improve access for all patients to this type of education.

Abbreviations

ERAS: Enhanced Recovery after Surgery; NHS: National Health Service; MDT: Multidisciplinary team; BCT: Behaviour change technique

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13741-021-00188-2.

Additional file 1. Survey questions

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Authors' contributions

IFJ—primary researcher, drafted paper, primary data collector and analyst. CG—substantial contribution through feedback of design, review of content. FJC, DHC, DZHL, JAM—substantial contribution with regard to content review and feedback on design. All authors read and approved the final manuscript.

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Availability of data and materials

All survey data is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Not required

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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References

Bombard Y, Baker GR, Orlando E, Fancott C, Bhatia P, Casalino S, et al. Engaging patients to improve quality of care: a systematic review. IS. 2018;13(1):98.
Dawson S. Principles of preoperative preparation. In: Manley K, Bellman L, editors. Surgical nursing: advancing practice. 1st ed. Edinburgh: Churchill Livingstone; 2000. p. 386–407.
Fecher-Jones I, Grimmett C, Edwards MR, Knight JS, Smith J, Leach H, Moyses H, Jack S, Grocott MPW, Levett DZH Development and evaluation of a novel pre-operative surgery school and behavioural change intervention for patients undergoing elective major surgery: Fit-4-Surgery School. Anaesthesia. 2021. doi: https://doi.org/10.1111/anae.15393. Epub ahead of print. PMID: 33538015.
Gillis C, Wischmeyer PE. Pre-operative nutrition and the elective surgical patient: why, how and what? Anaesthesia. 2019;74(Suppl 1):27–35. https://doi.org/10.1111/anae.14506.
Giraudet-Le Quintrec JS, Coste J, Vastel L, Pacault V, Jeanne L, Lamas JP, et al. Positive effect of patient education for hip surgery: a randomized trial. Clin Orthop Relat Res. 2003;414:112–20. https://doi.org/10.1097/01.blo.0000079268.91782.bc.
Goodman H, Parsons A, Davison J, Preedy M, Peters E, Shuldham C, et al. A randomised controlled trial to evaluate a nurse-led programme of support and lifestyle management for patients awaiting cardiac surgery 'Fit for surgery: Fit for life' study. Eur J Cardiovasc Nurs. 2008;7(3):189–95. https://doi.org/10.1016/j.ejcnurse.2007.11.001.
Grimmett C, Bradbury K, Dalton SO, Fecher-Jones I, Hoedjes M, Varkonyi-Sepp J, et al. The role of behavioral science in personalized multimodal prehabilitation in cancer. Front Psychol. 2021;12:261.
Grimmett C, Corbett T, Brunet J, Shepherd J, Pinto BM, May CR, et al. Systematic review and meta-analysis of maintenance of physical activity behaviour change in cancer survivors. Int J Behav Nutr Phys Act. 2019;16(1):37. https://doi.org/10.1186/s12966-019-0787-4.
Health Services Research Centre Perioperative Quality Improvement Project (PQIP). Available from: www.pqip.org.uk/content/home [Accessed 3 August 2019]

Kim H, Xie B. Health literacy and internet- and mobile app-based health services: a systematic review of the literature. Proceed Assoc Inform Sci Technol. 2015; 52(1):1–4.
Kitagawa R, Yasui-Furukori N, Tsushima T, Kaneko S, Fukuda I. Depression increases the length of hospitalization for patients undergoing thoracic surgery: a preliminary study. Psychosomatics. 2011;52(5):428–32. https://doi.org/10.1016/j.psym.2011.03.010.
Levett DZH, Grimmett C. Psychological factors, prehabilitation and surgical outcomes: evidence and future directions. Anaesthesia. 2019;74(Suppl 1):36–42. https://doi.org/10.1111/anae.14507.
Li C, Carli F, Lee L, Charlebois P, Stein B, Liberman AS, et al. Impact of a trimodal prehabilitation program on functional recovery after colorectal cancer surgery: a pilot study. Surg Endosc. 2013;27(4):1072–82. https://doi.org/10.1007/s00464-012-2560-5.
Macmillan. Prehabilitation evidence and insight review 2017 Available from: www.macmillan.org.uk/_../prehabilitation-evidence-and-insight-review_tcm9-335025.pdf. [Accessed 12 September 2019]
McDonald S, Page MJ, Beringer K, Wasiak J, Sprowson A. Preoperative education for hip or knee replacement. Cochrane Database Syst Rev. 2014;2014(5):1–68.
McGregor AH, Rylands H, Owen A, Dore CJ, Hughes SP. Does preoperative hip rehabilitation advice improve recovery and patient satisfaction? J Arthroplasty. 2004;19(4):464–8. https://doi.org/10.1016/j.arth.2003.12.074.
Mezzanotte EJ. Group instruction in preparation for surgery. Am J Nurs. 1970; 70(1):89–91.
Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Ann Behav Med. 2013;46(1):81–95. https://doi.org/10.1007/s12160-013-9486-6.
Moore J, Merchant Z, Rowlinson K, McEwan K, Evison M, Faulkner G, et al. Implementing a system-wide cancer prehabilitation programme: the journey of Greater Manchester's 'Prehab4cancer'. Eur J Surg Oncol. 2020.
Moore JA, Conway DH, Thomas N, Cummings D, Atkinson D. Impact of a perioperative quality improvement programme on postoperative pulmonary complications. Anaesthesia. 2017;72(3):317–27. https://doi.org/10.1111/anae.13763.
National Audit Project (NAP) Anaesthesia, surgery and life-threatening allergic reactions RCoA 6th National Audit Project: Perioperative Anaphylaxis 2018. Available from: https://www.nationalauditprojects.org.uk/downloads/NAP6%20Report%202018.pdf [Accessed 30 March 2021)
Nepogodiev D, Martin J, Biccard B, Makupe A, Bhangu A, National Institute for Health Research Global Health Research Unit on Global S. Global burden of postoperative death. Lancet. 2019;393(10170):401.
NICE. Behaviour change: individual approaches public health guideline [PH49] NICE; 2014 Available from: https://www.nice.org.uk/guidance/ph49. [Accessed 4 March 2019]
Rosenberger PH, Jokl P, Ickovics J. Psychosocial factors and surgical outcomes: an evidence-based literature review. J Am Acad Orthop Surg. 2006;14(7):397–405. https://doi.org/10.5435/00124635-200607000-00002.
Rowlands G, Protheroe J, Winkley J, Richardson M, Seed PT, Rudd R. A mismatch between population health literacy and the complexity of health information: an observational study. Br J Gen Pract. 2015;65(635):e379–e86. https://doi.org/10.3399/bjgp15X685285.
Royal College of Anaesthetists. Fitter Better Sooner. 2017 Available from: www.rcoa.ac.uk/patient-information/preparing-surgery-fitter-better-sooner [Accessed 9/6/2019)
Seesing FM, Drost G, Groenewoud J, van der Wilt GJ, van Engelen BG. Shared medical appointments improve QOL in neuromuscular patients: a randomized controlled trial. Neurology. 2014;83(3):240–6. https://doi.org/10.1212/WNL.0000000000000588.
Shuldham CM, Fleming S, Goodman H. The impact of pre-operative education on recovery following coronary artery bypass surgery. A randomized controlled clinical trial. Eur Heart J. 2002;23(8):666–74. https://doi.org/10.1053/euhj.2001.2897.
Survey Monkey. Available from: surveymonkey.co.uk [Accessed 2 June 2019]
The Health Foundation. Available from: https://www.health.org.uk/improvement-projects/improving-surgical-care-for-patients-and-their-families-in-greater-manchester-%E2%80%93. [Accessed 3 August 2020)
Wittink H, Oosterhaven J. Patient education and health literacy. Musculoskelet Sci Pract. 2018;38:120–7. https://doi.org/10.1016/j.msksp.2018.06.004.
Zorn MaR, S.. Health risk communication In: Medicine NLo, editor. Current bibliographies in medicine 2000. Bethesda, MD.2000.

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Implementing a system-wide cancer prehabilitation programme: The journey of Greater Manchester's 'Prehab4cancer'

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ABSTRACT

Patients undergoing major cancer interventions such as major surgical resection, chemotherapy, radiotherapy, and immunotherapy are prone to the adverse effects of their cancer, as well as to the side effects of the treatments designed to cure them. The Prehabilitation process supports cancer patients in preparing for the physiological challenges of their cancer treatments, whilst aiming to shorten recovery time, reduce peri-operative complications and improve compliance with non-surgical treatments. Prehabilitation will be most useful in older patients. Greater Manchester Integrated Care system is the first regional system in the UK to introduce delivery of system-wide, large scale physical activity supported multi-modal prehabilitation and recovery programme, Prehab4Cancer as a standard of care for cancer patients. It builds upon the successful implementation of Enhanced Recovery After Surgery + programme to improve surgical care in Greater Manchester. During this review we describe the journey to develop a system wide prehabilitation model for patients with cancer. Prehab4Cancer to date has focused on robust co-design, development, and implementation of an effective service model with attention paid to stakeholder engagement. This has led to receipt of high numbers of referrals from across Greater Manchester for the all the cancer groups involved. The successful implementation of the P4C pathway in GM presents a best practice model that might be adopted by other local and combined authority areas nationally.

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Introduction

Patients undergoing major cancer interventions such as major surgical resection, chemotherapy, radiotherapy, and immunotherapy are prone to the adverse effects of their cancer, as well as to the side effects of the treatments designed to cure them. For surgery, despite advancing innovations and the use of more minimal resection techniques, morbidity and mortality rates remain high [1,2], particularly amongst the older and most frail patients, who are more likely to adopt sedentary lifestyles [3,4].

Prehabilitation (commonly known as "Prehab") and supported recovery are increasingly recognised as important by people affected by cancer and healthcare providers internationally [5,6]. Following a cancer diagnosis, the prehab process aims to optimise a person's physical, nutritional, and psychological health in the time period before their cancer treatment begins and throughout treatment for non-surgical interventions [7]. The core components of a multi-faceted prehab programme include cardiovascular and

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skeletal muscle fitness training, nutritional management, wellbeing with psychological support, and medical optimisation. This optimisation process supports the patient in preparing for the physiological challenges of their cancer treatments, whilst aiming to shorten recovery time, reduce peri-operative complications and improve compliance with non-surgical treatments [8].

The most effective prehab programmes provide a holistic approach to promote patient empowerment, adherence and improved experience; which includes a graded, evidence-based exercise prescription to give the best opportunity to improve fitness in the constrained time-period before cancer treatment [9]. High-intensity interval training (HIIT) exercise provides an effective, time efficient approach to increasing fitness, but any exercise could be viewed as potentially beneficial for patients [10]. The rehabilitation side of the programme supports patients' recovery from their cancer interventions and where necessary can be used to prepare them for other treatments [11]. Rehabilitation should aim also to support the transition to lifelong exercise and so help in the prevention of future cardiovascular and cancer events [10].

Most supporting evidence for prehab has come from surgical patients undergoing colorectal, lung and oesphago-gastric resections [12–17]. There is currently less evidence supporting the use of prehab programmes in hepato-pancreato-biliary surgery but prehab studies in patients undergoing liver resection have shown improvement in pre-operative physical fitness especially in the least fit groups [18]. Multi-modal prehab may prove to be particularly important in the surgical treatment of pancreatic cancer, a diagnosis often associated with cachexia and malnutrition. Recent evidence from ongoing initiatives in Manchester (UK) recommends nutritional assessment and supplementation before and after major pancreas resection (personal communication).

Prehabilitation is likely to be most useful in older cancer patient cohorts, who are more likely to have complex co-morbidities as well as sensory, balance or cognitive impairment with reduced functional abilities [19]. Lawrence et al. evaluated functional recovery following major abdominal surgery in older patients (mean age 69). In the absence of a prehab or rehab programme, the results showed that eight weeks post-operation only 30% of patients had recovered to preoperative levels and at six months, only 50% had achieved baseline functional ability [20].

This is supported by more recent evidence from the GOSAFE international evaluation and follow-up of older patients (mean age 78) undergoing major oncological surgery which reports on-going decreased functional capacity in 1/3 of colorectal patients at 3 months [21]. The objective of GOSAFE investigators [22] to provide meaningful data to assist clinicians in tailoring care of elderly patients to avoid under or overtreatment appears very pertinent and supports reports from others suggesting that older patients identify good functional recovery as a priority rather than duration of survival and [7,23] highlights quality of life as an important metric for prehabilitation. The development of a prehabilitation programme designed to derive optimal engagement and benefit for older people supports the recent focus from UK national health policy for healthcare innovations to support people to 'age well' [24], with greater consideration given to people experiencing mild, moderate and severe frailty [25].

Rather than relying on chronological age, functional age appears a better predictor of outcomes [26] and this can be measured in a number of ways to allow detection of significant physiological and psychomotor defects. Formal evaluation of older patients' functional capacity would support fitter older patients to undergo more radical treatments, while protecting those who do not possess the required physiological reserve. It may also help to evaluate the outcomes of prehabilitation more effectively and ensure safe delivery of prehab programmes for such patient groups.

The individualised prehab requirements of cancer patients based upon their functional, rather than chronological, age can be considered using the universal-targeted-specialised model endorsed by Macmillan-RCOA [7], (See Fig. 1). As patient needs increase, the level of support increases providing a 'specialised' healthcare-exercise service provision at the top of the triangle.

Case for change in cancer care Greater Manchester, UK

Although there is growing evidence for the effectiveness of prehab, it has not yet been accepted into core clinical practice by the National Health System. Robust multi-centre trials are underway in the UK [27,28] and internationally [29] with the aim to evaluate prehabilitation care on a much larger scale than was previously conducted to derive the underpinning evidence of effectiveness and efficacy as well as patient acceptance of the interventions.

People in Greater Manchester (GM) diagnosed with cancer tend to be less active and have poor health compared to other UK areas [30]. Many have complex unmet health and social care needs throughout their treatment, which can remain for up to six months or more after treatments. Cancer outcomes was one of the composite health metrics that drove the creation of the Greater Manchester Health and Social Care Partnership (GMHSCP) Integrated Care System. In 2015, NHS organisations and councils agreed the GM devolution deal entrusting GM to 'take charge' of its own health and social care budget bringing together the social care and healthcare of its 2.8 million population [31].

This restructuring of the Greater Manchester (GM) healthcare system has supported innovative transformation projects for patients affected by cancer in GM including: the rapid screening programme for lung cancer, Enhanced Recovery After Surgery Plus (ERAS+) programme for major surgery, the CURE project to support smoking cessation, and prehab for those with cancer through the 'Prehab4Cancer' and recovery programme [32].

Working with partners in Greater Manchester to improve surgical care

The ERAS + project

Prehab for cancer patients undergoing surgery in GM has evolved from the surgical pathway innovation Enhanced Recovery After Surgery+ (ERAS+) [33], a pre and post-surgery care pathway designed and developed in GM and aimed to reduce pulmonary complications the most common significant complication after major surgery [34]. The original implementation of ERAS + at Manchester Royal Infirmary, demonstrated a 50% reduction in respiratory complications in patients undergoing major surgery and reduced hospital length of stay by 3 days [33].

ERAS+ is built on a traditional enhanced recovery after surgery stepped recovery approach and incorporates the ICOUGH respiratory bundle [35]. As a direct innovation it integrates prehab into the ERAS pathway, with the aim of improving patient's fitness before surgery with cardiovascular activity and muscle strengthening recommendations, alongside nutritional support, lifestyle advice and medical optimisation. This embedding of prehabilitation into ERAS is now being recognised as an essential step in major surgical care [8,36].

Patient and family education about the ERAS + pathway are facilitated through the 'Surgery School' format. Patients are invited with family members, carers and friends to attend the multidisciplinary education session prior to their surgery. At this 90 min weekly-facilitated session, healthcare professionals

(medical, nursing and Allied Healthcare Professionals) involved in the surgery care pathway 'walk' the patient and their accompanying friends/family members through the ERAS + innovation with an emphasis on 'training for their surgery'. Using behavioural change methodology, 'Surgery School' is designed to empower patients and families, viewing major surgery preparation as a teachable moment [37,38]. Pre-operative cardiovascular exercise, muscle strengthening, smoking cessation, medical optimisation, post-operative pain management are all explained alongside the ICOUGH aims of early mobilisation, good oral healthcare, use of incentive spirometers and early fluids and nutrition. Patients and family members are encouraged to ask MDT members facilitating 'surgery school' any questions they may have, and they are also invited to visit the High Dependency Unit and ward areas where they will be looked after following surgery. This helps to establish realistic expectations, reassurance and 'normalisation' to reduce any potential experience of anxiety a patient may be having in anticipation of their surgery. It was also found to strengthen the partnership between healthcare provider, patients, and their networks of support (unpublished data).

Following its success at Manchester Royal Infirmary Hospital, the ERAS + platform was adopted by the GMHSCP system for implementation at a further six NHS hospital trust sites within the GM region as the GM ERAS + programme, supported and funded by a Health Foundation Scaling up Improvement grant (2018–2020) [39].

As part of the initial rolling out of the GM ERAS + programme and the ambition to facilitate patients getting fitter prior to surgery (prehabilitation), hospital sites began to formulate links with their local GM borough leisure organisation health-focused partners to help consider and develop the delivery of community-based physical activity intervention prehabilitation for surgical patients in their locality utilising existing exercise referral schemes. These links were formed in parallel with the development of the CAN-Move exercise rehabilitation programme [40], a commissioned exercise referral scheme available for Salford residents recovering from cancer treatments including surgery and oncological interventions. The specialist exercise instructor leading this programme would become the Prehab4Cancer exercise lead.

During a similar timeframe the GM Active board was conceived, bringing together 12 separate leisure and community organisations from across GM, working collaboratively to increase the levels of exercise and physical activity of the GM population. The formation of GM Active enabled relationships formed with individual leisure providers to be expanded to include health-focused representatives from all the GM leisure organisations, a progression which became a 'lever' for the concept of system-wide prehabilitation delivery at scale.

Patients accessing the ERAS + programme were signposted to local physical activity resources through their ERAS + teams, during 'pre-op' appointments and 'surgery school' and were encouraged to attend on a voluntary basis. The community-based exercise referral schemes could be accessed by both oncological and non-oncological major surgical patients either free of charge, or with minimal costs, through locally agreed introductory rates. A combination of cardiovascular and resistance-based training was provided to patients, using the existing referral fitness instructors in borough sites who were already delivering pulmonary rehabilitation, falls rehabilitation, pain management, cardiac rehabilitation and in some cases cancer rehabilitation sessions.

Patients entering these preliminary programmes increased their exercise capacity in the pre-operative period (unpublished data). There were, however, a number of barriers identified to wider scale adoption including organisation of gym referral and patient appointments; ownership of referral from secondary healthcare;

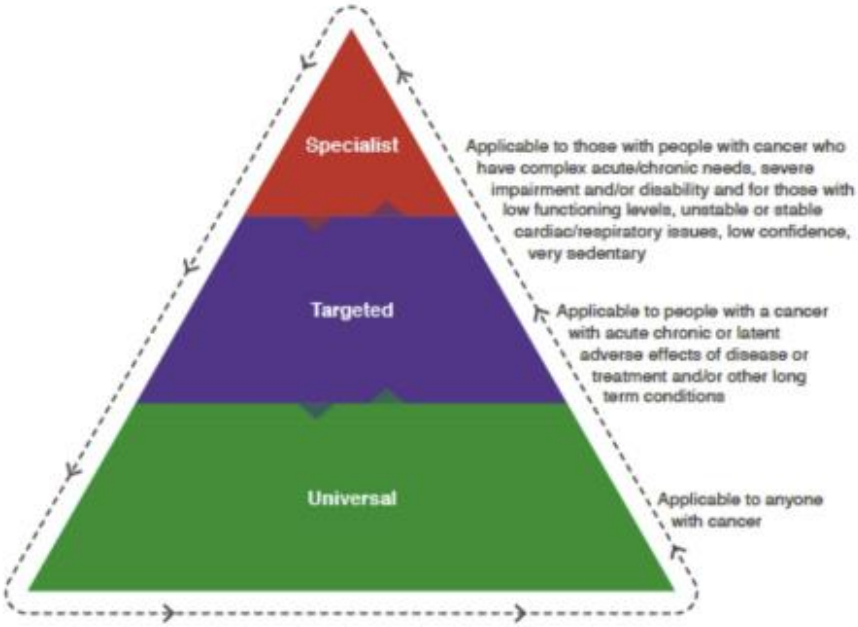

Fig. 1. Prehab categories.

