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Revolutionising rapid recovery: a quality improvement project in hip and knee replacement

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ABSTRACT

With increasing bed pressures and an ageing population, there is a need to increase throughput and reduce the bed burden of joint replacements. These issues were recognised in North Devon and an enhanced recovery pathway was established. Enhanced recovery, which aims to optimise the patient journey and shorten the inpatient admission, was first adopted for hip and knee replacements in North Devon District hospital in 2011. The Rapid Recovery Group, comprised a multidisciplinary team involved in the perioperative patient pathway, formed in the third financial quarter of 2018/2019 (Q3). The group was tasked with the optimisation of the pathway for patients requiring hip and knee replacement from referral to 12 months postoperation. Representatives from the group visited a similar sized hospital with successful outcomes from their pathway in order to compare and then construct a new pathway based on observed practices. Multiple interventions were instigated, alongside continuous data collection, forming a combination of simultaneous and sequential Plan Do Study Act cycles. Interventions involved intraoperative local anaesthetic injection protocols, use of Taurus frames together with nurse-led mobilisation and trials of simplified drug charts. Information collected included type of surgery, length of stay, who mobilised patients and when. Mean length of stay in total hip and knee replacement has dropped from 3.6 to 2.4 days and 3.6 to 2.0 days respectively, comparing mean for the fiscal year 2018/2019 to 2019/2020, putting the hospital in the top 10 trusts in the country. With multiple changes occurring simultaneously, the impact of individual elements is difficult to isolate but the overall impact of the interventions is evident. A drastic improvement in the length of stay has been seen and the collaborative multidisciplinary approach has been pivotal to success.

PROBLEM

Pressures related to bed requirements continue to be an issue in the National Health Service (NHS). In the winter of 2017–2018, the throughput for elective operating at North Devon District hospital saw a reduction. This was due to record number accident and emergency department attendance and admission figures across Devon. With acutely unwell patients filling beds and emergency care taking priority, elective operating was temporarily ceased. There already existed an increased demand for joint replacement, largely due to trends towards an ageing population.[1] The National Joint Registry in the UK demonstrated a rise in hip and knee arthroplasty cases each year, with 193 875 in 2017 compared with 166 495 performed in 2013. With this pre-existing increased input and an acute cessation to throughput, mounting waiting lists resulted in some patients beginning to seek treatment elsewhere.

To tackle the issue of delayed procedures and minimise the financial penalties incurred by the Trust for missing targets, it was essential that pathways for elective hip and knee replacement become cohesive. Improved efficiency of the elective joint replacement pathway would serve to increase the number of patients treated locally without compromising the quality of care. Additionally, by creating such pathways, the patient experience should also improve due to increased preoperative information, a shorter length of stay and better outcomes.

BACKGROUND

The concept of enhanced recovery originated in 1995 observing patients receiving epidural analgesia, and early oral nutrition and mobilisation after colonic surgery.[2] This was consolidated and published in the anaesthetic literature in 1997 when Dane H Kehlet hypothesised 'multimodal interventions may lead to a major reduction in the undesirable sequelae of surgical injury with accelerated recovery and reduction in postoperative morbidity and overall costs'.[3 4] His approach combined management of pain, exercise and patient education alongside control of other physiological parameters.[3] As time progressed the concept was adopted by orthopaedic surgeons, having noted the positive outcomes observed general surgery.

The recent consensus document from the Enhanced Recovery After Surgery (ERAS)

Society contains many evidence based recommendations for successful management of patients over the perioperative period. An important recommendation is the need for audit and continuous improvement.[5]

Enhanced recovery began in the North Devon district hospital in 2011, initially focusing on patient education and physiotherapy. This was by means of a therapy lead 'Joint School' and patient information leaflet provision. Multidisciplinary and multimodal enhanced recovery was formalised with the establishment of the Rapid Recovery Group in 2018. This group aimed to improve waiting lists and relieve bed pressures by optimisation of the pathway for patients requiring hip and knee replacement from referral to 12 months postoperation.

Herein, the quality improvement project performed by the Rapid Recovery Group is described and its outcomes evaluated. Prior to commencement, data comparing 130 hospitals providing joint replacement services showed that North Devon had a median length of stay of 4.2 days for total hip replacement (41st nationally) and 3.9 days for total knee replacement (34th nationally) as a 12-month rolling median in the financial Q4 of 2017/2018.[6] This provided a national measure to demonstrate improvements from the pathway once it was implemented.