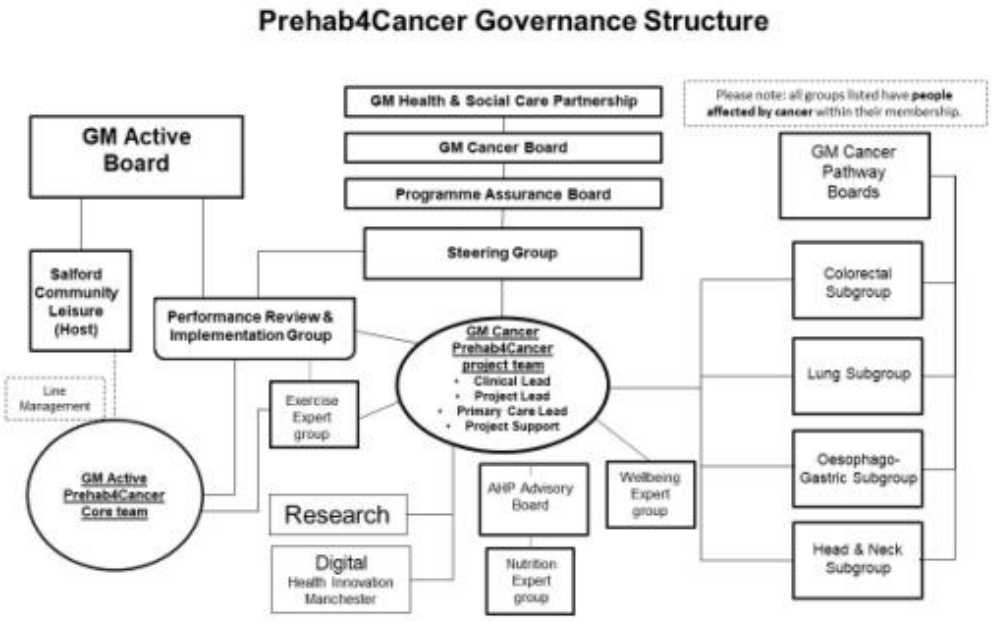

Fig. 2. P4C governance structure.

differences in the exercise aspects on offer, variation in cost, which despite being mainly low it remained as a barrier to some patients undertaking the sessions. Importantly, there had not been a large-scale investment in secondary and primary care understanding of the gym prehab sessions and, as such, patients received inconsistent recommendation to engage from key clinicians within their surgical pathways, if any recommendation was made at all. Prehab4Cancer focus groups comprised of People Affected By Cancer (PABC) confirmed this important barrier to engagement. It is therefore essential that surgeons, oncologists, Cancer Nurse Specialists (CNSs) and other key healthcare professionals advocate engagement in prehab using consistent communication (similar

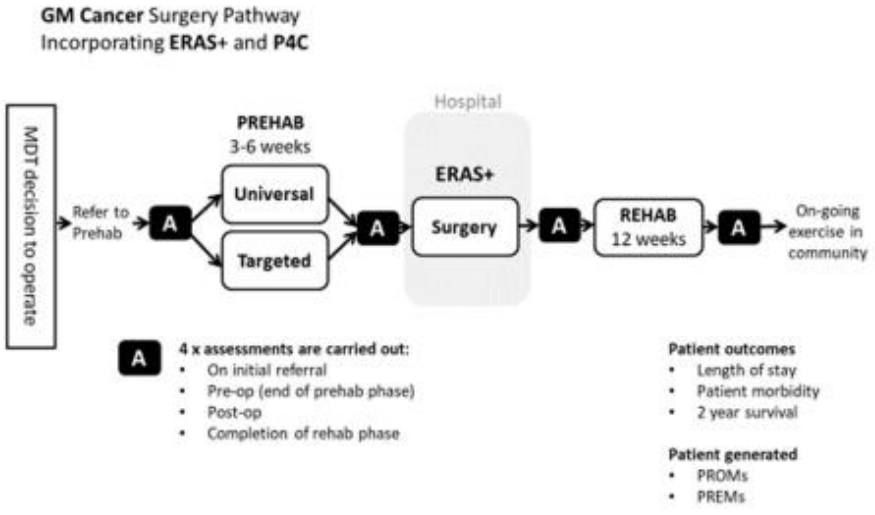

Fig. 3. GM Cancer surgery pathway incorporating ERAS+ and P4C.

Table 1
P4C outcome metrics.

Type:	Outcome Measure:
Physiological measures:	
Functional dynamic test	**6 Minute Walk Test (6MWT)** Incremental Shuttle Walk Test (ISWT)
Weight	To be measured in kilograms.
Height	To be measured in metres.
Heart Rate/BP	Resting heart rate/BP. Plus recording heart rate range during sessions.
Oxygen saturation Levels	Recorded at rest and throughout the 6MWT/ISWT
Resistance	Rep max percentage programming. Heaviest weight you can lift for 10 consecutive exercise repetitions. Quad, Core, Shoulder.
Grip Strength	Hand Grip Strength (dynamometer) measured in kg
Bespoke nutritional screening assessment *takes into account Body Mass Index (BMI), weight trend (loss or gain), changes in ability to swallow solid food (IDDSI food and drink descriptors) and hand grip strength.*	
Patient Reported Outcome Measures (PROMs):	
General Health and Wellbeing (Quality of Life - QOL)	**EQ-5D-5L** Descriptive system of health-related quality of life states consisting of five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression) each of which can take one of five responses. The responses record five levels of severity (no problems/slight problems/moderate problems/severe problems/extreme problems) within a particular EQ-5D dimension.
Physical Activity	**International Physical Activity Questionnaire-Short Form (IPAQ – SF)** The IPAQ assesses physical activity across a comprehensive set of domains including: a) Leisure time physical activity, b) Domestic and gardening activities, c) Work-related physical activity, d) Transport-related physical activity. N.B. Developed and tested for use in adults (age range 15–69 years), not validated in older adults. https://sites.google.com/site/theipaq/background
Cancer-specific QOL	**EORTC QLQ-C30** (version 3) This is a QOL questionnaire targeted to the management of chronic illness. It is included in the NHS England recommended Living with and Beyond Cancer/Personalised Care QOL metrics. It asks more extensive QOL questions which go beyond the EQ-5D.
Frailty (Activities of Daily Living)	**Rockwood Clinical Frailty Scale**
Disability	**World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0)** This self-administered questionnaire asks about difficulties related to health conditions that impact on someone's ability to do their daily activities.
Efficacy	**Self-Efficacy for Exercise Scale** This supports action planning to identify barriers to engagement as the patient accesses the programme whilst also focusing on confidence levels and general self-efficacy of the patient to engage in exercise.
Patient Reported Experience Measure(s) (PREMs):	
Participant Experience	**NHS Family and Friends Test** Bespoke 'Prehab4Cancer' participant experience survey

language, explanation of the service, written information and positive affirmation).

Prehab4Cancer design

The evolving relationship of the GM secondary healthcare providers with the GM Active leisure organisation enabled learning to be adopted from the preliminary implementation of prehab in individual boroughs, fostered through the GM ERAS + programme delivery. This in turn became a catalyst for key representatives from the GM Active board and the ERAS + programme team to consider the development of a GM system-wide prehab service model for Greater Manchester 'The Prehab4Cancer and Recovery programme' with GM Cancer oversight and supported financially through transformation funding.

The Prehab4Cancer (P4C) programme, with system-wide stakeholders now in place, was co-designed with PABC as patient involvement representatives, alongside cancer surgical pathway healthcare experts and exercise professionals from GM Active. The programme was initiated with an ambition to facilitate two thousand patients to undertake community-based prehabilitation and recovery, close to their residential address, in the eighty-six GM Active leisure facilities across the GM conurbation. Patients would be supported before (prehab) and after (rehabilitation) cancer treatments (including surgery, chemotherapy and radiotherapy), and where applicable during treatment, to have increased physical, nutritional and wellbeing support.

The initial patient cohorts chosen, based upon the current strongest evidence base and reflective of the relationships already in places with GM ERAS + teams, were colorectal, lung and oesophago-gastric cancer surgery pathways [12–17]. It was agreed that all patients resident in GM within these tumour groups and with an offer of curative surgery could additionally be offered 'Prehab4Cancer' as an integral component of their treatment pathway. Additional eligibility criteria included age >18 and being able to safely participate in the exercise programme [41].

Cancer clinical pathway specific subgroups for each surgical cohort worked closely with PABC and members of MDTs from around GM to design the specific surgical P4C pathway for their patients, supported by clinical (medical/therapies/psychological), academic and exercise expertise. Meetings took place on a monthly basis chaired by a clinical lead (surgeon or physician) and supported by the 'Prehab4Cancer' programme and clinical leads. These subgroups informed the co-design and effective implementation of the referral process, patient uptake and adherence to the programme, clinical considerations for programme delivery specific to tumour group cohorts and consistent communication for patients and family members. The output and ownership from these subgroups appear critical to the success of the programme delivery and would be a recommended component for the development of other prehab programmes being considered.

The project team managing the delivery of P4C consists of a secondary healthcare clinical lead (anaesthetic and critical care

consultant, with specialist experience in peri-operative medicine), primary care lead (Macmillan GP), GM Cancer programme lead (specialist occupational therapist with a background in complex rehabilitation and community NHS service leadership) and GM Active programme manager (former CAN-Move manager). The combination of members of this inter-disciplinary team provided oversight of a patient's journey from referral through treatment and into recovery, and a comprehensive understanding of the clinical and holistic needs of cancer patients.

The governance structure (Fig. 2) which supports the project team and ultimately delivery of P4C includes an overarching steering group reporting into the GMHSCP via the GM Cancer Board, cancer clinical pathway specific subgroups, intervention-specific expert groups and an AHP Advisory board (including dietitians, occupational therapists, physiotherapists, speech and language therapists and PABC).

Attention was particularly given to older patients considered to be high risk or identified to be pre-frail/frail, agreeing assessments and interventions which could be graded to such patient cohorts for maximal engagement and safe delivery of the programme. As a result, relatively few patients are excluded from the programme with patients in their 70s, 80s and 90s effectively participating in P4C. This was further supported by education events to wider healthcare professional stakeholders involved in referral to the P4C service and who would be in contact with programme participants.

P4C intervention

The exercise interventions, pathways and outcome metrics (see Table 1) for P4C were developed by the authors in partnership with PABC, the expert exercise and pathway subgroups and were aimed to improve patient cardiovascular fitness, muscle strengthening and incorporate nutritional and wellbeing support to complement existing provision within GM cancer patient pathways.

The programme recognises many of the secondary symptoms that cancer patients experience related to their diagnosis and subsequent treatment including fatigue, low mood and feelings of anxiety [42]. It builds on widely understood principles surrounding exercise positively contributing to the reduction of such secondary symptoms, particularly related to mental health [43–45], with the overall aim of providing a holistic pathway to improve patient quality of life, during and after treatment. This in turn supports people with cancer to recover faster from their treatment with motivation for resumed independence and the ability to perform their pre-morbid occupations including returning to work, self-care and other important and personally meaningful activities of daily life.

Participants' wellbeing modality was constructed using the NICE 2004 stepped care model [46] approach to psychological support, highlighted in the Macmillan Prehabilitation Evidence and Insight report from 2017 [47], and accepted as an effective framework to deliver mental wellbeing assessment and intervention.

In addition, by using well-equipped community-based leisure resources, as opposed to hospital gymnasiums, there was also the intention that this would support a secondary programme aim to induce long-term lifestyle behavioural change, supporting patients' adoption of on-going exercise following discharge from the programme.

Through existing partnerships with GM Active, the non-profit organisation UKactive, who represent the fitness and leisure sector partnered with the Prehab4Cancer team. Their research institute's principal investigator provided input to the prehab-intervention design and training of GM Active staff, in addition to the reporting and evaluation of the exercise components. This included careful consideration of the timeframe available for the prehabilitation component (typically 3–4 weeks) and the minimal effective exercise dose that could be provided.

Exercise dose was considered for both cardiovascular and resistance exercise based upon manipulation of the intensity of effort required ('how potent?'), the volume/duration for which it was performed ('how much?'), and also frequency of sessions across each week ('how often?'). Within this, a standardised intervention was developed that enabled individualisation to scale to patient's fitness levels (due to prescription based upon effort i.e. exercise demands relative to patient's current capacity) and enabled flexibility in delivery across the various leisure facilities involved.

An overview of the exercise prescriptions is shown in Table 2. Briefly, both followed progression in terms of the potency of dose prescribed based upon intensity of effort, a concomitant adaptation of volume/duration in line with this, and fixed frequency of 3x/week sessions. The resistance training component provided a progressive intensity of effort with minimal effective dose as previously delivered for older adults [48,49]. The cardiovascular training was adapted from the RE-HIIT (reduced exertion high intensity interval training) protocol providing a tolerable approach to HIIT [50]. Exercise selection was deliberately flexible within this prescription to accommodate the varying equipment between sites of delivery, and patient preferences, functional limitations, and injuries. Resistance training included a minimum of 3 exercises performed to target the main large muscle groups of the body

Table 2
Examples of cardiovascular and resistance training exercise dose prescription. Note: Most patients received 3 weeks and progression is built around this length of time between diagnosis and surgery. Exercise past this time continues to progress or maintains at week 3 prescription.

	Resistance training				Cardiovascular training		
	Week 1	Week 2	Week 3		Week 1	Week 2	Week 3
How potent?	nRM	sdRM	-MF	*How potent?*	12-13 RPE	14-17 RPE	18+ RPE Borg Scale*
Intensity of effort	RP-E/D	RP-E/D	RP-E/D	Intensity of effort	Borg Scale*	Borg Scale*	
How much?	15-18 reps	8-12 reps n/a	8-12 reps n/a	*How much?*	30 min n/a	20 min n/a	(RE-HIIT*)
Repetitions	~50–60%1RM	2	1 n/a	Duration	1	1	10–20 s n/a 2
Load	2	2–4 min		Speed/Power			
Sets (Rest-sets)	2–4 min			Bouts			
How often?	3x/week	3x/week	3x/week	*How often?*	3x/week	3x/week	3x/week
Frequency				Frequency			
Decision Rules	~50–60%1RM (Brzycki formula*)			*Decision Rules*	Determined by initial fitness (i.e. RPE)		
Starting level	From week 2; + <10% load if > 12 reps before set end			Starting level	Based upon changing fitness (i.e. RPE)		
Progression	point achieved			Progression			

Resistance training intensity of effort based upon set endpoints and rating of perceived effort [48,52]; nRM = not repetition maximum; sdRM = self-determined repetition maximum; MF = momentary failure; 1RM = one repetition maximum; RP = E/D = rating of perceived effort (effort/discomfort); RE-HIIT = reduced exertion – high intensity interval training (see Metcalfe et al., 2012).

(upper body multi-joint push e.g. chest press/overhead press/seated dip; upper body multi-joint pull e.g. pulldown/seated row; and a lower body multi-joint exercise e.g. leg press/deadlift) with additional single-joint exercise included as supplementary where specific functional deficits existed. Similarly, cardiovascular training was performed using an available ergometer (e.g. cycle, treadmill, cross-trainer, stepper, rower, ski-erg, or arm crank).

Data from patients attending the leisure facilities in the P4C programme, is collected using the ReferAll data collection system, which has been used in previous work examining exercise referral schemes [51–53]. UK Active and GM Active have many years of experience working with the ReferAll system, which has been adapted to allow capture of data relating to both outcome and fidelity of the interventions in line with the Consensus on Exercise Reporting Template (CERT) [54].

The knowledge from the project team and expert groups of the holistic needs of predicted patient cohorts led to areas for continued professional development (CPD) and education. This has included all GM Active fitness instructors involved in service delivery being trained in level 1 stepped-care model [46] communication SAGE and Thyme skills training workshop [55], bespoke nutritional screening (devised by cancer specialist dietitian members of the AHP Advisory Board), exercise prescription, prehabilitation overview and consideration of potential complex needs 'Prehab4Cancer' participants may present with. There is on-going CPD training which includes facilitated reflective peer session with oncology specialist psychologist and programme lead to provide emotional support to staff delivering P4C intervention, as well as weekly education sessions covering topics such as severe and enduring mental health conditions and cognition.

The P4C patient pathway

The starting point for the surgical P4C pathway is the Multidisciplinary team decision to operate (See Fig. 3). In phase 1, all patients undergoing colorectal, lung and upper GI cancer surgery are offered 'Prehab4Cancer' without restriction. The patient is then referred through the GM Active 'Prehab4Cancer' on-line referral form (https://www.gmactive.co.uk/prehab4cancer/). Here patient referral information including demographics, diagnosis, relevant past medical history and other specified details is provided by a named healthcare professional referrer to support on-going gym-healthcare liaison and the creation of a ReferAll patient record. Upon receipt of the referral the P4C referral coordinator contacts the patient within 48 h and arranges attendance at an initial assessment clinic within another 48 h from telephone contact. This initial assessment clinic will be held at a local leisure facility within 5 miles or 30 min travel from the patient's residential postcode. The assessment clinic is facilitated by one of the P4C Specialist Instructors, at one of the 17 assessment clinics held weekly. The specialist instructors are trained in cardiac, pulmonary and cancer rehabilitation as well as qualifications on falls prevention, obesity & diabetes and musculoskeletal disorders to allow them to work with complex patients.

At the initial assessment, a patient is assessed using P4C agreed clinical, physiological, functional and psychosocial metrics (Table 1). Details of their assessments are recorded on the ReferAll system. An exercise prescription is generated in line with the standardised intervention detailed above providing a combination of cardiovascular and resistance exercise with the aim for patients to attend a minimum of three gym sessions per week leading up to surgery and 2–3 sessions per week during neo-adjuvant chemotherapy. Following evaluation, patients are triaged into a targeted (less fit) or universal (fitter) pathway, which offer varying levels of supervision dependent upon patient fitness, nutritional needs, frailty, requirement for psychological support and ability to self-manage their exercise prescription independently in a potentially unfamiliar gym environment. Patients undergoing neo-adjuvant chemotherapy treatments as part of OG or lower GI cancer pathway are automatically entered into the targeted pathway, with the expectance that these patients will deteriorate in their endurance and physiologically during their oncological treatment. These neo-adjuvant prehab pathways last for 2–3 months and continue up until surgery.

In the targeted pathway for patients who require increased levels of support, patients attend for group sessions, with an attending exercise specialist or local instructor. The patient is monitored and HR data, RPE and Borg scales recorded during sessions. The universal patients are provided with a detailed exercise programme to adhere to and educated on achieving their training zones at the gym with additional weekly regular specialist reviews for support. They are given details of the targeted group sessions, which they are invited to attend should they wish to and encouraged to undertake other gym activities which appeal to them. On non-gym days all patients are encouraged to be active and aim to undertake 30 min of moderate physical activity, which can be spread throughout the day, in line with national physical activity advice [10].

Once undertaking the P4C programme, patients are re-assessed using the same outcome metrics prior to surgery following their prehab phase, 4–6 weeks post-surgery when they are deemed physically able to resume engagement in exercise and again finally at the point of discharge from the service following 12 weeks of a recovery programme.

In contrast to the prehab phase, which is deliberately prescriptive for those patients who have completed their treatment following surgery, the recovery phase aims to provide an exercise prescription which is more personalised to patient preference and physical activities which will be more likely to lead to long term behavioural change. P4C specialist instructors utilise the relationship they have developed with patients, as well as their local knowledge of available community resources to engage participants in physical activity they will be motivated to continue to do, whilst supporting their recovery from major surgery. Beyond the 12 weeks funded recovery phase, patients can be transitioned to other exercise referral schemes or subsidised, independent gym access dependent on the patient's ongoing needs and the borough they live in.

For patients who require further adjuvant therapies following surgery (OG and Lung adjuvant chemotherapy), their rehabilitation adopts a similar prescriptive nature to their prehab, which will be on-going through their post-op treatment. When this is completed, they will be offered transition to a recovery phase programme.

'Specialised' P4C pathways aimed at those most high-risk patients experiencing sarcopenia and/or moderate/severe frailty and subsequent higher risk of complications through surgery or other curative oncological treatment are now in development in GM. We are working with sports medicine and academic colleagues to explore the potential pathway, staffing groups (including AHPs working with specialist fitness instructors) and interventions that will help optimise this groups of patients.

Evaluation of Prehab4Cancer

Since it launched in April 2019, at the time of writing, over 600 patients from across the GM conurbation have participated in the P4C programme. Of colorectal patients (n = 331), average age of patients entering P4C is 67 (35–91), 60% are male with over 47% of patients in P4C over the age of 70 and from all boroughs in GM. For lung (n = 258) the average age of patients entering P4C is 69, with

47% male and more than 57% of patients over the age of 70, with again representation from all over GM. Approximately 80% of people referred agree to attend their initial assessment and 95% of those attending this appointment engage in the programme, demonstrating acceptability for people diagnosed with cancer in GM. Initial participant feedback focus groups held at 6 months into the programme have generated consistently positive support for P4C.

The high uptake rates from phase 1 cohorts will enable the second phase of patients undergoing major surgical procedures including hepato-pancreato-biliary surgery, head and neck and urology cancer diagnoses to commence in advance of the project's planned delivery timeline along with lung cancer patients on non-surgical treatment pathways accessing the programme.

Despite evidence for the efficacy of prehab and rehabilitation in controlled settings, robust evaluation of its 'real world' effectiveness is needed. By early 2021, P4C will have supported ~2000 patients to participate in freely accessible community-based prehab and recovery programmes across the GM region. Its successful implementation in GM presents a potential best practice 'Whole Population' model, adaptable for all appropriate cancer patients in the UK. This work would, to our knowledge, represent the first large scale evaluation of a treatment pathway focused around cancer prehab and rehabilitation within a 'real world' context (i.e. within the context of usual day to day delivery of care) as opposed to within a controlled research context (i.e. a randomised controlled trial). Thus, we will generate evidence regarding the 'real world' effectiveness of Prehab4Cancer's implementation that might support the sustainability and extension of the current programme, as well as the transferability and scalability of similar models of care delivery to be adopted by other local and combined authority areas in the UK.

During P4C implementation, all patients referred into the service, and meeting the inclusion criteria, will have been offered the intervention. The majority of participants would be classed as older adults (over 65 years old), with many in their 70s, 80s and 90s. This will allow us to evaluate the role of prehabilitation in older patients who have traditionally been absent from cancer intervention trials [56,57].

Throughout the programme, intervention fidelity and patient outcomes will be measured and digitally captured including survival rates, surgical complications, hospital readmissions, treatment recovery, physiological and functional measures, and quality of life (QOL) patient reported outcomes (PROMs). This dataset, in combination with historic 'legacy' datasets representing usual care models, will enable the evaluation to take place and allow a pragmatic evaluation of Prehab4Cancer.

Conclusion

The introduction of ERAS+ in 2015 as a new pathway in Greater Manchester (GM) including a prehabilitation advice and support package, in-hospital best care surgical model, and post-hospital recovery supporting patients, has already led to rapid improvements in post-surgical complications and costs (unpublished GM ERAS + data).

With the addition of P4C, GM Cancer is the first regional system in the UK to introduce delivery of system-wide, large scale physical activity supported multi-modal prehabilitation and recovery interventions as a standard of care for cancer patients. P4C to date has focused on robust co-design, development, and implementation of an effective service model with attention paid to stakeholder engagement. This has led to receipt of high numbers of referrals from across GM for the all the cancer groups involved. Prehab in older and more frail patients will be reviewed in the evaluation of the current P4C model, which will help in the design of the specialised prehabilitation models for patients in GM.

The successful implementation of the P4C pathway in GM presents a best practice model that might be adopted by other local and combined authority areas nationally. However, robust evaluation is needed to evidence its effectiveness, 'value for money' and to help maximise its impact to influence the case for national adoption of prehabilitation service delivery.

Declaration of competing interest

There are no conflicts of interest for this article for any of the authors.

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References

[1] Pearse RM. Global patient outcomes after elective surgery: prospective cohort study in 27 low-, middle- and high-income countries. Br J Anaesth 2016;117(5):601–9.
[2] Tjeertes E, Ultee KHJ, Stolker RJ, et al. Perioperative complications are associated with adverse long-term prognosis and affect the cause of death after general surgery. World J Surg 2016;40:2581–90.
[3] Richards SJC, Frizelle FA, Geddes JA, et al. Frailty in surgical patients. Int J Colorectal Dis 2018 Dec;33(12):1657–66.
[4] Sadiq F, Kronzer VL, Wildes TS, et al. Frailty phenotypes and relations with surgical outcomes: a latent class Analysis. Anesth Analg 2018 Oct;127(4):1017–27.
[5] Thorsen L, et al. Cancer patients' needs for rehabilitation services. Acta Oncol 2011;50(2):212–22.
[6] Silver J. Cancer rehabilitation and prehabilitation may reduce disability and early retirement. Cancer 2014;120(14):2072–6.
[7] MacMillan Cancer Support, Royal College of Anaesthetists, and the National Institute for Health Research. Prehabilitation for people with cancer: principles and guidance for prehabilitation within the management and support of people with cancer. https://www.macmillan.org.uk/about-us/healthprofessionals/resources/practical-tools-for-professionals/prehabilitation.html; 2019.
[8] Carli F, Gillis C and Scheede-Bergdahl C. Promoting a culture of prehabilitation for the surgical cancer patient. Acta Oncol, 56:2, 128-133.
[9] Tew GA, Ayyash R, Durrand J, et al. Clinical guideline and recommendations on pre-operative exercise training in patients awaiting major non-cardiac surgery. Anaesthesia 2018 Jun;73(6):750–68.
[10] Department of Health and Social Care. UK chief medical officers' physical activity guidelines. London: Dept. of Health and Social Care; 2019.
[11] Faithfull S, Turner L, Poole K, et al. Prehabilitation for adults diagnosed with cancer: a systematic review of long-term physical function, nutrition and patient-reported outcomes. Eur J Canc Care 2019 Jul;28(4).
[12] Piraux E, Caty G, Reychler G. Effects of preoperative combined aerobic and resistance exercise training in cancer patients undergoing tumour resection surgery: a systematic review of randomised trials. Surg. Oncol 2018;27:584–94.
[13] Barberan-Garcia A, Ubré M, Roca J, et al. Personalised prehabilitation in high-risk patients undergoing elective major abdominal surgery: a randomized blinded controlled trial. Ann Surg 2018 Jan;267(1):50–6.
[14] West MA, Loughney Lythogoe D, et al. Effect of prehbailitation on objectively measured physical fitness after neoadjuvant treatment in preoperative rectal cancer patients: a blinded interventional pilot study. Br J Anaesth 2014;114(2):244–51.
[15] Hughes MJ, Hackney RJ, Lamb PJ, et al. Prehabilitation before major abdominal surgery: a systematic review and meta-analysis. World J Surg 2019;43:1661–8.
[16] Vermillion SA, James A, Dorrell RD, et al. Preoperative exercise therapy for gastrointestinal cancer patients: a systematic review. Syst Rev 2018;7:103.
[17] Vagvolgyi A, Rozgonyi Z, Kerti M, et al. Effectiveness of pulmonary rehabilitation and correlations in between functional parameters, extent of thoracic surgery and severity of post-operative complications: randomised clinical trial. J Thorac Dis 2018;10(6):3519–31.
[18] Dunne DF, Jack S, Jones RP, et al. Randomized clinical trial of prehabilitation before planned liver resection. Br J Surg 2016 Apr;103(5):504–12.
[19] Pergolotti M, et al. The prevalence of potentially modifiable functional deficits and the subsequent use of occupational and physical therapy by older adults with cancer. J Geriatr Oncol 2015;6:194–201.
[20] Lawrence VA, Hazuda HP, Cornell JE, et al. Functional independence after

major abdominal surgery in the elderly. J Am Coll Surg 2004;199:762–72.
[21] Saur NM, Montroni, Ugolini G, et al. Outcomes that matter to patients? the geriatric oncology surgical assessment and functional recovery after surgery (GOSAFE) study: subgroup analysis of 440 patients undergoing colorectal cancer surgery. J Geriatric Oncol 2019;10(6 Supplement 1):S11.
[22] Montroni I, Rostoft S, Spinelli A, et al. Gosafe - geriatric oncology surgical assessment and functional rEcovery after surgery: early analysis on 977 patients. J Geriatr Oncol 2020 Mar;11(2):244–55.
[23] Bachini M, Moravek C, Lindsey SC, Fleshman J, Rocha FG, Maithel SK. The patient perspective to cancer care: aligning physician expectations with patients' wishes. HPB 2019;21(1).
[24] **NHS long term plan.** https://www.longtermplan.nhs.uk/wp-content/uploads/2019/08/nhs-long-term-plan-version-1.2.pdf; **2019.**
[25] **NHS RightCare frailty toolkit 2019.** https://www.england.nhs.uk/rightcare/wp-content/uploads/sites/40/2019/07/frailty-toolkit-june-2019-v1.pdf.
[26] Schmidt M, Eckardt R, Altmeppen S, et al. Functional impairment prior to major non-cardiac surgesy is associated with mortality within one year in elderly patients with gastrointestinal, gynaecological and urogenital cancer: a prospective observational cohort study. J Geriatr Oncol 2018 Jan;9(1):53–9.
[27] **The wessex fit-4-cancer surgery trial. Westfit Trial,** https://clinicaltrials.gov/ct2/show/NCT03509428.
[28] **PREPARE-ABC.** http://www.uea.ac.uk/prepare-abc.
[29] Rooijen S, Carli F, Dalton S, et al. Multimodal prehabilitation in colorectal cancer patients to improve functional capacity and reduce postoperative complications: the first international randomized controlled trial for multimodal prehabilitation. BMC Canc 2019;19:987–9811.
[30] **GM Cancer Plan. 2017.** https://gmcanceroguk.files.wordpress.com/2016/08/achieving-world-class-cancer-outcomes-in-gm-v1-0-final-02-2017.pdf.
[31] Bougeard AM, Moore J. Delivering perioperative care in integrated care systems. Clin Med 2019 Nov;19:450–3. 6.
[32] **GM Cancer Annual Report. 2019.** https://gmcanceroguk.files.wordpress.com/2020/03/gm-cancer-annual-report-2019-published.pdf.
[33] Moore JA, Conway DH, Thomas N, et al. Impact of a peri-operative quality improvement programme on postoperative pulmonary complications. Anaesthesia 2017 Mar;72(3):317–27.
[34] Fernandez-Bustamante A, Frendl G, Sprung J, et al. Postoperative pulmonary complications, early mortality, and hospital stay following noncardiothoracic surgery: a multicenter study by the perioperative research network investigators. JAMA Surg 2017 Feb 1;152(2):157–66.
[35] Cassidy MR, Rosenkranz P, McCabe K, et al. I cough: reducing postoperative pulmonary complications with a multidisciplinary patient care program. JAMA Surg 2013 Aug;148(8):740–5.
[36] **Carli F, Bousquet-Dion G, Awasthi R, et al. Effect of multimodal prehabilitation vs postoperative rehabilitation on 30-day postoperative complications for frail patients undergoing resection of colorectal cancer: a randomized clinical trial. JAMA Surg 2020;22.** https://doi.org/10.1001/jamasurg.2019.5474. **Published online January.**
[37] Lawson P, Flocke SA. Teachable moments for health behavior change: a concept analysis. Patient Educ Counsel 2009 July;76(1). 25–3.
[38] Grocott MPW, Plumb JO, Edwards M, et al. Re-designing the pathway to surgery: better care and added value. Perioperat Med 2017;6:9.
[39] **Moore J. Improving surgical care for patients and their families in Greater Manchester – ERAS+ GM. London: The Health Foundation; 2019. Available at:** https://www.health.org.uk/improvement-projects/improving-surgical-care-for-patients-and-their-families-in-greater-manchester-%E2%80%93. **[Accessed 27 February 2020].**
[40] https://www.salfordcommunityleisure.co.uk/can-move.
[41] **Prehab4Cancer eligibility criteria.** https://www.gmactive.co.uk/wp-content/uploads/2019/04/Referral-Information-Pack-web.pdf.
[42] Stark D, Kiely M, Smith A, et al. Anxiety disorders in cancer patients: their nature, associations, and relation to quality of life. J Clin Oncol 2002 Jul 15;20(14):3137–48.
[43] Gordon BR, McDowell CP, Lyons M, Herring MP. The effects of resistance exercise training on anxiety: a meta-analysis and meta-regression analysis of randomized controlled trials. Sports Med 2017;47(12):2521–32.
[44] Gordon BR, McDowell CP, Hallgren M, Meyer JD, Lyons M, Herring MP. Association of efficacy of resistance exercise training with depressive symptoms: meta-analysis and meta-regression analysis of randomized clinical trials. J Am Med Assoc Psych. 2018;75(6):566–76.
[45] Chekroud SR, Gueorguieva R, Zheutlin AB, Paulus M, Krumholz HM, Krystal JH. Association between physical exercise and mental healthin 1-2 million individuals in the USA between 2011 and 2015: a cross-sectional study. Lancet Psych 2018;5(9):739–46.
[46] **Stepped care model.** https://www.nice.org.uk/guidance/cg23/documents/cg23-depression-nice-guideline-marked-up-with-proposed-amendments2; **2004.**
[47] **Macmillan prehabilitation evidence and Insight report.** https://www.macmillan.org.uk/_images/prehabilitation-evidence-and-insight-review_tcm9-335025.pdf; **2017.**
[48] Steele J, Raubold K, Kemmler W, Fisher J, Gentil P, Giessing J. The effects of 6 months of progressive high effort resistance training methods upon strength, body composition, function, and wellbeing of elderly adults. BioMed Res Int 2017;2017:2541090.
[49] Fisher JP, Steele J, Gentil P, Giessing J, Westcott WL. A minimal dose approach to resistance training for the older adult; the prophylactic for aging. Exp Gerontol 2017;99:80–6.
[50] Metcalfe RS, Babraj JA, Fawkner SG, Vollaard NB. Towards the minimal amount of exercise for improving metabolic health: beneficial effects of reduced-exertion high-intensity interval training. Eur J Appl Physiol 2012;112(7):2767–75.
[51] Rowley N, Steele J, Wade M, Copeland RJ, Mann S, Liguori G, et al. Are exercise referral schemes associated with an increase in physical activity? Observational findings using individual patient data meta-analysis from The National Referral Database. J Phys Activ Health 2020. In press.
[52] **Steele J, Wade M, Polley M, Copeland RJ, Stokes S, Mann S. The National Referral Database: An initial overview. 2019, January 12.** https://doi.org/10.31236/osf.io/rgywq.
[53] Wade M, Mann S, Copeland RJ, Steele J. Effect of exercise referral schemes upon health and well-being: initial observational insights using individual patient data meta-analysis from the National Referral Database. J Epidemiol Community Health 2020;74:32–41.
[54] Slade SC, Dionne CE, Underwood M, et al. Consensus on exercise reporting template (CERT): explanation and elaboration statement. Br J Sports Med 2016;50:1428–37.
[55] **Connolly M, Perryman J, McKenna Y et al. Sage & Thyme: a model for training health and social care professionals in patient-focused support.**
[56] Ethan B, Ludmir 1, Walker Mainwaring BA2, Lin Timothy A. BA1,2Factors associated with age disparities among cancer clinical trial participants. JAMA Oncol 2019;5(12):1769–73.
[57] Cancer Research Uk. Advancing cancer, advancing years: Improving cancer treatment and care for an ageing population London. CRUK; 2018.

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The care of older cancer patients in the United Kingdom

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Review

Abstract

The ageing population poses new challenges globally. Cancer care for older patients is one of these challenges, and it has a significant impact on societies. In the United Kingdom (UK), as the number of older cancer patients increases, the management of this group has become part of daily practice for most oncology teams in every geographical area. Older cancer patients are at a higher risk of both under- and over-treatment. Therefore, the assessment of a patient's biological age and effective organ functional reserve becomes paramount. This may then guide treatment decisions by better estimating a prognosis and the risk-to-benefit ratio of a given therapy to anticipate and mitigate against potential toxicities/difficulties. Moreover, older cancer patients are often affected by geriatric syndromes and other issues that impact their overall health, function and quality of life. Comprehensive geriatric assessments offer an opportunity to identify and address health problems which may then optimise one's fitness and well-being. Whilst it is widely accepted that older cancer patients may benefit from such an approach, resources are often scarce, and access to dedicated services and research remains limited to specific

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centres across the UK. The aim of this project is to map the current services and projects in the UK to learn from each other and shape the future direction of care of older patients with cancer.

Keywords: *geriatric oncology, older patients, cancer, United Kingdom*

Introduction

Cancer is mostly a disease of older adults with about 60% of cases diagnosed in those aged 65 years and above [1]. In the United Kingdom (UK), the number of older adults living with a cancer diagnosis in 2010 was 1.3 million, but this is rapidly increasing and is estimated to reach 4.1 million by 2040 [2]. Older cancer patients can have wider health needs and are the majority; in fact, they represent everyday practice for oncologists across multiple cancer sites. The growing number of older cancer patients increases the demand on the National Health Service (NHS). Ageing is associated with increasing frailty which, in turn, may increase the complexity of care. Importantly, UK law is clear that age discrimination must not occur (Equality Act 2010 Order 2012), and therefore, the NHS cannot (and should not) provide inferior services solely because of a patient's age. In the context of these important epidemiological and sociological drivers, there has been a significant effort in recent years across different sectors in the UK to improve care and research for older cancer patients.

National Health Service (NHS)

In 2018, the NHS (England, Wales and Scotland) marked its 70th anniversary, and the NHS England Long Term Plan was developed [3]. This plan identified improving care for all older people living with frailty (such as cancer patients) as a priority. It includes enhancing health within care homes and also strengthening community teams to be more proactive and to support patients at home during a crisis. Specifically for cancer patients, one key aim has been to deliver a comprehensive model for personalised care with the assessment of needs and further integration of Clinical Nurse Specialists and other support workers, alongside increased community-based support. It is, therefore, hoped that the care for frail cancer patients, who are mostly older, should have a significant boost in resources in the coming years. In this context, and as a part of the NHS England RightCare Pathways, the NHS RightCare Frailty Toolkit was published in 2019 [4]. This resulted from a collaboration with National Clinical Director for Older People at NHS England, the charity Age UK, the NHS improvement programme Getting It Right First Time and the National Institute for Health and Care Excellence. This toolkit provides expert guidance on how to commission and provide the best system-wide care for people living with frailty. In essence, it helps us to understand the priorities in frailty identification and care, provides a benchmark and identifies key actions for improvement.