MEASUREMENT

Data from the trust Model hospital[6] record were reviewed. The Model Health System is a data-driven improvement tool that supports health and care systems to improve patient outcomes and population health. It was developed after a 2015 review into how efficiency and savings could be improved within the NHS. Through web-based data, one can review quality of care, productivity and organisation within their hospital and therefore infer areas for improvement. In addition to Model Hospital data, to make a more in-depth assessment prior to the rapid recovery interventions in Q3 of 2018, data were collected locally to identify the baseline length of stay and mobilisation time frame (Q4 2017/1018-Q2 2018/2019 inclusive). This was collected retrospectively from the records of all patients who underwent hip or knee replacement in the trust.

The mean length of stay in total hip and knee replacement in this baseline period was 3.6 for both groups. As stated by department policy at this time, patients were being mobilised by physiotherapists prior to nurses assisting with their postoperative mobilisation. Consequently, working hours of the physiotherapy staff became a limiting delaying factor to mobilising.

From Q4 2018/2019, data collection became prospective. This was achieved using a bedside data collection sheet and uploaded to a bespoke database. Data points included, operation, demographic details, length of stay, who mobilised patients and when. The continuous data collection was supported by regular meetings to cascade findings and to ensure that there was adequate user compliance and data input. Demographics of the retrospective (pre-implementation group) and prospective (postimplementation group) data were analysed with one-tailed t-test used to statistically assess the comparability based on age and χ^2 test for comparability based on sex. Unpaired two-tailed t-test was the statistical method used to analyse length of stay in the preimplementation group and postimplementation group.

DESIGN

The Rapid Recovery Group consisted of a multidisciplinary group including members from; management, preoperative assessment, anaesthetics, theatre staff, pharmacy, ward staff, pain team, occupational therapy, physiotherapy and informatics with support from the Zimmer-Biomet Enhanced Recovery team. The group was tasked to identify and discuss which patient outcomes could be regularly assessed and where improvements could be made. A retrospective review of cases from Q4 2017/2018 to Q2 2018/2019 was undertaken to examine these patient outcomes, mainly seen as mobilisation and discharge patterns. This provided a baseline assessment against which we could compare our progress and effects of interventions.

Milton Keynes University Hospital was deemed to be a centre of a similar size and site structure. Over a 12-month period (2018/2019), North Devon had a throughput of 436 elective cases and Milton Keynes had a throughput of 484 cases. Having been introduced locally in 2010 and driven by Professor O Pearce, the National Lead for Rapid Recovery Programme (RRP) for Hip and Knee Replacement UK, the effective RRP at this centre is nationally acknowledged. All staff groups were invited and the visit took place on the fourth of December 2018. With group members across the multidisciplinary spectrum all in attendance there was a threefold benefit; there was insight gained that other professional groups would not have picked up in observation, individuals could better conceptualise other disciplines roles and buy-in to the process from all staff groups was attained. This was particularly useful for those from nursing and therapy background who once established rarely have opportunities for exposure to other centres' processes.

Second, the whole pathway was mapped from referral to aftercare. This improved team understanding of how their roles interrelated and allowed identification of areas of potential improvement.

Using this baseline, simultaneous and sequential Plan Do Study Act (PDSA) cycles were conducted as various group members contributed quality improvement strategies and continuous prospective data collection was initiated to monitor progress. The core data were collected by the ward team with nursing staff taking ownership for recording time of first mobilisation, discharge and reasons for delay (see data collection sheet online supplemental appendix 1 for details). Patient demographics, joint school attendance, the surgical team involved, type of surgery, anaesthetic details, mobilisation and discharge

outcomes were collected and analysed in a regular and rolling manner having subscribed to Zimmer-Biomet's data analytics pack. This was readily accessible by a point of contact at Zimmer-Biomet and the Departmental manager, with monthly reports sent to a Departmental Consultant. Other elements such as prescribing patterns and opiate drug usage were monitored via pharmacy ward stock use and targeted audits.

STRATEGY

The Specific, Measurable, Applicable, Realistic, Timely (SMART) aim of this study was to increase the throughput of elective hip and knee joint replacement, to have 90% of cases mobilising day 0 postoperatively and reduce length of stay by 1 day within 1 year. Patients were already routinely admitted on the day of surgery so our quality improvement strategies focus primarily on the postoperative management.