Specialised Clinical Frailty Network (SCFN)

Frailty is a state of increased vulnerability to poor resolution of homoeostasis after a stressor event, which increases the risk of adverse outcomes. Moreover, frailty is associated with ageing; hence, in 2018, the NHS Elect was commissioned to deliver the SCFN in England. This is a clinically led quality improvement collaborative working with specialised teams across different medical areas to explore how frailty assessment and management can best be integrated. This network was launched following the success of the Acute Frailty Network developing front door frailty services in secondary care. A key element is the integration of the Rockwood clinical frailty scale (CFS) in routine clinical assessments [5]. This nine-level scale provides a quick and simple method to identify frailty and is based on how active and independent patients are on their daily life activities. The first wave of specialised services started in late 2018 and included five cancer services across England, focusing mainly on patients with lung cancer being considered for chemotherapy. More recently, in late 2019, the third wave was launched and expanded the scope to cancer surgery services with a focus on gynaecological cancer. Following on from the collaborative work developed within the first two waves, the Specialised Clinical Frailty Toolkit was launched [6]. This toolkit is not exclusive to oncology

and is targeted at anyone working with older people with frailty and involved in the design and delivery of specialised services. The aim is to provide guidance on how to develop the most appropriate pathways for frail patients within specialised services to optimise their outcomes.

Cancer charities

In 2015, the cancer charity Macmillan convened a multidisciplinary Expert Reference Group (ERG) in cancer in the older person. This group scoped current assessment methods employed across the UK in cancer services and used this along with a nominal consensus approach to come to an expert consensus on the optimal geriatric oncology assessment tool for use in the UK [7]. The ERG also produced a consultation document [8] highlighting the need to educate the NHS workforce in issues pertinent to older people. Mutual education was recommended with geriatric specialists being upskilled in oncological issues and vice versa. To facilitate this, the ERG developed educational sessions and material for primary care teams and other healthcare professionals, and it also coordinated study days with the British Geriatric Society. Moreover, whilst being involved in the international Delphic process to establish the core curriculum in Geriatric Oncology, it promoted changes in the training curricula for medical and clinical oncologists in the UK. Beyond promoting education, the Macmillan ERG played a role in the development of specific recommendations in the NHS England Cancer Strategy plan for 2015–2020. These include piloting a comprehensive care programme for older people with cancer [assessment of holistic needs and comprehensive geriatric assessment (CGA)] and to develop dedicated research protocols [9].

Cancer Research UK is the largest cancer charity in the UK, and whilst it has no funding stream dedicated to geriatric oncology, it produced a report in 2018 on how to prepare for the increasing number of older patients [10]. This report echoed calls to assess frailty, implement CGA and introduce new processes in multidisciplinary team meetings. The report also asked for policy changes to NHS waiting time targets, arguing that, in older patients, the time spent before treatment in assessing and optimising fitness was valuable, yet potentially discouraged by these targets which mandate a rapid start of treatment.

National Cancer Research Institute (NCRI)

Research is key, and the NCRI has been committed, through its working groups, to support research that considers the distinct issues of older people. The NCRI conducted a scoping exercise for priorities in living with and beyond cancer. Priority number 3 focuses on how to better coordinate care for people with complex needs living with and beyond cancer [11]. Moreover, the NCRI developed an important workshop highlighting these issues and suggesting ways to optimise the research design for older cancer patients [12, 13].

Professional societies

The British Geriatrics Society (BGS) was founded in the UK in 1947 and is a multidisciplinary society that welcomes everyone specialising in the healthcare of older people. In 2015, the BGS Special Interest Group in Geriatric Oncology was founded. It is open to any healthcare professionals involved in the care of older cancer patients and aims to promote education, training and research in the field. Its long-term aims include an e-learning package for geriatricians, sharing examples of good practice and providing practical advice on how to develop business cases.

On the global stage, the UK has been actively involved within the International Society of Geriatric Oncology (SIOG), which was founded in 2000 and is growing rapidly. This multidisciplinary group's sole purpose is to promote geriatric oncology and optimise the treatment of older adults with cancer. SIOG promotes efforts in three strategic directions: education, clinical practice and research. Its original 10 priorities' proposal from 2011 is currently being revised, and publication is expected soon, which is an important initiative to advocate for better care and research in this field [14]. Finally, SIOG's dedicated Journal of Geriatric Oncology has disseminated many guidelines and practice to change the research outcomes worldwide. The UK is continuously represented at SIOG through its national representative and also with members at the governance level.

National audits in geriatric oncology

National audits are a good opportunity to understand practice and outcomes across the UK. The National Audit of Breast Cancer in Older Patients (NABCOP) is a comprehensive and on-going study of the pathways of care and outcomes for women diagnosed with breast cancer over the age of 70 (with comparative data obtained from a cohort of women aged 50–69 years). The audit has now produced a third annual report which has highlighted significant disparities in care [15]. The NABCOP has been successful in implementing the Rockwood CFS assessment as a field within the National Cancer Data Registry, making it the first disease site to mandate the collection of these data through a national dataset.

Geriatric oncology services and projects across the UK

England

The NHS England is comprised of seven regional teams according to geographic areas which serve as a population of approximately 56 million people (Figure 1). Cancer care is coordinated at a more local level through 20 cancer alliances which bring together key organisations in their areas.

Figure 1. Geographic representation of key services and projects. 1—Brighton (Sussex Cancer Centre—Brighton and Sussex University Hospitals NHS Trust). 2—London (Guy's and St. Thomas' NHS Foundation Trust, University College London Hospitals NHS Foundation Trust). 3—Cambridge (Cambridge University Hospitals NHS Foundation Trust). 4—Nottingham (Nottingham University Hospitals NHS Trust). 5—Sheffield (Sheffield Teaching Hospitals NHS Foundation Trust). 6—Manchester (The Christie NHS Foundation Trust; Manchester University NHS Foundation Trust). 7—Leeds (Leeds Teaching Hospitals NHS Trust). 8—Hull (Queen's Centre for Oncology and Haematology—Hull University Teaching Hospitals NHS Trust). 9—Newcastle upon Tyne (Newcastle upon Tyne Hospitals NHS Foundation Trust). 10—Dundee (Ninewells Hospital—NHS Tayside). 11—Glasgow (Beatson West of Scotland Cancer Centre). 12—Belfast (Belfast Health and Social Care Trust—NHS Greater Glasgow and Clyde). 13—Swansea (South West Wales Cancer Centre, Swansea Bay University Health Board). 14—Cardiff (Cardiff and Vale University Health Board).

Brighton

The Brighton and Sussex University Hospitals Trust developed a joint geriatric breast surgery clinic which is staffed by a surgeon and a geriatrician. This runs in parallel with a specialist oncology clinic and with support from breast cancer nurse specialists. Patients are referred at the start of their pathway if they are potentially unfit for, or they decline, the standard treatment for breast cancer. There are no specific age-based referral criteria. Patients are jointly assessed by the breast surgeon and geriatrician, who undertake an abbreviated CGA focussed on the management of comorbidities, functional status, polypharmacy, cognitive function, mood and social support. Following this joint assessment, the clinicians formulate a management plan with options that are discussed with the patient in a shared decision-making approach. For the patients planned for surgery, an anaesthetic review is also arranged.

In the period between April 2015 and March 2020, a total of 182 breast cancer patients were seen. First appointments averaged 45 minutes to include an abbreviated CGA, evaluation of breast cancer and discussion of diagnosis and management plan. The mean age was 82 years (range 69–99 years). 57% of patients had subsequent assessments/reviews (between 1 and 6 times), which averaged 25 minutes duration. Regarding their outcomes, 13% of patients were referred for surgery, and in 35%, the medical management was changed, typically for treatment optimisation, further investigations or referral to other specialists [16].

Future plans for the clinic include providing diagnostic clinics for patients identified as frail and for the joint care of suitable patients with advanced disease.

Cambridge

Cambridge University Hospitals NHS Foundation Trust (CUH) addressed the problem that ECOG and Karnofsky performance status scales, which are routinely used, are problematic in assessing older cancer patients' pre-treatment. In 2016, they explored how the Rockwood CFS, which was developed in the acute/community setting, would perform in routine outpatient cancer clinics. A total of 114 cancer patients were assessed using these three clinical tools. The CFS was the best tool at differentiating patients below and above 70 years ($p = 0.0056$) followed by the Karnofsky ($p = 0.02$), whereas the ECOG performance status found no differences [17].

In 2018, the CUH lung cancer team joined the SCFN led by NHS Elect in England as one of the five pilot oncology teams. The team implemented a questionnaire incorporating the CFS and covering the different domains of CGA. This was divided into two parts, the first being patient-led and the second healthcare professional-led. It was targeted at all new advanced lung cancer patients being considered for systemic anticancer treatment with an ECOG performance status of 2+. The Rockwood CFS was used as a complementary measure but not to determine who might benefit from CGA. Ultimately, the team aimed at mapping frailty and the domains affected to better inform treatment decisions. This work further supported the use of CFS which provided more granularity compared with the conventional ECOG performance status. Moreover, the team reported that the information provided by these additional assessments helped to tailor treatment decisions, medicine discontinuation and appropriate referrals to therapists. It also highlighted a significant burden of physical and psychological factors contributing to frailty.

Hull

The Queen's Centre for Oncology and Haematology in conjunction with Transform group from the Hull York medical school (funded by Yorkshire Cancer Research) is developing a programme of research in tandem with a service development for older cancer patients. Their initial research was to look at the feasibility of CGA in an oncology outpatient setting [18]. At present, they are in the process of developing an oncogeriatric service for patients with established or suspected cancer before they are discussed at multidisciplinary meetings so that decision about cancer care can be better made. Ultimately, this will involve collecting the data by smartphone or tablet apps.

The team is also developing a programme of tailored nutrition and exercise intervention for those over 70-year old with lung cancer (CanBenefit) to improve symptoms and fitness for systemic cancer therapy. Finally, the team is also planning to address the barriers to clinical trial entry for these older cancer patients with a mixture of systematic reviews and stakeholder involvement.

Leeds

The Clinical Trial Unit in Leeds coordinated the recently published GO2 trial [19]. This is a multicentre phase 3 trial which compared three different doses of oxaliplatin and capecitabine in 514 frail/elderly patients with advanced gastroesophageal cancer and a definite indication for chemotherapy. This study recruited patients between 2014 and 2017 across 61 UK centres. In this trial, a comprehensive health assessment was performed before randomisation, and the study included a novel outcome measure, i.e., overall treatment utility (OTU). OTU is a composite endpoint derived from both clinical- and patient-reported outcomes and is scored as good, intermediate or poor. A good OTU is achieved if: 1) there is an absence of disease progression (clinical and radiological) and 2) there is no significant toxicity and good patient acceptability.

The presence of one adverse outcome results in an intermediate OTU and both a poor OTU. This population had a median age of 76 years, and 58% were scored as being very frail. The trial concluded that the lowest dose of chemotherapy achieved the highest rates of good OTU. An initial analysis found that paradoxically, the least frail and better performance status patients gained most from reducing the dose of chemotherapy, whereas age was not associated with worse outcomes. This trial confirmed that it is feasible to recruit frail/elderly patients into clinical trials. Moreover, it questions the long-held oncology paradigm that systemic anticancer therapy dosing should be based on the maximum tolerated doses. Future trials are needed to identify minimal effective dosing for the elderly/frail patients in other cancer sites.

London

At Guy's and St. Thomas' NHS Foundation Trust, the Geriatric Oncology Liaison Development (GOLD) service was a pioneer in the UK. It was established with a clear aim: to facilitate equity for older people's cancer treatment decision-making, based on fitness for treatment and patient choice rather than chronological age. An initial screening questionnaire identifies medical, functional and/or psychosocial problems [20]. These are then addressed in a multidisciplinary outpatient clinic with geriatric-trained doctors and nurses, and occupational therapy and physiotherapy were needed to deliver an optimisation plan for older patients undergoing cancer treatment. In the current model, GOLD identifies patients needing CGA interventions by both a referral-based model and active case finding using the geriatric assessment tool developed by UK ERG and delivered by allied health professionals in a number of clinical areas (e.g., radiotherapy, chemotherapy unit and acute oncology). The GOLD clinical reviews with a multidisciplinary team are largely 'one-stop' face to face but with a number of other actions being managed remotely or through nurse-led telephone clinics. Patients are seen within 1–3 weeks of referral, often faster in order not to impact cancer treatment waiting times. Mostly, patients aged 70+ are not only seen but also younger patients (age 55+) as it became evident that biologically frail younger patients with poor performance status and/or multi-morbidity had similar CGA needs. A key element of this integrated service involves linking up all primary and secondary care providers. In fact, this fills a gap, where local GPs described that they tended to lose sight of older cancer patients once they have been referred to oncology. The GOLD service has proven successful by demonstrating that more older patients (aged 70+) completed chemotherapy as planned (OR 4.14, $p = 0.006$) and fewer required treatment modifications (OR 0.34, $p = 0.006$). Overall grade 3+ toxicity rates were 43.8% in those receiving GOLD service support compared to 52.9% in those receiving usual care [21]. *Moreover*, 62.5% of oncologists reported that GOLD influenced decision-making. Of these, 67% reported that GOLD assisted in the evaluation of fitness for treatment, more often in favour of active treatment [22].

A number of new clinical pathways have been successfully embedded across areas within oncology and haemato-oncology via quality improvement projects. One example is a pathway with prostate cancer nurse specialist-led clinics, whereby all patients over the age of 70 years on antiandrogen therapy are referred for vascular, bone health and comorbidity risk assessment [23]. Finally, in regard to the inpatient setting, *the team piloted a model with daily GOLD clinical nurse specialist visits and clinical fellow rounds* demonstrating a significant reduction in the average length of stay.

Other centres, such as the University College London Hospitals NHS Foundation Trust (UCLH), have also been developing services for older cancer patients particularly as a part of the SCFN led by NHS Elect in England since late 2018. The focus at UCLH has been mostly on lung cancer patients admitted to oncology wards, where these have been screened by the oncology medical team using the Rockwood CFS. This triggers a referral to the Geriatric Team for a CGA which is then discussed at a newly piloted frailty multidisciplinary team meeting.

Manchester

The Christie NHS Foundation Trust is a standalone cancer centre without a geriatric department. However, the Oncology of Later Life Group was set-up in 2015 as a multi-professional group of individuals aiming to support and coordinate the project in geriatric oncology. The initial focus was to build awareness locally, followed by the development of an annual Onco-Geriatric Study Day since 2018. Currently, a business case is underway to develop a frailty team for a multilevel approach. The key data to support this business case were derived from the SCFN quality improvement project as the lung team joined this project led by NHS Elect in 2018. The Rockwood CFS was incorporated as an electronic tool within the standard outpatient assessment for all new lung cancer patients. Over 1000 patients have been screened since then with about 40% being vulnerable or frail (CFS 4+). Frailty correlated with ageing ($p < 0.01$) and a worse ECOG PS ($p < 0.01$) [24]. These patients were also 20%–30% less likely to be offered systemic anticancer treatment and less likely to continue beyond one cycle of treatment with more admissions. This highlighted the need for improvement in patient optimisation, selection and support. Therefore, the use of the CFS is being expanded across the trust. The team is currently working to validate this tool for use in cancer patients within the outpatient setting since this was not how it was originally developed. The gynaecological surgery team is a part of the third wave of the SCFN, with the CFS incorporated into MDT referrals and pre-operative assessments.

Meanwhile, the first dedicated oncogeriatric clinic in Greater Manchester was started in October 2018 at Wythenshawe Hospital (Manchester University NHS Foundation Trust). This focused on lung cancer patients, and all new cases aged 65+ are screened by healthcare assistants using the geriatric 8 (G8) tool. Those who fail screening are booked for a CGA, but direct referrals are also accepted. The clinic is geriatrician led, but patients benefit from subsequent referrals to allied health professionals for targeted interventions as needed. The ultimate aim is to create a multidisciplinary team. The integration of a new service is often a slow process, and whilst less than 100 patients were assessed, the number of patients completing optimal adjuvant chemotherapy saw a 15% increase since this service was implemented.

In parallel, the ambition to improve cancer outcomes in Greater Manchester has led to the development of Prehab4Cancer. It was launched in April 2019 and is the first system-wide prehabilitation and rehabilitation service for cancer patients in the UK. It focuses on optimising physical fitness and strength, nutrition and psychological well-being. Cancer patients undertake community-based prehabilitation and recovery close to their residential address, accessing the service in one of the 86 public leisure facilities overseen by Greater Manchester Active. Over 800 patients undergoing major surgical resection for colorectal, oesophagogastric and lung cancers have participated in Prehab4Cancer in its first year as a standard of care. 65% of participants were aged 70+, and the results showed that it is most useful in older patients [25]. This programme is now planned to be extended to non-surgical cancer patients as well.

In regard to research, in the medical oncology field, the ELDERS study was developed at Christie focusing on the role of immunotherapy with checkpoint inhibitors in older patients with advanced cancer. This single site, prospective cohort study enrolled 140 patients with advanced lung cancer or melanoma. The primary endpoint is safety (incidence of moderate–severe immune-related adverse events), whereas the quality of life is the key secondary endpoint. This is the first study in the field of immunotherapy to focus on older cancer patients whilst also incorporating frailty and geriatric assessments. The final results are expected to be published in 2020. Moreover, in the surgical field, the Geriatric Oncology Surgical Assessment and Functional rEcovery after Surgery trial is a real-life observational study that defined quality of life and functional recovery as its primary outcomes [26]. The hepatobiliary and pancreatic cancer unit at Manchester Royal Infirmary (Manchester University Hospitals NHS Foundation Trust) was the only centre in the UK recruiting patients to this large international trial, where a total of 1003 patients aged 70+ were recruited. The final results are also expected in 2020.

Newcastle upon Tyne

Newcastle upon Tyne Hospitals NHS Foundation Trust performed several practice audits, which confirmed that across a number of different tumour types, older patients were at higher risk of toxicity and have lower rates of active treatment, particularly chemotherapy [27–29].

In 2018, the lung team also joined the SCFN led by NHS Elect and implemented the Rockwood CFS early on in the cancer pathway to all those presenting with potential lung cancer [30]. Whilst not having a dedicated team for older cancer patients, similarly to the other sites within this network, the implementation of this tool was considered useful to the team and generated more in-depth discussions. Targeted interventions were then performed by an occupational therapist on site. Pilot for early assessment in lung cancer outpatient clinics is ongoing whilst experience in an outpatient clinical trial unit showed a high level of demand with significant potential for early intervention [31]. The implementation of the Rockwood CFS has been extended to other tumour types and to those admitted to oncology wards.

Research in oncogeriatrics is facilitated by the hospital's close links with the Newcastle University Institute of Ageing and the NIHR Newcastle Biomedical Research Centre. The Newcastle 85+ study is a cohort study of people in the community aged 85+, who do not necessarily have a diagnosis of cancer. In this cohort, a series of blood tests have been shown to predict the frailty and subsequent mortality [32]. The pilot work then showed key differences in these blood tests in patients with lung cancer from the Newcastle 85+ cohort and showed that they can predict mortality [33]. In addition, sarcopenia is a key element of frailty, and this was investigated in Newcastle by assessing grip strength which when adjusted for age and gender has a prognostic value in cancer patients awaiting clinical trials [34]. Sarcopenia can also be assessed by muscle bulk on CT scan, and the radiology team developed a simple methodology to minimise intra- and interobserver variability that can be used both in clinical trials and routine practice [35].