The PDSA cycles were simultaneous rather than strictly sequential as we did not want to lose the momentum and enthusiasm of any staff group. Progressive improvement occurred within parallel but closely linked PDSA cycles. During the process for implementing change in each cycle, reviews occurred to assess the effect of the change at that point and whether alterations of the process were required.

PDSA cycle 1: postoperative analgesia

Inadequate intraoperative or postoperative analgesia may cause a patient to be in too much pain, be confused or suffer from sickness. These can result in a delay to mobilisation and discharge. This cycle aimed to change aspects of the patient's perioperative journey in order to reduce the requirement of postoperative analgesia.

During the retrospectively reviewed period, plans were made to shift from oral morphine sulphate solution to oxycodone modified release (MR) as a standard short-term postoperative analgesia prescription. A prospective pain team audit was completed to monitor this. Later a simplified version of this was added to the continuous monitoring proforma. The dose equivalent usage of morphine, the incidence of postoperative nausea and patient satisfaction were reviewed at each stage.

In late 2018, ropivacaine-based local anaesthetic injection protocols for hip and knee replacement were agreed by orthopaedics, anaesthetics and pharmacy and formally introduced into elective surgery. This was with the intent of decreasing postoperative pain and motor blockade. An effective similar regime with good outcomes had been practised in Australia by a consultant member of the Rapid Recovery Group and became incorporated locally. This included a standardised injection regime with differing drug amounts based on patient weight being above or below 60 kg. 200 mL of 0.2% ropivocaine was mixed with 1 mL of 1:1000 epinephrine, with half of the solution receiving an additional 80 mg of kenalog. Wound infiltration occurred with a given volume of ropivacaine, epinephrine and saline into specific regions of the capsule and synovium.

This was followed by two trials of preprinted drug charts with a standardised postoperative protocol, including non-steroidal anti-inflammatories, MR and standard release oral opioid medications, venous thromboembolic prophylaxis and antiemetics. In each trial, the preprinted charts were used for the entirety of a patient's admission, and this standardised the perioperative prescribing for these cohorts of patients. Feedback was collected form staff using the charts and alterations made accordingly.

PDSA cycle 2: physiotherapy

Physiotherapy-related factors which could improve postoperative early mobilisation related to how the patient mobilised and who was assisting with patient mobilisation. This cycle aimed to resolve issues that could cause a delay to mobilisation.

After attending an enhanced recovery conference in late 2017, our senior physiotherapist was made aware of the benefits to early mobilisation brought about by a Taurus frame. This was conveyed to the department and the frames planned for trial. This trial was reviewed by nurses and physiotherapists for a decision about the permanence of Taurus frames in the department.

It was felt that reliance on physiotherapy staff to mobilise patients postoperatively was an unnecessary dependence. The concept of nurse-led mobilisation was introduced in mid-2018. Information provision on soft hip precautions provided nursing staff more confidence for independence. In conjunction with the increased number of Taurus frames in Q3 of 2018 the ethos of nurse-led mobilisation gained momentum and has now been adopted as normal ward culture.

PDSA cycle 3: change with local policy

Several key policies were altered through evidence-based practice. These changes aimed to optimise the use of bed space and prevent delays to admission, theatre and discharge.

In preoperative assessment, routine asymptomatic midstream urine samples (MSU) were no longer collected. Sousa *et al* performed a systemic review including 28 588 patients which concluded that routine urinary screening prior to elective total joint arthroplasty and treatment of asymptomatic patients is not recommended.[7]

The use of thromboembolism-deterrent (TED) stocking was terminated in favour of intermittent compression foot pump. Studies have examined the benefits of using stockings and foot pumps, finding they promote early mobilisation.[8] Pitto and Young evaluated thromboprophylaxis in hip and knee replacement patients, finding that there was no increase in thromboembolic embolic events and there was better patient compliance with foot pumps alone.[9]

Additionally, the elective Orthopaedic ward was formally ring-fenced, separating staff and patients from trauma and potentially infective patients.[10] The protected

beds would also ensure that pressures in other areas of the hospital should not impact the throughput for elective joint replacement surgery. Inclusion of the nursing team in the departmental governance aided in presenting the details of policy changes and the improvements for which they had been a vital part and lead to an improvement in morale.

RESULTS

Overall, the demographics of the preimplementation and postimplementation groups were comparable. The pre implementation group was 47.5% male and 52.5% female with an age range of 40–92 and a mean age of 71 years. This was compared with 45% male and 55% female with an age range of 40–91 and a mean age of 71 years in the postimplementation group.

Age and sex were comparable between the preimplementation and postimplementation group after statistical analysis (p=0.35742 and p=0.535006, respectively).

The American Society of Anesthesiologists (ASA) physical status classification showed a shift towards higher risk patients in the post implementation group with a decrease from 71% to 58% being ASA 2 and an increase from 21% to 32% being ASA 3. With the two cohorts not being statistically different for age and sex, as well as progressing to a more complex patient cohort, it is likely that improvements in outcomes are due to interventions and not differences among the populations.

The primary outcome measure of improved throughput of hip and knee joint replacements was achieved. Predicted yearly throughput from Q4 2019/2020 improved to 560 joint cases compared with 480 predicted throughput prior to protocol implementation.

Comparing the length of stay over the 2019/2020 fiscal year with that of pre protocol implementation group, there was reduction in length of stay from a mean of 3.6 to 2.4 days (p<0.0001) and 3.6 to 2.0 days (p<0.0001) for hips and knees, respectively.

PDSA cycle 1: postoperative analgesia

Introduction of regular oxycodone MR as part of a multimodal postoperative analgesic regime, meant that the morphine equivalent (ME) opioid consumption increased up to the first postoperative day but the overall consumption decreased significantly.

We found that the incidence of nausea, which is correlated to patient satisfaction, remains at a similar level (figure 1). Despite this 90% of patients reported being satisfied or very satisfied with care based on the first 24 hours postoperatively. This oxycodone MR use has become imbedded in routine practice as evident from ward stock use. The amount of breakthrough analgesia required has also reduced, decreasing the amount of nursing time required to check controlled drugs.

Standardising anaesthetic technique with the ropivacaine-based local anaesthetic injection protocol increased the chances of patients being mobilised on day 0. We saw a significant decrease in postoperative muscle weakness/motor block (figure 2) with a slight improvement in pain scores within the first 24 hours. The introduction of local anaesthetic infiltration also coincided with a decreased use of postoperative opioid analgesia.

Feedback pertaining to the preprinted prescription chart resulted in several changes. Changes made following the first trial included: the boxes for signing identified as too small, the section for induction antibiotic prescription being unnecessary due to duplication of paperwork and length of the chart reduced from 14 to 5 days as patients rarely stayed in more than a few days. Feedback from the updated version was well received and no further changes were made.

Over the course of the cycle, the total opioid use per patient decreased from approximately 400 mg of ME, to less than 300 mg (figure 3). The reduction of opioid use may be due to the standardised local anaesthetic protocol or because the multimodal postoperative analgesic regimen better controlled pain.

Feedback from pharmacy towards the latter stage of the cycle demonstrated improvement with efficiency for

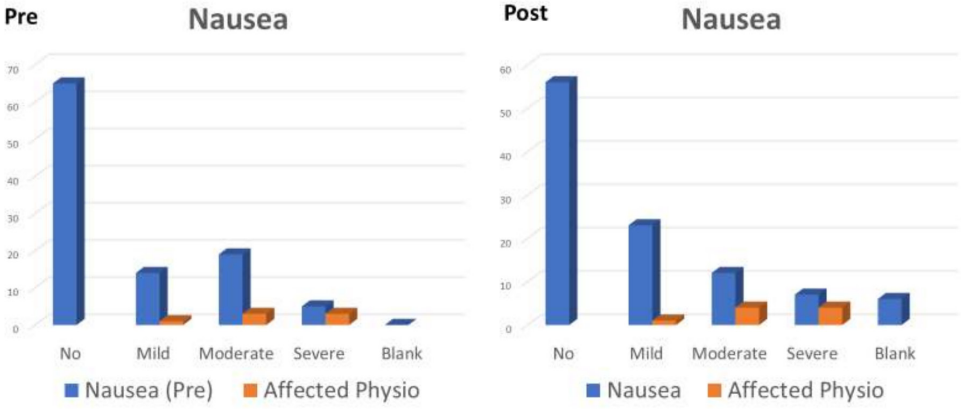

Figure 1 This figure demonstrates the incidence of nausea before and after the introduction of oxycodone MR in postoperative pain management. MR, modified release.