Nottingham

The Nottingham University Hospitals NHS Trust established the 'SCOPES oncology' service (Systematic Care for Older People in Elective Surgery) in 2013. This is based on a model originally set up for older people undergoing elective orthopaedic procedures. The concept was extended to patients with upper gastrointestinal cancers who are being considered for curative surgery. In this setting, older patients (no age criteria but mostly 70+) and/or those with complex comorbidities can be referred for a geriatrician-led CGA, performed with the support of an upper gastrointestinal specialist nurse and the dietetics service. Ultimately, this team performs a fitness assessment and delivers interventions to optimise patients before surgery, promoting a timely post-operative recovery. More recently, this team has also been running a clinic for older patients suspected to have a malignancy, who require further investigations. This provides an opportunity to assess fitness for cancer treatments, to discuss the risk/benefit of further invasive investigations and to intervene/optimise patients in preparation for potential treatments. Moreover, the team is setting up a pilot for a prehabilitation service specific for lung and hopefully upper gastrointestinal cancer patients who are about to undergo treatment. The plan is that this will incorporate physical activity, nutrition, smoking cessation and psychological support. Similar to other regions in the UK, the aim is to use community sports facilities to make the service more local to patients. In August 2019, a clinical fellowship post in geriatric oncology was established with the aim to nurture the role of geriatricians embedded in an oncology department.

The University of Nottingham is also actively involved in the field and leads a unique programme on primary breast cancer in older women. The research programme has the overarching goal of optimising the management of primary breast cancer in older women and consists of three themes including the areas of breast cancer biology, geriatric assessment and quality of life and health economics. The programme offers opportunities to pursue a PhD in the field, and the team has presented its work at numerous national and international conferences, in particular, at the annual SIOG meeting. Leading on from this, the region is host to the 'Symposium on Primary Breast Cancer in Older Women'. This is a biennial event running since 2010 organised by the University of Nottingham, in association with SIOG.

Sheffield

The Sheffield Teaching Hospitals NHS Foundation Trust has also been actively involved in the SCFN, led by NHS Elect in England since late 2018. The Rockwood CFS was initially implemented in 116 lung cancer patients within chemotherapy clinics. In this cohort, age was not associated with CFS; 43% of patients were classed as CFS 4–6, whereas only one patient was CFS 7–9 probably because very frail patients are not usually referred for chemotherapy; those with a CFS 4+ had longer admissions to hospital and were more likely to die within 30 days of chemotherapy. Subsequently, CFS was measured in a cohort of 103 new lung cancer patients referred to the oncology clinic. In this cohort, CFS correlated strongly with ECOG performance status; CFS 4–6 patients were more likely to stop subsequent chemotherapy after just 1

cycle, and treatment was more likely to be complicated by admission to hospital. Following this, CFS assessment was introduced earlier in the patient pathway, measured at diagnosis and recorded as a part of MDT minutes. During this process, the team further engaged with geriatric services available in the hospital. At present, a protocol for a prospective cohort of lung cancer is currently in development to define the patient groups most at risk and, therefore, most in need of early intervention. This will include several systematic health and frailty assessments. The next steps include plans to develop an oncogeriatric clinic for pre-frail and frail lung cancer patients.

The University of Sheffield coordinated the multicentre bridging of the age gap study which aimed to optimise the management of older women with operable breast cancer, reducing the age-related gap in cancer outcomes seen between older and younger women. This study collected data on over 3,400 older women (70+) with operable breast cancer from 57 sites across the UK. Recruitment was completed in June 2018, and an analysis is ongoing. The study collected real-world data on the measures of comorbidity, quality of life and functional status/frailty, in addition to treatment and outcome data (survival and quality-of-life) to identify potential areas for improvements in practice. The study also designed and developed decision support tools for clinicians and patients based on cancer registry data [36], which are freely available online [37]. The risk and outcome prediction data are stratified by patient and tumour characteristics to aid in treatment decision-making by providing more personalised outputs. These were assessed via a clustered randomised controlled trial nested within the main study.

The University of Sheffield has also recently launched a new Institute, the Healthy Lifespan Institute in 2019. This aims to bring together researchers from across the University to develop cross-disciplinary research across the range of age and multimorbidity disciplines and has a research focused on the biology and genetics of ageing, psychology of ageing, big data and machine learning to handle large datasets to better understand aspects of ageing and links with engineering to understand how to measure frailty and its treatments.

Scotland

The NHS Scotland is comprised of 14 territorial health boards, which serves as a population of approximately 5.4 million people. Cancer care is divided into three geographical cancer networks (west, southeast and northeast) delivering cancer care in conjunction with local cancer teams.

West of Scotland

The Beatson West of Scotland Cancer Centre is the largest cancer centre in Scotland, and it serves 60% of the Scottish population. It hosts cancer for older persons' service, which is the only dedicated geriatric oncology service within the West of Scotland. The service was first established in 2016 with MacMillan funding and led by two consultant geriatricians supported by a full-time elderly care haematology liaison nurse specialist. More recently, in 2019, the service was expanded for older patients with solid tumours with the appointment of an elderly care oncology liaison nurse specialist. This service is multidisciplinary and is comprised of geriatricians, oncologists, physiotherapists, occupational therapists, palliative and pastoral care. Patients aged 65+ with a diagnosis of cancer requiring specialist expertise may be referred. This includes patients requiring expertise in the management of comorbidities and polypharmacy, impaired mobility and falls, cognitive impairment, functional difficulties impairing activities of daily living, incontinence and complex discharge planning. This service has evolved predominantly within the inpatient setting. However, it also provides outpatient review for older cancer patients with a weekly consultant geriatrician- or nurse specialist-led clinic. Moreover, a weekly MDT provides an opportunity to discuss and review more complex cases. In 2019, a total of 244 inpatients were reviewed by the service with fewer outpatient reviews. However, an internal audit of inpatients revealed that a significant proportion of older patients who satisfy the referral criteria were not referred. To address the underutilisation of this service, efforts have focussed on improving service uptake through a number of initiatives and projects: the development of a geriatric focussed educational programme, raising awareness on the benefits of early integration of specialist geriatric care and, more recently, the implementation into routine practice of an electronic frailty screening tool for patients admitted via the acute oncology assessment unit which is currently being piloted.

North and Southeast of Scotland

Despite the recognition of service development to meet the needs of older cancer patients in these regions, at present, there is no established service. However, the Oncology and Palliative Medicine Departments in Ninewells Hospital, Dundee, started a collaboration in 2019 to develop a pilot-enhanced supportive care clinic for patients with advanced cancer, who are due to commence anticancer treatment. This multidisciplinary clinic was co-led by a medical oncologist, and a palliative care consultant will be based around the principles of realistic medicine which has been highlighted as a priority by the Scottish Government and is planned to include a CGA with capacity and expertise for personalised targeted interventions.

Wales

NHS Wales is comprised of seven territorial health boards, which serves as a population of approximately 3.1 million people with most of its population concentrated in the south. The Wales Cancer Network provides a single, patient-focused, clinically led organisation integrating Welsh Government, all health boards and cancer service stakeholder groups.

North Wales

The Betsi Cadwaladr University Health Board launched in October 2019 the first pilot prehab programme aimed at cancer patients. This is delivered in a local leisure centre, and the team consists of an occupational therapist, physiotherapist and dietician, who run three sessions a week. The sessions consist of supervised exercise sessions, respiratory muscle training, diet education and anxiety management. It is aimed at patients undergoing surgery for upper-GI and colorectal cancer.

Southeast of Wales

In the University Hospital of Llandough in Cardiff, the first oncogeriatric service was set-up in 2017. In order to implement this service in breast cancer, a core team comprised of a breast surgeon consultant, a geriatric trainee and two breast cancer nurses, attended a leadership in improvement programme. It was felt appropriate that breast cancer was the first cancer group to develop this service as it is a neater model, with less emergencies unlike some of the other cancer groups. The Edmonton Frailty Score is used for all patients aged 70+, and this is used quite early on the pathway since it is used for all patients with a potential diagnosis of breast cancer at their initial one-stop assessment clinic. The geriatrician also attends the weekly breast multidisciplinary team meeting, where the frailty score is available. After the breast cancer diagnosis is confirmed, if the patient was screened as frail (defined as a score > 6), then an appointment is made with the geriatrician, and the patient undergoes a CGA. The implementation of this service has changed not only the assessment but also the management of older breast cancer patients in the region. Moreover, the team is currently collaborating with the primary care to link this service with a prehabilitation programme.

Southwest of Wales

In the Southwest Wales Cancer Centre in Swansea, the Health Education and Improvement Wales funded a Clinical Leadership Fellow in 2019 to spend a year out of programme to investigate the unmet needs of older cancer patients. The post was filled by a geriatric medicine registrar who aimed at reviewing service models and local frailty services to see how best to serve this population. Under the auspices of this fellowship, a single geriatrician-led pilot was in place between January and March 2020 which focused on patients with upper gastrointestinal cancer of any age, with comorbidities and/or polypharmacy. Patients underwent a systems review, medication review, assessment of fall risk and bone health and cognitive assessment. Data from this pilot will be used to support a business case for the continuation of this service hopefully integrated with other local services for older people.

Prehabilitation programmes are also being widely developed in the region. A study performed in South Wales demonstrated that cancer patients are more likely to have conditions requiring intervention and optimisation at the point of referral from primary care [38]. Therefore, patients with suspected lung cancer are now being offered prehabilitation classes led by physiotherapists in secondary and tertiary care centres. As many patients live in rural communities far from teaching hospitals, classes continue locally after an initial assessment. Similar group classes are being developed for older gynaecological cancer patients, with a focus on continence, exercise tolerance and sexual function.

Northern Ireland

Health and Social Care in Northern Ireland is the designation of the service that provides care for this population of 1.9 million, about 2.8% of the whole UK population [39]. Unfortunately, between January 2017 and January 2020, there was a collapse of the devolved administration in Northern Ireland, with no responsible minister. This had a significant impact on the health service, which has been managing for several continuous years on a day-to-day basis. Within oncology, the 62-day ministerial target, whereby a cancer patient must begin treatment within 62 days of referral for suspected cancer, has not been met in over 3 years by any health trust, with the most recent figure being 48% for September 2019 [40].

The Northern Ireland Cancer Network aims to deliver improvements in outcomes, enhance experience and deliver excellence within cancer care in the region. Unfortunately, in this context, there are no projects or a healthcare strategy specific for the geriatric oncology population. Moreover, within five health trusts in Northern Ireland, there are no specific projects or guidance about the older patient with cancer. Similarly, in the research sphere, there are no dedicated regional projects either. However, in conjunction with a local cancer charity, the Belfast Health and Social Care Trust has launched a pilot of a patient-reported outcomes app called Noona. This app can be used for audit and data purposes, which may provide a useful insight about how older cancer patients are being treated and their associated toxicities. A downfall is that this app is limited to those on treatment with systemic anticancer therapy in the larger cancer centre within the region, therefore not providing any information about those not suitable for treatment as well as those having options such as surgery or radiotherapy.

Conclusion

The care of older patients is a significant part of daily practice in oncology across the UK. However, in the vast majority of centres, the routine care of these patients does not yet include a formal multidisciplinary geriatric or frailty assessment/management. Similarly, the use of treatment toxicity prediction tools to help guide treatment decisions is not standard practice. Even where there are specialist services that care for older patients, integration with oncology is usually limited. Despite all these observations, there is a widespread acceptance that more specialised and multidisciplinary support is required for this patient population. It is, therefore, encouraging to see that over the past 5 years, geriatric oncology is now being considered within the UK healthcare strategies, and new services and collaborative projects are growing sustainably across most regions. The models of care are still very heterogeneous and adapted to the local priorities, needs and resources available. Establishing the links between oncology services and services in the primary care/community or even secondary care is crucial. Hopefully, the next 5 years will show further developments as the teams and trusts across the UK witness, acknowledge and share the benefits of dedicated oncogeriatric practice.

Conflicts of interest

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References

1. IARC. (2012) *Cancer Incidence, Mortality and Prevalence Worldwide* GLOBOCAN [http://gco.iarc.fr/]
2. Maddams J, Utley M, and Moller H (2012) **Projections of cancer prevalence in the United Kingdom, 2010–2040** *Br J Cancer* **107**(7) 1195–1202 https://doi.org/10.1038/bjc.2012.366 PMID: 22892390 PMCID: 3461160
3. NHS *NHS Long Term Plan* 2019
4. NHSEngland *NHS Right Care Frailty Toolkit* 2019 [https://www.england.nhs.uk/rightcare/products/pathways/frailty/]
5. Rockwood K, Song X, and MacKnight C, *et al* (2005) **A global clinical measure of fitness and frailty in elderly people** *Can Med Assoc J* **173**(5) 489–495 https://doi.org/10.1503/cmaj.050051
6. SCFN *NHS Elect—Specialized Clinical Frailty Network Toolkit* 2018
7. Kalsi T and Harari D (2020) **Assessment methods and services for older people with cancer in the United Kingdom** *World J Clin Oncol* **11**(3) 152–161 https://doi.org/10.5306/wjco.v11.i3.152 PMID: 32257846 PMCID: 7103526
8. Bridges J and Simcock R 2017 **Meeting the workforce challenges for older people living with cancer** *Int J Nurs Stud* **65** A1–A2 PMID: 27884390
9. NHSEngland (2015) *Cancer Taskforce—Achieving World-Class Cancer Outcomes: a Strategy for England 2015–2020* [https://www.england.nhs.uk/wp-content/uploads/2017/10/national-cancer-transformation-programme-2016-17-progress.pdf].
10. CRUK (2018) **Treating and caring for an ageing population—report** [https://www.cancerresearchuk.org/about-us/we-develop-policy/our-policy-on-access-to-cancer-treatments/treating-and-caring-for-an-ageing-population]
11. NCRI (2018) *Living with and Beyond Cancer Research Priorities*
12. Alexander S, Bridges J, and Kalsi T, *et al* (2019) **Improving outcomes for older people with cancer - A workshop of the UK National Cancer Research Institute** *J Geriatr Oncol* **10**(3) 378–381 https://doi.org/10.1016/j.jgo.2019.01.025 PMID: 30846282
13. Simcock R (2019) **Improving cancer research in older adults. The UK National Cancer Research Institute initiative** *J Geriatr Oncol* **10**(3) 382–383 https://doi.org/10.1016/j.jgo.2019.01.026 PMID: 30765269
14. Extermann M, Aapro M, and Audisio R, *et al* (2011) **Main priorities for the development of geriatric oncology: a worldwide expert perspective** *J Geriatr Oncol* **2**(4) 270–273 https://doi.org/10.1016/j.jgo.2011.07.001
15. NABCO (2019) **National Audit of Breast Cancer in Older Patients—2019 annual report**
16. Ugolini JWF and Reed M (2017) **Our experience of a joing geriatric oncology clinic for the management of elderly women diagnosed with breast cancer** *J Geriatr Oncol* **8** XXI–XXVI
17. Denholm M, Corrie P, and Qian W, *et al* (2017) **The Rockwood Geriatric Clinical Frailty Scale is a more discriminatory tool for assessing older cancer patients compared with standard oncology performance status scales** NCRI [https://abstracts.ncri.org.uk/abstract/the-rockwood-geriatric-clinical-frailty-scale-is-a-more-discriminatory-tool-for-assessing-older-cancer-patients-compared-with-standard-oncology-performance-status-scales/]
18. Jackson G, Gabe R, and Johnson M, *et al* (2019) **CAMERA—complete assessment of elderly patients with cancer: a non-randomised feasibility study** *J Geriatr Oncol* **10**(1) 175–177 https://doi.org/10.1016/j.jgo.2018.07.005
19. Hall PS, Swinson D, and Waters JS, *et al* (2019) **Optimizing chemotherapy for frail and elderly patients (pts) with advanced gastroesophageal cancer (aGOAC): the GO2 phase III trial** *J Clin Oncol* **37**(15_suppl) 4006 https://doi.org/10.1200/JCO.2019.37.15_suppl.4006
20. Whittle AK, Kalsi T, and Babic-Illman G, *et al* (2017) **A comprehensive geriatric assessment screening questionnaire (CGA-GOLD) for older people undergoing treatment for cancer** *Eur J Cancer Care* **26**(5) https://doi.org/10.1111/ecc.12509

21. Kalsi T, Babic-Illman G, and Ross PJ, *et al* (2015) **The impact of comprehensive geriatric assessment interventions on tolerance to chemotherapy in older people** *Br J Cancer* **112**(9) 1435–1444 https://doi.org/10.1038/bjc.2015.120 PMID: 25871332 PMCID: 4453673
22. Kalsi T, Babic-Illman G, and Ross PJ, *et al* (2015) **The impact of comprehensive geriatric assessment interventions on tolerance to chemotherapy in older people** *Br J Cancer* **112**(9) 1435–1444 https://doi.org/10.1038/bjc.2015.120 PMID: 25871332 PMCID: 4453673
23. Krasteva E, Kalsi T, and Illman GB, *et al* (2019) **CGA delivery for older patients with prostate cancer receiving androgen deprivation therapy** *J Geriatr Oncol* **10**(6) S64–S65 https://doi.org/10.1016/S1879-4068(19)31226-3
24. Gomes F, Baker K, and Eaton M, *et al* (2020) **Clinical frailty in advanced lung cancer patients: an opportunity to improve outcomes** *Lung cancer (Amsterdam, Netherlands)* **139** S45 https://doi.org/10.1016/S0169-5002(20)30132-X
25. Moore J, Merchant Z, and Rowlinson K, *et al* (2020) **Implementing a system-wide cancer prehabilitation programme: the journey of Greater Manchester's 'Prehab4cancer'** *Eur J Surg Oncol* https://doi.org/10.1016/j.ejso.2020.04.042
26. Montroni I, Rostoft S, and Spinelli A, *et al* (2020) **GOSAFE - Geriatric Oncology Surgical Assessment and Functional Ecovery after Surgery: early analysis on 977 patients** *J Geriatr Oncol* **11**(2) 244–255 https://doi.org/10.1016/j.jgo.2019.06.017
27. Hannaway N, Gardiner J, and Hughes A, *et al* (2018) **Lung cancer treatment and compliance with NICE chemotherapy guidelines in patients aged over 70 years** *Lung cancer (Amsterdam, Netherlands)* **115** S10 https://doi.org/10.1016/S0169-5002(18)30049-7
28. Iqbal MS, Haris N, and Kagzi M, *et al* (2014) **EP-1090: experience of definitive chemoradiotherapy in senior adults with head and neck cancers** *Radiother Oncol* **111** S16–S17 https://doi.org/10.1016/S0167-8140(15)31208-1
29. Mactier K, Bonner J, and Suthermaraj G, *et al* (2016) **107 Performance status, not age, influences decision-to-treat in non small cell lung cancer (NSCLC)** *Lung cancer (Amsterdam, Netherlands)* **91** S38 https://doi.org/10.1016/S0169-5002(16)30124-6
30. Greystoke A, Ward A, and Welford J, *et al* (2020) **Implementation of the rockwood clinical frailty score (CFS) into the newcastle upon tyne NHS trust lung cancer practice** *Lung Cancer (Amsterdam, Netherlands)* **139** S81–S82 https://doi.org/10.1016/S0169-5002(20)30220-8
31. Welford J and Greystoke A (2020) **Setting up an outpatient occupational therapy service for patients on early clinical trials: impact on patients with thoracic malignancies** *Lung Cancer (Amsterdam, Netherlands)* **139** S78 https://doi.org/10.1016/S0169-5002(20)30209-9
32. Mitnitski A, Collerton J, and Martin-Ruiz C, *et al.* (2015) **Age-related frailty and its association with biological markers of ageing** *BMC Med* **13**(1) 161 https://doi.org/10.1186/s12916-015-0400-x PMID: 26166298 PMCID: 4499935
33. Wyatt N, Hogarth L, and Turner D, *et al* (2017) **P2.01-070 circulating biomarkers of frailty are associated with a poor prognosis in patients with advanced non-small cell lung cancer (NSCLC): topic: marker for prognosis** *J Thorac Oncol* **12**(1) S829–S830 https://doi.org/10.1016/j.jtho.2016.11.1122
34. Maitland S, Talks B, and Russell C, *et al* (2018) **Can we predict patient survival using grip strength? NCRI** [https://abstracts.ncri.org.uk/abstract/can-we-predict-patient-survival-using-grip-strength/]
35. Perthen JE, Ali T, and McCulloch D, *et al* (2018) **Intra- and interobserver variability in skeletal muscle measurements using computed tomography images** *Eur J Radiol* **109** 142–146 https://doi.org/10.1016/j.ejrad.2018.10.031 PMID: 30527297
36. Collins K, Reed M, and Lifford K, *et al* (2017) **Bridging the age gap in breast cancer: evaluation of decision support interventions for older women with operable breast cancer: protocol for a cluster randomised controlled trial** *BMJ Open* **7**(7) e015133 https://doi.org/10.1136/bmjopen-2016-015133 PMCID: 5642653
37. AgeGap [https://agegap.shef.ac.uk/2020]
38. Barlow RC, Chan DSY, and Mayor S, *et al* (2018) **Fit for cancer treatment: a prospective feasibility study of primary care initiated prehabilitation for patients with suspected cancer** *BJGP Open* **2**(4) bjgpopen18X101608 https://doi.org/10.3399/bjgpopen18X101608
39. NISRA. 2018 Mid-year Population Estimates for Northern Ireland 2019
40. **Northern Ireland Waiting Time Statistics: Cancer Waiting Times** July–September 2019

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Delivering perioperative care in integrated care systems

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ABSTRACT

In 2016, NHS England set up 10 integrated care systems (ICSs) which aim to devolve some responsibility for delivery of health and social care services to local healthcare providers in partnership with local government, social care, primary care networks, and voluntary and charitable organisations. These are new ways of working and provide an opportunity to better integrate perioperative care across the entire pathway from the moment of contemplation of surgery through to recovery at home. This review describes the ways in which the aims of many ICS plans can be met with good perioperative care, and how clinicians can use this opportunity to make significant progress in improving outcomes for patients. We describe examples of initiatives in cancer pathways which are already proving successful and have caught the imagination of the local community at all levels, as well as examples of integrated perioperative care across the country which can be applied to other systems. We hope to demonstrate ways in which perioperative care can add value to a local health population given the right support and chance to deliver it.

KEYWORDS: Integrated care systems, perioperative care, prehabilitation, enhanced recovery, cancer

Introduction

In 2016, NHS organisations and councils in England joined to form 44 sustainability and transformation partnerships (STPs).[1] Their aim was to plan care at a local level around the needs of their community and bring leaders from across the health and social care sector to deliver this. Over the following 2 years, a number of these STPs evolved into integrated care systems (ICSs) which foster closer collaboration with NHS organisations, councils, the voluntary sector and local community groups.[2] ICS leaders have more freedom and devolved responsibility to manage their resources and performances to deliver health services to the specific needs of the population they serve. Latterly, there has been a natural evolution through the addition of further ICS areas, and by full devolution in some areas, including Greater Manchester and Surrey Heartlands.

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More than 30% of England's population is now covered by an ICS and the anticipation is that 100% coverage will follow by 2021.

A recent survey of the membership of the Royal College of Anaesthetists (RCoA) revealed a degree of cynicism about ICSs and STPs, citing concerns about perceived lack of clinician engagement, and low levels of awareness of plans in their local area. The barriers to delivering perioperative care included difficulties in changing pathways, funding new initiatives, identifying patients earlier in the pathway to optimise and prehabilitate, and engaging other specialties in doing this. In 2018, the college commissioned an in-depth analysis of all published ICS plans to cross-reference them against the core principles of perioperative care.[3] The report found common themes and demonstrated how perioperative care can address some of the aims set out in individual ICS plans, referencing example initiatives from other systems to demonstrate how this could be done.

The Centre for Perioperative Care (CPOC) aims to enhance collaborative, integrated, multidisciplinary working across the perioperative pathway, therefore it makes sense to work within ICSs to deliver these improvements. While the ICS plans are limited to England, the devolved nations have similar approaches in place to deliver improved population health across the health and social care sectors.[4–6] This review will look at the opportunities offered by the new models of care for optimising integrated perioperative care pathways, using case examples to illustrate how this might be achieved.

Relevance of surgery to local health systems

High-quality perioperative care starts from the moment of contemplation of surgery and continues until the individual has made a full recovery. Surgery represents a significant burden on a health system: over one in 10 patients will undergo a surgical procedure per year.[7] The RCoA launched their Perioperative Medicine Programme in 2015 highlighting the burden of high-risk surgery as a resource intense intervention, with 15% of patients accounting for 80% of deaths following surgery, and an even greater proportion suffering significant morbidity resulting in ongoing health service needs in the long term.[8] Effective integration of care and consideration of the impact of surgery in the context of local population health is therefore very important.

Structure of ICSs

The ICS works on three levels.

- System: setting strategy, budget, workforce and degree of integration.
- Place: planning local services and delivery of secondary and community care.

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- Neighbourhood and primary care networks: groups of general practitioner (GP) practices covering populations up to 50,000 providing a range of multidisciplinary services to the community, plus charitable and local government sector: 70–90% of ICS work will take place at this level.[9]

There are some key challenges with this model. Firstly, the ICS is not yet part of the statutory NHS arrangements and relies on good will between providers. Secondly, there will be changes to the current purchaser–provider relationship, which will impact the way in which services are commissioned. This is important in the context of a surgical pathway. Thirdly, regional level agreements are needed to cover networked services and ambulance trusts.

Let us consider perioperative care at primary care network level: many ICSs are setting up community hubs, which bring together services to support patients with long-term conditions. These hubs also provide support with lifestyle advice, and co-locate nursing, social workers, occupational therapists, social prescribers, community pharmacists among others. Grocott *et al* describe an ideal perioperative pathway, making use of the time between referral and surgery to optimise a patient's condition.[10] Use of the community hub allows access these services early, and locally. Consequently, by the time decisions on surgery are made, some optimisation has already occurred. It would be hard to argue that this approach doesn't make sense, since at individual and population level these interventions are likely to be beneficial regardless of whether or not the patient ultimately undergoes surgery.

Cancer pathways

Recently, the RCoA, Macmillan and the National Institute for Health Research Cancer and Nutrition Collaboration launched guidance for prehabilitation for people with cancer.[11] Most ICS plans include targets for cancer outcomes (early diagnosis, 1-year survival, quality of life after treatment for cancer and reducing unwarranted variation in outcomes), aims for improved population health through disease prevention and improving self-efficacy through social prescribing, public health campaigns and access to lifestyle interventions. Many ICSs also aim to streamline elective care pathways and reduce in-hospital treatment. The mainstay of treatment for solid tumours is surgery, therefore prehabilitation, cancer care and perioperative care are inextricably linked. The aims of prehabilitation (covered in detail elsewhere in this issue) align and overlap with those of ICSs and *The NHS Long Term Plan*.[12] The ICS is a good way to deliver these objectives. An example is the PREPARE programme at Imperial College Healthcare NHS Trust which is offered to patients having major cancer surgery.[13] This is a multimodal intervention offering an exercise programme, respiratory exercises, nutritional support, psychological support, smoking cessation, alcohol reduction support and enrolment into an enhanced recovery programme for surgery. The programme has reduced Clavien–Dindo grade II or more complications by 45% over 2 years and has won a number of awards, particularly for patient involvement.

Keeping people out of hospital

Many ICS priorities focus on care of its citizens out of hospital. While this is impractical in many surgical pathways, there are gains to be had in ambulatory surgery. The British Association of Day Surgery directory lists index procedures and expected day case rates.[14] The delivery of these targets is being evaluated by the Getting it Right First Time (GIRFT) programme for anaesthesia and perioperative medicine. It appears anecdotally that hospitals with high performing day surgery units have robust structures and processes in place across all perioperative pathways.[15] Increasingly complex surgery is now being offered on a day case basis, including major joint replacements, nephrectomy, mastectomy and cholecystectomy (including emergency cases). Clearly this is attractive to an ICS, however, to maintain success and increase the proportion of surgery offered as a day case, there must be support in the community with outreach services, community services and multidisciplinary teams to manage patients in the community as they rehabilitate.

Technology, digital records, communication

Communication across a complex surgical pathway can be difficult. Our perioperative care leads encounter problems with lack of information coming from the community or from clinical records located at different hospitals. Many ICSs have recognised this gap as a barrier to continuity of care and have addressed this in their plans. Nottinghamshire have developed their capability for technology enabled care, including information sharing between staff and self-care support, as have Surrey Heartlands, and Dorset, who now have 95% of GPs using the same online system. Similar technology could be utilised in preassessment: patients can complete much of their own preassessment, which, with the referral, can allow triage to different pathways. The record can then accompany the patient through their inpatient stay, be contributed to by all professionals involved and continue with the transition out of hospital.

Population health, self-care and the prevention agenda

All ICS plans promote interventions to improve public health, including smoking cessation, alcohol reduction, improving physical activity and maintaining a healthy weight. Many ICS plans also emphasise the principle of self-management and self-efficacy when it comes to long-term health conditions. *Personalised care*, launched on the back of *The NHS Long Term Plan* earlier this year, looks at ways of better delivering on these principles.[16] Contemplation of surgery represents a 'teachable moment' whereby an individual is more receptive to interventions to improve their health over the short and long term. Smoking cessation programmes at the time of surgery have been shown to have better long-term cessation rates than otherwise.[17]

Diabetes concerns all professionals along a perioperative pathway. Patients often arrive at preassessment with poor glycaemic control and require referral back to their GP for optimisation before elective surgery, or, if on an urgent pathway, have to proceed with suboptimal glycaemic control, risking complications. Many ICS plans prioritise diabetes care and management, for example, One Gloucestershire have a diabetes prevention programme, Buckinghamshire is integrating diabetes services across primary, acute and community care and Berkshire West is supporting patients with complex diabetes. Royal Bournemouth Hospital has a specialist preassessment clinic for patients with diabetes to plan glycaemic control before, during and after their surgery, backed up by e-learning and safe

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prescribing education for hospital clinicians. They have reduced average length of stay for inpatient surgery to parity with non-diabetic patients. Unpublished data from GIRFT demonstrate that there is wide variation in length of stay for diabetic patients across surgical specialties, therefore, there are significant gains to be had by integrating across the pathway. We have recent guidance from the National Confidential Enquiry into Patient Outcome and Death to support development of these initiatives.[18]

But how do we do it?

CPOC represents an opportunity to deliver consistent messaging about perioperative care from all constituent organisations. While the time is right to embed perioperative care into ICSs it is difficult to work out how to do it. Below are two case studies demonstrating how clinicians, researchers, patients and charities have come together to start this process. The commonality of these examples is with secondary care making the case for change and putting themselves forward to lead and make changes. They have had rich pickings and positive engagement, suggesting that there is will for this to happen. Experience from the vanguard sites reflects a willingness to take risks with different ways of working, with less focus on structure in favour of 'doing the right thing'.[19] This is very much the remit of perioperative care.

The Greater Manchester Cancer alliance

Restructuring of the Greater Manchester (GM) healthcare system is supporting rapid transformation projects for patients undergoing major surgery such as Enhanced Recovery After Surgery Plus (ERAS+) and Prehab4Cancer.

Organisation restructure

Greater Manchester Combined Authority (GMCA) brings together the 10 boroughs of GM in a single organisation. In 2015, NHS organisations and councils signed the GM devolutional deal supporting GM taking charge of its own health and social care budget. In turn, the Greater Manchester Health and Social Care Partnership was developed to oversee the devolution of the health and social care services.

In 2016, both provider and commissioning boards for cancer services in GM agreed to set up a single system-wide cancer board, the Greater Manchester Cancer Board, which now oversees all cancer activity in the area, and reports into the Greater Manchester Health and Social Care Partnership. Through its cancer clinical pathways structure Greater Manchester Cancer can ensure that every patient in GM, no matter where they live, is afforded the same level of care following a diagnosis of cancer, while working to the NHS Cancer targets.

ERAS+ and Prehab4Cancer

The major surgical care for patients in GM, ERAS+, was developed at Manchester University NHS Foundation Trust (MFT) in a drive to reduce postoperative pulmonary complications (PPC), a common complication after major surgery affecting up to 25% of patients and associated with increased length of hospital stay and mortality.[20]

ERAS+ comprises prehospital prehabilitation (exercise, nutrition, smoking cessation, anaemia management and medical optimisation), a hospital-based postoperative respiratory care bundle (I COUGH), a prescription order set for oral healthcare, mobilisation and the use of incentive spirometry, which is built on ERAS stepped recovery model.[21] *The multidisciplinary patient education 'Surgery School' was developed to help support patient and family education about the ERAS+ programme and to help addresses the physical and psychological stressors associated with major surgery. The ERAS+ programme at Manchester Royal Infirmary was utilised with 1,000 patients using quality improvement methodology between 2014–16, reducing PPCs by 50% and hospital length of stay by 3 days, saving £500,000 each year.*[22]

The scaling of the ERAS+ perioperative care across GM has been made significantly easier by the creation of the GMCA with senior oversight and GMCA sign-off supporting its uptake through the hospitals within GM. A Scaling Up Improvement grant from the Health Foundation was awarded to the ERAS+ programme in 2017 to support the implementation of ERAS+ across GM, and to understand its impact.

The GM ERAS+ programme is now a collaboration of multiprofessional clinical teams across the GM conurbation, aiming to improve outcomes for patients undergoing major surgery.

Most recently the preparation of patients in GM undergoing cancer surgery has been further enhanced by the Prehab4Cancer transformation project, supported by Greater Manchester Cancer which aims to facilitate prehab (exercise, nutritional and psychological support) for 2,000 patients over the next 2 years.[23]

Wesfit[24]

In Wessex, the STP has part-funded a research study in collaboration with the University of Southampton NHS Foundation Trust and the Wessex Cancer Alliance. This will evaluate the impact of individualised exercise programmes and psychological support at community-based centres, on a number of outcomes:

- *postoperative complications*
- *length of stay*
- *quality of life*
- *longevity of fitness behaviour change*
- *tumour regression*
- *1-year mortality.*

The project has been driven at community level with a range of partner organisations including private gyms, local charities and community centres, and has been co-designed with patients. The research will contribute to a body of evidence on the role of exercise prehabilitation interventions, in particular how they can be effectively delivered at community level. The WesFit model has had such appeal that other centres, including Plymouth, have now secured funding and engagement at local level to start recruiting patients.

Conclusions

There is a strong case that perioperative care adds value to a local health population given the right support and degree of integration. While in their relative infancy, it is clear that ICSs are

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here to stay, and although they will evolve, their establishment represents an opportunity to better deliver perioperative care across the whole of the pathway. The 'how-to' piece is the challenge. John F Kennedy said, 'Change is the law of life. And those who look only to the past or present are certain to miss the future.'[25] As a centre for perioperative care, we must equip our members with the confidence and consistent messaging that harnessing this opportunity is key. Perioperative care offers ways to deliver on the outcomes that politicians, clinicians and communities want. We should seize this opportunity.

References

1 NHS England. *Sustainability and transformation partnerships*. NHS. www.england.nhs.uk/integratedcare/stps [Accessed 14 July 2019].
2 NHS England. *Integrated care systems*. NHS. www.england.nhs.uk/integratedcare/integrated-care-systems [Accessed 14 July 2019].
3 Royal College of Anaesthetists. *A teachable moment: delivering perioperative medicine in integrated care systems*. London: RCoA, 2019. www.rcoa.ac.uk/document-store/delivering-pom-integrated-care-systems [Accessed 14 July 2019].
4 Realistic Medicine, 2019. www.realisticmedicine.scot [Accessed 14 July 2019].
5 Public Health Wales. *Prudent healthcare*. Public Health Wales, 2016. www.prudenthealthcare.org.uk/wp-content/uploads/2016/02/Securing-Health-and-Wellbeing-for-Future-Generations1.pdf [Accessed 14 July 2019].
6 Department of Health Northern Ireland. *Health and Wellbeing 2026 – delivering together*. Department of Health Northern Ireland, 2017. www.health-ni.gov.uk/publications/health-and-wellbeing-2026-delivering-together [Accessed 14 July 2019].
7 Abbott TEF, Fowler AJ, Dobbs TD *et al*. Frequency of surgical treatment and related hospital procedures in the UK: a national ecological study using hospital episode statistics. *BJA* 2017;119:249–57.
8 Royal College of Anaesthetists. *Perioperative Medicine: The pathway to better surgical care*. London: RCoA, 2015. www.rcoa.ac.uk/periopmed/vision-document [Accessed 14 July 2019].
9 British Medical Association. *Integrated Care Systems (ICSs)*. BMA, 2019. www.bma.org.uk/collective-voice/policy-and-research/nhs-structure-and-delivery/nhs-structures-and-integration/integrated-care-systems [Accessed 14 July 2019]
10 Grocott MPW, Plumb JOM, Edwards M, Fecher-Jones I, Levett DZH. Re-designing the pathway to surgery: better care and added value. *Perioper Med (Lond)* 2017;6:9.
11 Macmillan Cancer Support, NIHR Cancer and Nutrition Collaboration, Royal College of Anaesthetists. *Prehabilitation for people with cancer: Principles and guidance for prehabilitation within the management and support of people with cancer*. Macmillan, 2019. www.macmillan.org.uk/assets/prehabilitation-guidance-for-people-with-cancer.pdf [Accessed 14 July 2019].
12 NHS. *The NHS Long Term Plan*. NHS, 2019. www.longtermplan.nhs.uk [Accessed 14 July 2019].
13 Imperial College Healthcare NHS Trust. *The PREPARE programme*. Imperial College Healthcare NHS Trust, 2019. www.imperial.nhs.uk/our-services/cancer-services/oesophago-gastric-cancer/prepare-programme [Accessed 14 July 2019].
14 British Association of Day Surgery. *BADS directory of procedures*, 6th Edn. London: BADS, 2019.
15 Snowden C. Personal communication, July 2019.
16 NHS England. *Personalised care*. NHS, 2019. www.england.nhs.uk/personalisedcare [Accessed 14 July 2019].
17 Lee SM, Landry J, Jones PM, Buhrmann O, Morley-Forster P. Long term quit rates after a preoperative smoking cessation randomized controlled trial. *Anesth Analg* 2015;120:582–7.
18 National Confidential Enquiry into Patient Outcome and Death. *Perioperative diabetes: Highs and lows*. London: NCEPOD, 2018. www.ncepod.org.uk/2018pd.html [Accessed 14 July 2019].
19 NHS Providers. *The journey to integrated care systems*. NHS. https://nhsproviders.org/provider-voices-integrated-care [Accessed 14 July 2019].
20 Mazo V, Sabate S, Canet J *et al*. Prospective external validation of a predictive score for postoperative pulmonary complications. *Anaesthesiology* 2104;121:219–31.
21 Cassidy MR, Rosencrantz P, McCabe K, Rosen JE, McANeny D. I COUGH: reducing postoperative pulmonary complications with multidisciplinary patient care program. *JAMA Surg* 2013;148:740–5.
22 Moore JA, Conway DH, Thomas N, Cummings D, Atkinson D. Impact of a peri-operative quality improvement programme on postoperative pulmonary complications. *Anaesthesia* 2017;72:317–27.
23 Greater Manchester Cancer. *Prehab4cancer*. Greater Manchester Cancer. https://gmcancer.org.uk/our-areas-of-work/prehab4cancer [Accessed 14 July 2019].
24 ClinicalTrials.gov. *The Wessex Fit-4-Cancer Surgery Trial (WesFit)*. ClinicalTrials.gov Identifier: NCT03509428.
25 Kennedy JF. *Public papers of the presidents of the United States: John F. Kennedy: 1963: containing the public messages, speeches, and statements of the president, January 1 to November 22, 1963*. Washington: United States Government Printing Office, 1963:517.