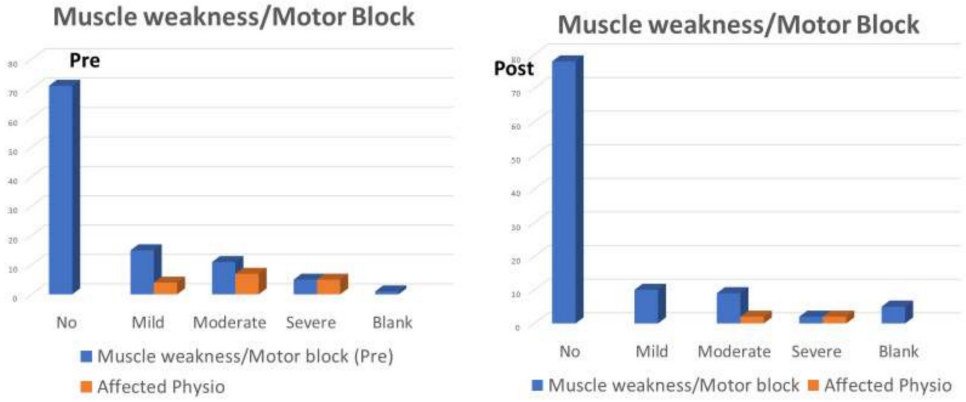

Figure 2 This figure demonstrates the incidence of muscle weakness and motor block before and after the introduction.

time to discharge. Standardised protocols and the use of To Take Away packs of analgesia on the wards caused the time taken for pharmacy to process a discharge prescription drop by around 15 min since their introduction.

PDSA cycle 2: physiotherapy

With the design of the Taurus frame incorporating patient upper body strength and less stress on the operated joint postoperatively, patients had more confidence in their ability to mobilise soon after their operation. Discussion with nurses and physiotherapists occurred locally and with other centres about whether this addition was having a beneficial effect. This review deemed the acquirement of more frames to be a necessary step in this cycle to further improve early mobilisation. Six frames were then purchased increasing to 12, with financial support from the hospital League of Friends charity, as this became the normal aid for first mobilisation.

In Professor Pearce's team's writing on rapid recovery, it states that 'mobilisation of patients is predominantly performed by physiotherapists and, to a lesser extent, the ward nurses'.[11] However, we have seen a paradigm shift in this where nursing staff have taken on responsibility for early mobilisation with impact. Due to the technique being embraced by nursing staff and the improved equipment made available, in the most recent 3 months of data all patients were mobilised on day 0. The majority of patient's first postoperative mobilisation is now accompanied by nurses, with only 3.5% in this same 3-month period being mobilised by a physiotherapist in the first instance.

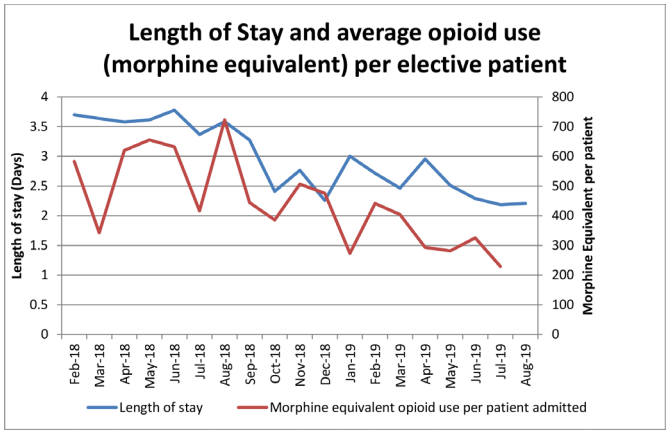

Figure 3 This figure demonstrates the chronological relationship between length of stay and opioid equivalent use per patient

PDSA cycle 3: change in local policy

The policies related to termination of routine MSU collection, mechanical thromboembolic prophylaxis used instead of TED stockings and ring fencing have had a positive impact. They removed the possible time consumption or delay to theatre caused by awaiting microbiology results for an MSU or for a nurse to locate and fit a patient with compression stockings. It also saved money and resources and therefore was rapidly accepted.