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Original Article

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Impact of a peri-operative quality improvement programme on postoperative pulmonary complications

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Summary

Postoperative pulmonary complications are common, with a reported incidence of 2–40%, and are associated with adverse outcomes that include death, longer hospital stay and reduced long-term survival. Enhanced recovery is now a standard of care for patients undergoing elective major surgery. Despite the high prevalence of pulmonary complications in this population, few elements of enhanced recovery specifically address reducing these complications. In 2013, a prevalence audit confirmed a postoperative pulmonary complication rate of 16/83 (19.3%) in patients undergoing elective major surgery who were admitted to critical care postoperatively. A quality improvement team developed and implemented ERAS+, an innovative model of peri-operative care combining elements of enhanced recovery with specific measures aimed at reducing pulmonary complications. ERAS+ was introduced in June 2014, with full implementation in September 2014. Patients were screened during full ERAS+ implementation and again one year following implementation. Following ERAS+ implementation, postoperative pulmonary complications reduced to 24/228 (10.5%). Sustained improvement was evident one year after implementation, with a pulmonary complication rate of 16/183 (8.7%). Median (IQR [range]) length of hospital stay one year after implementation of ERAS+ also improved from 12 (9–15 [4-101]) to 9 (5.5–10.5 [3-81]) days. The ERAS+ pathway is applicable to patients undergoing elective major surgery and appears effective in reducing postoperative pulmonary complications.

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Introduction

Complications arising from major surgery pose a major healthcare challenge and are associated with increased hospital and postoperative mortality rates for up to three years [1–3]. Postoperative pulmonary complications (PPC) are one of the commonest complications following major surgery, with a reported incidence of 2–40%, and are associated with increased hospital stay and mortality [4–6]. The European Society of Anaesthesiology and the European Society of Intensive Care Medicine have produced a consensus definition for PPC [7]. Risk factors for PPC have been

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evaluated and prediction tools such as ARISCAT (Assess Respiratory risk in Surgical patients in CATalonia) are available [4, 5, 8–10].

Enhanced recovery after surgery (ERAS) is a peri-operative care pathway developed for major surgery with the intention that patients participate with the planned inpatient recovery in order to reduce postoperative complications and facilitate rapid discharge. A similar concept, 'Peri-operative Surgical Home' has been developed in the USA [11, 12]. Although implementation of ERAS has been successful in the UK, there are few interventions aimed specifically at reducing PPC [13]. In the USA, a simple multidisciplinary respiratory care bundle called 'ICOUGH' (Incentive spirometry; Cough/deep breath; Oral care; Understanding patient education; Get out of bed; Head of bed elevation) has had some impact in reducing the incidence of PPC [14,15]. The aim of this quality improvement project was to design and implement a model of peri-operative care for major surgery, 'ERAS+'. Our primary objective was to assess the impact of ERAS+ on the incidence of PPC.

Methods

Between April 2013 and January 2016, we conducted a five-stage quality improvement project at Central Manchester University Hospitals NHS Foundation Trust, a provider of major surgical services in Greater Manchester. The development and introduction of the ERAS+ pathway followed quality improvement methodology [16]. It was registered with the hospital's Audit Department and approved by the Trust's Caldicott Guardian. The design and implementation stages of ERAS+ and a comparison of baseline ERAS and ERAS+ components are shown in Fig. 1 and Table 1.

Stage 1: Baseline PPC prevalence study

In April 2013, we evaluated the incidence of PPC in patients admitted to critical care over a six-week period following major elective colorectal, gynaecology, head and neck, hepatobiliary, upper gastrointestinal, urology and vascular surgery. A trained data collector screened patients on days 3, 5, 7 and 15 after surgery and an ERAS+ consultant team member then reviewed clinical cases to confirm the diagnosis of PPC (Table 2).

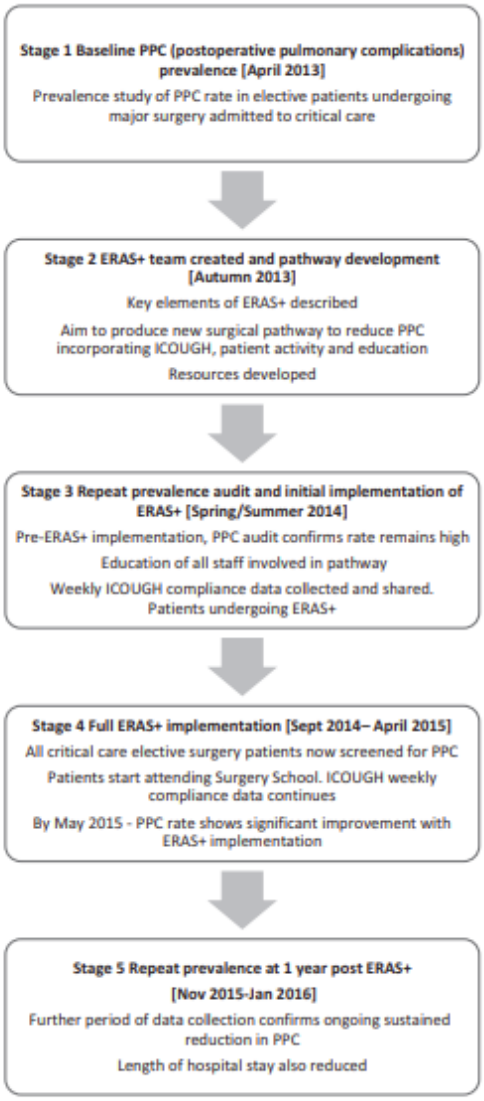

Figure 1 ERAS+ design and implementation stages.

Stage 2: ERAS+ team and pathway development

We created a multidisciplinary ERAS+ team with medical, nursing and allied health professionals (physiotherapy, dietetics and pharmacy), to build on our existing ERAS pathways. This team was led by an ERAS+ steering group which met monthly to develop the pathway,

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Table 1 Components of the ERAS and ERAS+ programs.

	Pre-operative	Intra-operative	Postoperative
ERAS (baseline)	Advice to cease smoking and reduce alcohol intake	Intra-operative fluid management techniques, including use of oesophageal Doppler, pulse contour analysis and/or echocardiography	Multimodal analgesia: local anaesthetic infusion via epidural and tissue plane blocks. Minimisation of i.v. opioid use.
	Pre-operative carbohydrate-rich drinks (2 h and 8 h)	Normothermia	Physiotherapy session for chest and mobilisation
	Day of surgery admission	Minimally invasive surgery, minimise drains	Early enteral nutrition (oral or jejunal) with cessation of i.v. fluids
	Cardiopulmonary exercise testing (CPET)		Early removal of surgical drains
ERAS+ (additional elements added to baseline ERAS)	Surgery School invitation ICOUGH-UK YouTube channel	No change	ICOUGH prescription Breathing and coughing exercises with incentive spirometry every 4–8 h
	Deep breathing exercises with incentive spirometers		Mobilisation twice daily
	Increase usual physical activity by at least 50%		Twice-daily toothbrush and chlorhexidine mouthwash
	Oral health advice		Prepare for recovery at home
	Nutritional advice		

ERAS, enhanced recovery after surgery; i.v., intravenous.

support training and identify resources. Cancer specialist nurses supported patient and family listening sessions before and after surgery to discuss ERAS+. Key goals for ERAS+ were identified: to reduce the incidence of PPC; to promote shared decision making in preparing for, and recovering from surgery; to improve patients' physical and psychological well-being before and after surgery; and to educate both professional groups and patients in preparation for surgery. Boston Medical Centre supported our incorporation of ICOUGH into ERAS+ [14, 15]. Six standards of ICOUGH were agreed: two-hourly use of incentive spirometry; regular coughing and deep breathing; twice-daily oral healthcare (teeth brushing and use of mouth wash); patient understanding of ICOUGH; twice-daily mobilisation; and bed-head elevation at time of review. The ERAS+ team created a prehabilitation programme with patients encouraged to view themselves as instrumental in their own recovery and 'training for their surgery' by increasing daily activity with support from families and friends. Thirty minutes of activity per day was recommended, combined with stretching exercises and nutritional advice [16, 17]. Patients were also encouraged to keep exercise diaries before and after surgery, to facilitate a return to pre-surgery fitness levels.

Table 2 Criteria used for the diagnosis of postoperative pulmonary complications.

Pneumonia	Clinician decision to commence antibiotics for suspected pneumonia based on two or more of: chest radiograph evidence of infiltration; fever > 38 °C; leucocytosis > 12 × 10^9 l^{-1}; and purulent sputum
Atelectasis	Chest radiograph evidence of lung opacification and mediastinal shift
Pleural effusion	Chest radiograph evidence
Pneumothorax	Chest radiograph evidence
Requirement for escalation to higher levels of respiratory support	$F_IO_2 \geq 0.6$ to maintain PaO_2 8–10 kPa and/or $SpO_2 \geq 95\%$ (90% if pre-existing chronic respiratory disease); requirement for nasal high-flow oxygen, CPAP, non-invasive ventilation; or the need for tracheal re-intubation except where a patient is required to return to theatre for further surgery

F_IO_2, fraction of inspired oxygen; PaO_2, partial pressure of oxygen in arterial blood; CPAP, continuous positive airways pressure.

Following the baseline audit, we targeted patients requiring critical care admission after elective surgery for ERAS+ implementation. A gap analysis compared our practice with ICOUGH standards and identified early mobilisation, oral healthcare and respiratory incentive

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spirometry as areas requiring improvement. In response, the ERAS+ implementation group undertook a series of Plan-Do-Study-Act cycles [18] with critical care staff. This resulted in an ICOUGH prescription sheet being attached to the standard drug chart detailing an order set for component interventions (Fig. 2). Concerns about early mobilisation were addressed with a stepped approach for mobilising patients with an epidural in-situ and/or receiving low-dose noradrenaline infusion.

Patients and their relatives were viewed as partners in their recovery from surgery and they helped to develop the information and education resources for ERAS+. Patients reported that a pathway walking them through the pre-hospital, surgery and post-surgery milestones gave them insight into what to expect. Two innovations, 'Surgery School' and 'ICOUGHUK TV' were developed to assist in this process. Patient and relatives were trained in elements of ERAS+ during a weekly

Adult Critical Care, Central Manchester University Hospitals NHS Foundation Trust, July 2015

Patient's name..... Hospital number.....Date of birth.....

Drug allergy/sensitivity.....

iCOUGH PRESCRIPTION

Always state indication and reason for stopping	Time to be given	Given/ check	Given/ check	Given/ check	Given/ check	Given/ check	Given/ check
	Date						
Procedure **Incentive spirometry**	**08.00**						
Start date and duration	**12.00**						
Special Instruction/Pharmacy	**16.00**						
Signature/Date	**20.00**						
Procedure **Mobilisation into chair**	Date / **AM**						
Start date and duration							
Special Instruction/Pharmacy **Aim for a minimum of 30-60 minutes twice daily on days 1 and 2**							
Signature/Date	**PM**						
Drug **Sodium Fluoride toothpaste**	Date / **AM**						
Dose **One application**							
Route **Topical**							
Start date							
Duration							
Special Instruction/Pharmacy **Dentures should also be washed**							
Signature/Date	**PM**						
Drug **Chlorhexidine mouthwash**	Date / **AM**						
Dose **20ml**							
Route **Topical**							
Start date							
Duration							
Special Instruction/Pharmacy **** Check allergy status to chlorhexidine**** *Must be used at least 30 minutes after brushing with fluoride toothpaste*							
Signature/Date	**PM**						

If unable to complete ICOUGH prescription please document reason using the following codes:

1. Chlorhexidine allergy
2. Patient felt unwell on mobilisation
3. Haemodynamic support precluded out of bed mobilisation
4. Patient refusal
5. > 5mL/hour of noradrenaline 4mg in 50mL glucose 5% following discussion with Consultant

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Figure 2 ICOUGH prescription chart detailing the components of ICOUGH.

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Table 3 Areas covered during Surgery School. Video available at http://bit.ly/1sk0DHu.

	Preparation at home	Postoperative critical care	Postoperative surgical ward	Recovery at home
Nutrition	Eat 'healthily', for example, green leafy vegetables. Do not try to lose weight	Early oral nutrition plus supplements/enteral feed. Manage nausea and vomiting	Oral intake including snacks 'little and often' plus supplements	Oral intake including snacks 'little and often'
Breathing	Deep breathing exercises. Train with incentive spirometers 8-hourly	Breathing and coughing with physiotherapist. Incentive spirometry 4 hourly	Breathing and coughing exercises. Incentive spirometry 4–8 hourly	Breathing and coughing exercises. Incentive spirometry 8 hourly
Activity	Advised to increase usual physical activity by at least 50%	Mobilise bed to chair twice daily	Mobilise around ward at least 20 m twice-daily	Increase activity until previous baseline achieved
Oral health	Twice daily toothbrush and mouthwash. Visit dentist if no recent appointments	Twice daily toothbrush and chlorhexidine mouthwash	Twice-daily toothbrush and chlorhexidine mouthwash	Twice-daily toothbrush and mouthwash
Psychological support	Links to Macmillan resources. Tour of critical care areas			Links to Macmillan resources and UK ICOUGH website
General health	Smoking cessation advice. Alcohol reduction			
Family support	Encouraged to involve families including attendance at Surgery School	Visiting hours and telephone contacts given in advance of surgery		Links to Macmillan resources and UK ICOUGH website

multidisciplinary-led session, 'Surgery School', which they were invited to attend (Table 3). During the 60–90 min session, preparation for surgery was discussed. Instruction in ICOUGH, mobilisation and oral healthcare were provided and patients were also given and trained to use an incentive spirometer. They were then asked to take the spirometer home and continue to practise with it. The team discussed in-hospital care, peri-operative pain management, the critical care environment and monitoring devices. Surgery School also provided a useful question and answer forum for patients and their relatives. Attendees were offered a tour of critical care areas to facilitate postoperative orientation. Web-based videos were developed focussing on ERAS+ preparation for surgery, ICOUGH and peri-operative pain management for patients, families and staff, and an ICOUGH UK TV channel was set up on YouTube [19]. The videos were shown in Surgery School as well as viewed at home. Patient information leaflets and multimedia resources were offered to patients.

Stage 3: Repeat prevalence audit, and initial implementation of ERAS+ incorporating ICOUGH

With ERAS+ resources in place, a pre-implementation audit was undertaken over a six-week period in Spring 2014. From June 2014, critical care, surgical and anaesthetic staff were trained in ERAS+ principles, supported by ICOUGHUK TV, brochures and posters. The ERAS+ team attended both surgical and anaesthetic department audit and clinical effectiveness meetings to introduce the initiative. Pre-operative assessment nurses and cancer nurse specialists also attended ERAS+ training sessions to support pre-operative patient education in ICOUGH and ERAS+. For critical care nursing and medical staff, the ERAS+ team delivered ongoing weekly multidisciplinary teaching and an ERAS+ support programme over the next three months (June–August), concentrated on the bundle's role in reducing PPC. All frontline critical care staff were trained, with a focus on key elements identified in the gap analysis.

To measure compliance, all elective surgery patients were assessed for all six elements of ICOUGH by the ERAS+ team during their critical care stay. Bundle compliance was determined three to four times per week during implementation, with results summated to give weekly compliance rates which were fed back using weekly ward implementation run charts (Fig. 3). The ERAS+ team performed walk-rounds to further support critical care staff and provide bedside

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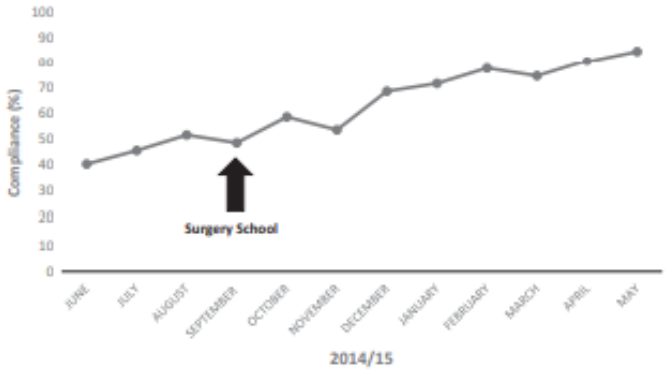

Figure 3 Compliance rates with ICOUGH elements shown following ERAS+ implementation in June 2014.

education around changes in practice. Learning points from team briefs were disseminated to staff.

Stage 4: Full implementation of ERAS+

Full ERAS+ clinical implementation began in September 2014. Surgical teams agreed that all elective major surgery patients with a planned critical care stay would receive ERAS+ interventions which were incorporated into surgical pathways. Patients were then invited to attend Surgery School, instructed on the principles of ERAS+ by pre-operative and specialist nurses and counselled by their surgeons. There were no major changes in anaesthetic or surgical technique during the study period 2013–2016, nor did referral criteria or conduct of pre-operative assessment (including cardiopulmonary exercise testing), change.

Stage 5: Repeat prevalence at one year following ERAS+ implementation

Repeat PPC screening was carried out. To promote sustainability, compliance audits for the ICOUGH bundle were embedded in the weekly reporting structure. For this project, we took convenience samples over three years rather than calculate a sample size. The population studied were elective surgical patients admitted to critical care who were at intermediate- or high-risk of developing PPC (ARISCAT score ≥ 26 [4]). Key outcome data were analysed, with data handled in terms of three groups: pre-implementation (April 2013 – May 2013 and April 2014 – May 2014); implementation (September 2014 – December 2014 and January 2015 – April 2015) and post-implementation (November 2015 – January 2016). Rates of PPC were analysed using chi-squared tests. Patients admitted to critical care following elective surgery with an ARISCAT score < 26 were not analysed; these patients had medical comorbidities and were admitted to critical care following low-risk surgery. Length of stay data were analysed using Student's t-test following log transformation of the data. A patient satisfaction survey regarding the experience of ERAS+ and Surgery School was sent to 100 consecutive patients who attended Surgery School and survived to hospital discharge between January 2015 to March 2015, with questions based on the NHS Friends and Family Test.

Results

Data were collected from 801 patients who scored ≥ 26 on the ARISCAT score corresponding to intermediate- or high-risk for PPC (Tables 4 and 5). Surgical activity increased through 2014–2016 following centralisation of surgical services. Major surgery specialties were represented in broadly similar proportions for each of the implementation phases (Table 5). The breakdown of intermediate- and high-risk surgical groups using ARISCAT suggests the PPC risk profile did not significantly change over time.

Following ERAS+ implementation, there was a reduction in PPC incidence from the baseline pre-implementation period (14/75 (18.7%) vs. 24/228

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Table 4 Baseline characteristics of patients admitted to critical care postoperatively following major surgery. Values shown are number (proportion), or median (IQR [range]).