As length of stay reduced, it was noted that the ward would often be devoid of patients over the weekend leading to nursing staff reallocation elsewhere. A review of the changes in this cycle emphasised the need for careful list planning across the week and moving to a smaller ward area, which allowed nurses to be utilised within their intended team and the initial larger ward to be allocated to specialities in need of more beds.

These elements have not had their impact on outcomes of length of stay and mobilisation directly monitored but rather have simply been part of a streamlined process which may have contributed to a more efficient postoperative process.

The acknowledgement of synergistic influence of pain management and exercise set out in the original enhanced recovery philosophy with cycles to improve these aspects have improved patient outcomes.

LESSONS AND LIMITATIONS

With the formation of the Rapid Recovery Group, many key multidisciplinary team members came together and had a variety of approaches to the problem. This was crucial to the success of the project for several reasons. Regular monthly meetings allowed for regular reviews of implementations and maintained momentum of the overall progression. The meetings acted as a site for the study and act components of the PDSA cycle.

Furthermore, due to the different roles in the multidisciplinary team present in meetings, the changes could be proposed to improve various aspects of the perioperative patient journey. These changes had a collaborative effect enhancing the overall outcome such as availability of Taurus frames and soft hip precautions increasing both nursing and patient confidence to mobilise early.

This quality improvement project was conducted in a small single centre where a demonstrated outcome can significantly skew the results in the short term. The results can be further skewed by a weakness inherent in the PDSA method where chance can lead to an intervention being incorrectly accepted or rejected. With the optimism bias often seen in quality improvement it may be that some interventions had less of a positive effect than perceived.[12] However, our statistical analysis supports the cycles and their outcomes. The nature of this project being performed in a small single centre unit warrants caution in regard to generalisability. Implementation of a multitude of interventions may occur at a different speed in larger institutions therefore results may be less reproducible.[13]

To avoid a loss of momentum and to quickly bring about an improvement in patient outcomes, many of the interventions were introduced concurrently. This could be criticised as the Rapid Recovery Group operating within the 'Do, Do, Do' culture where an emphasis on 'doing' can limit or even bypass the study phase.[14] By doing multiple interventions, one may have caused some interventions to be retained that did not actually contribute to the improvements seen here. More so, with concurrent interventions, it is difficult to ascertain the proportion, if any, of the improvement is attributable to each individual change. For example, standardised local anaesthesia infiltration protocols were adopted at the same time as nurse lead mobilisation became popularised, with each lacking a distinct PDSA cycle. It is hypothesised that patients could be mobilised because of better analgesia but it may simply be that patients were mobilised earlier because this was now the ward culture. Local anaesthetic infiltration in total hip replacements are not recommended in the more recent ERAS consensus document due to lack of evidence[4]. However, withdrawing them must be considered carefully as it may have unforeseen consequences. With no demonstrated complications from the infiltration protocol and the likely attributed benefits, it has been decided to continue.

With guidelines such as the ERAS consensus it could be argued that what we are observing is simply a 'rising tide' of improvement nationally.[15] However, the benefit of using Model Hospital for benchmarking is that we can see that length of stay locally has improved not only compared with historic data but also compared with other institutions.

CONCLUSION

This quality improvement project has achieved it's desired outcomes by reducing length of stay, increasing throughput and improving early mobilisation.

Between the end of the financial year 2017/2018 and 2018/2019, our trust has moved from being 41st to 8th and 34th to 4th in the country for length of stay for total hip and knee replacements, respectively. Beyond this, the trust has continued to see our length of stay drop further in ongoing data monitoring.

Length of stay improvements have financial implications. When calculated as bed days per 600 patients this equates to a reduction from 2160 to 1440 for hips and 2160 to 1200 for knees. With 600 shared cases between hip and knee replacements, equating to a mean reduction in 840 bed days, one can calculate the resultant savings. The unit cost of an excess bed day was estimated to be £346 in 2017/2018.[16] This represents a projected saving of £290 640 from an improvement in bed days.

There remains scope for improvement in the joint replacement enhanced recovery pathway such as preassessment patient optimisation, education by updated patient information and review of joint school processes.

The PDSA cycles in this quality improvement project are sustainable with data collection and analytics having been robustly established through involvement of key staff members and an external contract. A crucial driver for the success and continuation of the progress demonstrated here is the collaborative multidisciplinary approach to each stage of the PDSA cycle.

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