	April 2013–May 2013 n = 83	April 2014–May 2014 n = 75	Sep 2014–Dec 2014 n = 232	Jan 2015–April 2015 n = 228	Nov 2015–Jan 2016 n = 183
Cancer cases	69 (83%)	61 (81%)	188 (81%)	183 (80%)	154 (84%)
Sex; male	51 (61%)	42 (56%)	127 (55%)	139 (61%)	102 (56%)
Age; years	63 (12.4)	64 (12.3)	63 (13.1)	63 (12.7)	63 (12.5)
ASA 1–2	44 (53%)	43 (57%)	130 (56%)	121 (53%)	102 (56%)
ASA 3–4	39 (47%)	32 (43%)	102 (44%)	107 (47%)	81 (44%)
PPC	16 (19%)	14 (19%)	29 (13%)	24 (11%)	16 (9%)
In-hospital mortality	2 (2%)	2 (3%)	5 (2%)	5 (2%)	5 (3%)
Length of stay; days	12 (9–15 [4–101])	12 (9–15 [3–97])	11.5 (8–15 [3–246])	12 (5–19 [3–79])	9 (5.5–12.5 [3-81])

PPC, postoperative pulmonary complications; ERAS, enhanced recovery after surgery.

(10.5%); p = 0.017). One year after ERAS+ implementation, the PPC incidence had reduced further (6/183 (8.7%); p = 0.005) (Fig. 4). Median (IQR [range]) hospital length of stay was also reduced (Table 4) (p < 0.0005).

The Surgery School survey response rate was 75/100 (75%): 72/75 (96%) patients rated Surgery School as good or very good; 68/75 (91%) of patients stated they would recommend Surgery School to friends or family; 67/75 (89%) deemed the session time appropriate at 1 h; and information given was deemed sufficient and helpful by 63/75 (84%). Free text comments suggested patients felt empowered by the ERAS+ programme, that ERAS+ 'made sense' and that it should be offered to all patients having major surgery.

Discussion

We have demonstrated in a patient-centred quality improvement project that ERAS+ reduces the risk of pulmonary complications after major surgery, specifically in the context of major oncological resection. This innovation aligns domains 1, 3, 4 and 5 of the NHS Outcome framework 2015/6 [20], with a potential median reduction in patient length stay of 3 days.

Postoperative pulmonary complications represent one of the more common and significant adverse events following surgery. The prevalence of PPC ranges between 2% and 40% in non-cardiac surgical cohorts, which is higher than that of myocardial events in high-risk patients [8, 10]. Variability in

Table 5 Breakdown of patients by type of surgery and risk of postoperative pulmonary complications (PPC) according to Assess Respiratory Risk in Surgical Patients in CATalonia (ARISCAT) [4] score. Values are number (proportion).

	April 2013–May 2013 n = 83	April 2014–May 2014 n = 75	Sep 2014–Dec 2014 n = 232	Jan 2015–April 2015 n = 228	Nov 2015–Jan 2016 n = 183
Colorectal	9 (11%)	9 (12%)	25 (11%)	26 (11%)	19 (10%)
Gynaecology	10 (12%)	11 (15%)	31 (13%)	29 (13%)	24 (13%)
Head and Neck	8 (10%)	7 (9%)	24 (10%)	23 (10%)	18 (10%)
Hepatobiliary	26 (31%)	25 (33%)	93 (40%)	82 (36%)	69 (38%)
Upper gastrointestinal	11 (13%)	10 (13%)	22 (10%)	23 (10%)	20 (11%)
Urology	11 (13%)	8 (11%)	24 (10%)	23 (10%)	17 (9%)
Vascular	8 (10%)	5 (7%)	13 (6%)	22 (10%)	16 (9%)
Intermediate risk of PPC (ARISCAT 26–44)	63 (76%)	58 (77%)	180 (78%)	172 (75%)	141 (77%)
High risk of PPC (ARISCAT ≥ 45)	20 (24%)	17 (23%)	52 (22%)	56 (25%)	42 (23%)

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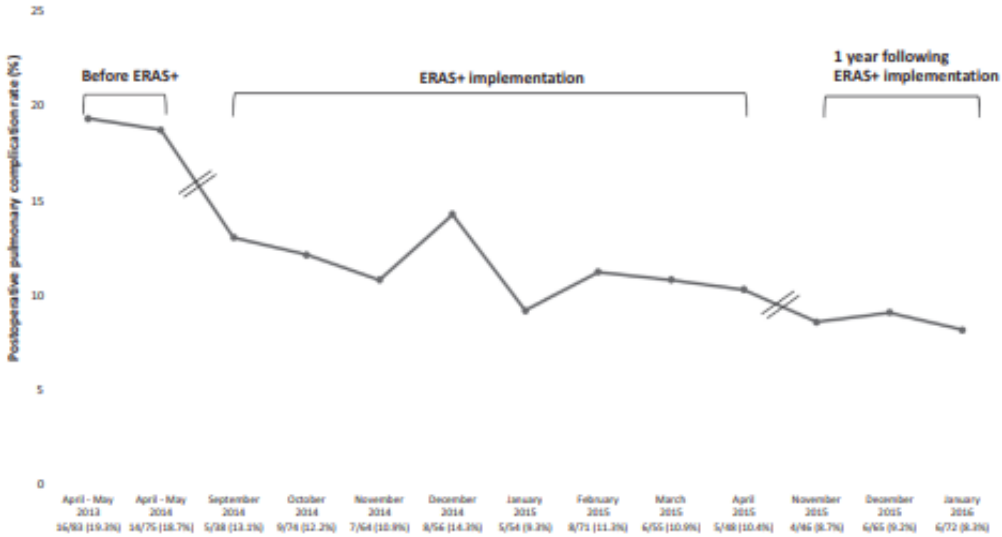

Figure 4 Postoperative pulmonary complication incidence over time. The graph demonstrates a timeline of pre-intervention, implementation and one-year post initial implementation (// denotes break in data collection).

PPC reporting due to the use of different diagnostic techniques has been addressed by the European Society of Anaesthesiology, by producing a guide on PPC diagnosis within the European Peri-operative Clinical Outcome (EPCO) document [7]. The 2015 EPCO consensus defines PPC based on the presence of respiratory failure (hypoxaemia), pulmonary infection, atelectasis, effusion, pneumothorax, aspiration pneumonitis or bronchospasm. The PPC criteria in this project are largely consistent with these definitions with the exception that EPCO diagnosis of pneumonia requires antibiotic administration plus one or more other signs of infection rather than two or more signs. Our definition of hypoxaemia reflects our local critical care oxygen target policy, namely $F_IO_2 \geq 0.6$ or high-flow / mechanical ventilation to maintain PaO_2 of 8.0–10 kPa (effectively a PaO_2:F_IO_2 ratio < 16.7 kPa), and/or $SpO_2 \geq 95\%$ (if no pre-existing respiratory disease), or 90% (if pre-existing chronic respiratory disease). This does differ from the EPCO definition of hypoxaemia which is PaO_2 < 8 kPa on room air, PaO_2:F_IO_2 ratio < 40 kPa or SpO_2 < 90% requiring oxygen therapy. The EPCO definition should, therefore, capture a higher prevalence of PPC and may explain the lower baseline incidence observed in our intermediate- and high-risk cohort compared with that described in the literature. As EPCO was published over half-way through this quality improvement project, we did not change to EPCO criteria in order to maintain diagnostic consistency.

The risk factors for developing PPC have been extensively investigated, and researchers have developed risk prediction tools based on these data [4, 9]. Canet et al. in the ARISCAT study identified seven key risk factors for PPC: low supine pre-operative oxygen saturation; recent respiratory infection; age; pre-operative anaemia; upper abdominal or intrathoracic surgery; surgical duration of at least 2 h; and emergency surgery. We used the ARISCAT score to confirm all patients included in our analysis were at intermediate- or high-risk of PPC [4].

The contents of our bundle were based on research using the ICOUGH care package. This demonstrated a trend towards reduction in PPC rates from 2.6% to 1.6% one year after implementation [14]. Two Cochrane reviews on peri-operative incentive spirometry, one in cardiac surgery and one in upper gastrointestinal surgery, were unable to identify any benefit of this intervention in terms of reduction in

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rates of PPC [21, 22]. Although the reviewers noted the generally poor quality of these studies, we observed that pre-hospital training in incentive spirometry improved understanding and compliance in the post-operative period. Our ICOUGH bundle emphasised good oral care leading up to and after surgery. Our patient cohort was administered chlorhexidine mouthwashes while within critical care areas. A systematic review of chlorhexidine mouthwash use in thoracic surgical patients demonstrated a reduction in respiratory tract infections (relative risk 0.48 (95% CI 0.36–0.65)) [23]. However, other research has failed to show that chlorhexidine mouthwash use reduces the incidence of ventilator-associated pneumonia in a general intensive care population [24]. A Cochrane review of inspiratory muscle training does suggest efficacy at reducing rates of PPC [25]. ERAS+ built on the established ERAS pathway bundle that been implemented across the NHS since 2009 [13, 26] and some elements of ERAS, such as early mobilisation, may also reduce the incidence of PPC [27].

The impact of multi-faceted care bundles within quality improvement projects in critical care is well established. These bundles have been shown to reduce ventilator-associated pneumonia and catheter-related blood stream infections in various multisite projects in different healthcare systems [28, 29].

We used an ERAS+ implementation and project steering group with strong executive input. We utilised key elements of quality improvement methodology as advocated by the Institute for Health Improvement and NHS England Sustainable Improvement Team. These included: plan-do-study-act cycles; staff training programme in ERAS+; an ICOUGH prescription to support bundle implementation; nurse champions to support frontline staff; the use of safeguards to ensure mobilisation of patients; and run charts to support bundle compliance with weekly staff feedback [30, 31]. These processes helped support an increasing ICOUGH compliance.

We believe the involvement of patients and their families was essential to the success of this programme. Surgery School is an innovation which borrows from both orthopaedic joint schools and the educational element of Peri-operative Surgical Home [12]. Feedback from patients was generally positive and helped to change attitudes amongst staff and assisted the ERAS+ project team in refining the programme. Of primary importance was the principle of patients 'taking control of their own recovery', which is a positive and dynamic attitude consistently advocated by cancer charities [32].

The process of improving functional capacity to withstand an incoming stressor has been termed pre-habilitation [33]. Patients with lower functional capacity pre-operatively have been demonstrated to have higher mortality and morbidity rates following major surgery [34, 35]. Pre-habilitation exercise interventions have been successful in patients undergoing colorectal cancer surgery with improved functional recovery following neo-adjuvant treatment before surgery [36].

Quality improvement projects such as this report carry a number of limitations. The 'before and after' rather than randomised nature of group allocation is a potential source of bias. It is quite possible that other, unmeasured factors contributed to the improved outcomes. In the case of this project, changes in surgical or anaesthetic personnel may have occurred due to the centralisation of surgical services. This explains the increased number of operations performed in the 'after' phase of the study and there is epidemiological evidence that large-volume surgical services perform better than those with smaller volumes [37]. Similarly, new techniques in anaesthesia or surgery, outside of those promoted within ERAS+, may have contributed to improved patient outcomes. As patients were not randomly selected to join one group, it is possible that the 'after' group was better selected and at lower risk of PPC than the 'before' group, despite our application of the ARISCAT risk tool and using the same selection criteria through pre-operative screening, including the widespread use of cardiopulmonary exercise testing. The ERAS+ project team deliberately used the Hawthorne effect [38] to drive improvements in bundle compliance and patient outcomes. As a result, we are unable to identify which elements of the bundle are the most effective. There were also changes in the clinical environment, with a refurbishment of the high dependency unit in 2014 and the general surgical wards in 2014–2015 which may have influenced our findings. Finally, this project is a single-centre project conducted by enthusiasts. We would welcome

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multicentre studies with longer follow-up periods to further investigate the utility of care bundles in the reduction of PPC.

The costs to develop and implement ERAS+ included: 4 h per week of consultant time; one whole- time equivalent specialist nurse (formerly the ERAS nurse); and one half-time equivalent data collector. Administration and nurse training costs were met within existing budgets. Following implementation, ongoing costs consisted of: 2 h per week consultant time with administration, nurse training; and data collection costs, and these were absorbed into critical care and surgical division budgets. Capital costs were minimal, and the only disposables were the incentive spirometers (approximately £3 (€3.3, $3.7) each).

The phenotype of a high-risk surgical population with disproportionately high peri-operative mortality and morbidity has been described in many healthcare environments [5, 39]. Patients who develop complications such as PPC have reduced life expectancy [1, 8]. This project has demonstrated a potential path towards reducing these complications and improving short-term outcomes. This new type of peri-operative care pathway requires the active involvement of patients and their families in partnership with the multiprofessional healthcare team. The care bundles are relatively low-cost and we believe they can be subject to widespread adoption in peri-operative care.

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References

1. Khuri SF, Henderson WG, DePalma RG, et al. Determinants of long-term survival after major surgery and the adverse effect of postoperative complications. *Annals of Surgery* 2005; **242**: 326–41.
2. Moonesinghe SR, Harris S, Mythen MG, et al. Survival after postoperative morbidity: a longitudinal observational cohort study. *British Journal of Anaesthesia* 2014; **113**: 977–84.
3. Pearse RM, Moreno RP, Bauer P, et al. Mortality after surgery in Europe: a 7 day cohort study. *Lancet* 2012; **380**: 1059–65.
4. Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology* 2010; **113**: 1338–50.
5. Mazo V, Sabate S, Canet J, et al. Prospective external validation of a predictive score for postoperative pulmonary complications. *Anesthesiology* 2014; **121**: 219–31.
6. Agostini P, Cieslik H, Rathinam S, et al. Postoperative pulmonary complications following thoracic surgery: are there any modifiable risk factors? *Thorax* 2010; **65**: 815–8.
7. Jammer I, Wickboldt N, Sander M, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. *European Journal of Anaesthesiology* 2015; **32**: 88–105.
8. Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. *American Journal of Medicine* 2002; **112**: 219–25.
9. Smetana GW, Lawrence VA, Cornell JE, et al. Preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. *Annals of Internal Medicine* 2006; **144**: 581–95.
10. Holcomb CN, Hollis RH, Graham LA, et al. Association of coronary stent indication with postoperative outcomes following noncardiac surgery. *Journal of the American Medical Association Surgery* 2016; **151**: 462–9.
11. Gustafsson UO, Scott MJ, Schwenk W, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS(R)) Society recommendations. *Clinical Nutrition* 2012; **31**: 783–800.
12. Kain ZN, Vakharia S, Garson L, et al. The perioperative surgical home as a future perioperative practice model. *Anesthesia and Analgesia* 2014; **118**: 1126–30.
13. Simpson JC, Moonesinghe SR, Grocott MP, et al. Enhanced recovery from surgery in the UK: an audit of the enhanced recovery partnership programme 2009-2012. *British Journal of Anaesthesia* 2015; **115**: 560–8.
14. Cassidy MR, Rosenkranz P, McCabe K, et al. I COUGH: reducing postoperative pulmonary complications with a multidisciplinary patient care program. *Journal of the American Medical Association Surgery* 2013; **148**: 740–5.
15. Wren SM, Martin M, Yoon JK, et al. Postoperative pneumonia-prevention program for the inpatient surgical ward. *Journal of the American College of Surgeons* 2010; **210**: 491–5.
16. Department of Health PA, Health Improvement and Protection. Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. https://www.sportengland.org/media/2928/dh_128210.pdf (accessed 01/06/2016).
17. Rock CL, Doyle C, Demark-Wahnefried W, et al. Nutrition and physical activity guidelines for cancer survivors. *CA A Cancer Journal for Clinicians* 2012; **62**: 243–74.
18. Langley GJ, Moen RD, Nolan KM, et al. *The Improvement Guide*, 2nd edn. San Francisco, CA: Jossey-Bass, 2009.
19. https://www.youtube.com/channel/UCvOamR8Sb4R-XENrS6fvRehA (accessed 01/06/2016).

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20. The NHS Outcomes Framework 2015/16. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/385749/NHS_Outcomes_Framework.pdf (accessed 01/06/2016).
21. do Nascimento Junior P, Modolo NS, Andrade S, et al. Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. *Cochrane Database of Systematic Reviews* 2014; **2**: CD006058.
22. Freitas ER, Soares BG, Cardoso JR, et al. Incentive spirometry for preventing pulmonary complications after coronary artery bypass graft. *Cochrane Database of Systematic Reviews* 2012; **9**: CD004466.
23. Pedersen PU, Larsen P, Hakonsen SJ. The effectiveness of systematic perioperative oral hygiene in reduction of postoperative respiratory tract infections after elective thoracic surgery in adults: a systematic review. *JBI Database of Systematic Reviews and Implementation Reports* 2016; **14**: 140–73.
24. Wong T, Schlichting AB, Stoltze AJ, et al. No decrease in early ventilator-associated pneumonia after early use of chlorhexidine. *American Journal of Critical Care* 2016; **25**: 173–7.
25. Katsura M, Kuriyama A, Takeshima T, et al. Preoperative inspiratory muscle training for postoperative pulmonary complications in adults undergoing cardiac and major abdominal surgery. *Cochrane Database of Systematic Reviews* 2015; **10**: CD010356.
26. Fearon KC, Ljungqvist O, Von Meyenfeldt M, et al. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. *Clinical Nutrition* 2005; **24**: 466–77.
27. Mackay MR, Ellis E, Johnston C. Randomised clinical trial of physiotherapy after open abdominal surgery in high risk patients. *Australian Journal of Physiotherapy* 2005; **51**: 151–9.
28. Eom JS, Lee MS, Chun HK, et al. The impact of a ventilator bundle on preventing ventilator-associated pneumonia: a multicenter study. *American Journal of Infection Control* 2014; **42**: 34–7.
29. Marsteller JA, Sexton JB, Hsu YJ, et al. A multicenter, phased, cluster-randomized controlled trial to reduce central line-associated bloodstream infections in intensive care units. *Critical Care Medicine* 2012; **40**: 2933–9.
30. Institute for Health Improvement. http://www.ihi.org/Pages/default.aspx (accessed 01/06/2016).
31. NHS England Sustainable Improvement Team. https://www.england.nhs.uk/ourwork/qual-clin-lead/nhsiq (accessed 01/06/2016)
32. https://cancerrecovery.org.uk/cancer-information/integrated-cancer-care/attitude/ (accessed 01/06/2016).
33. Ditmyer MM, Topp R, Pifer M. Prehabilitation in preparation for orthopaedic surgery. *Orthopaedic Nursing* 2002; **21**: 43–51; quiz 2-4.
34. Junejo MA, Mason JM, Sheen AJ, et al. Cardiopulmonary exercise testing for preoperative risk assessment before hepatic resection. *British Journal of Surgery* 2012; **99**: 1097–104.
35. Snowden CP, Prentis J, Jacques B, et al. Cardiorespiratory fitness predicts mortality and hospital length of stay after major elective surgery in older people. *Annals of Surgery* 2013; **257**: 999–1004.
36. Mayo NE, Feldman L, Scott S, et al. Impact of preoperative change in physical function on postoperative recovery: argument supporting prehabilitation for colorectal surgery. *Surgery* 2011; **150**: 505–14.
37. Finks JF, Osborne NH, Birkmeyer JD. Trends in hospital volume and operative mortality for high-risk surgery. *New England Journal of Medicine* 2011; **364**: 2128–37.
38. Parsons HM. What happened at Hawthorne?: new evidence suggests the Hawthorne effect resulted from operant reinforcement contingencies. *Science* 1974; **183**: 922–32.
39. Pearse RM, Harrison DA, James P, et al. Identification and characterisation of the high-risk surgical population in the United Kingdom. *Critical Care* 2006; **10**: R81.

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