Final report

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Innovating for Improvement

UCLH Enhanced Recovery APP (ER-APP): Improving Peri-Operative Quality for Elective Surgery using Data on Pathway Compliance and Surgical Outcomes

University College London Hospitals NHS Foundation Trust

The Health Foundation

About the project

Project title: UCLH Enhanced Recovery APP (ER-APP): Improving Peri-operative Quality for Elective Surgery using Data on Pathway Compliance and Surgical Outcomes

Lead organisation: University College London Hospitals NHS Foundation Trust

Project lead(s):

Monty Mythen, Professor of Critical Care and Anaesthesia

Khaled Dawas, Consultant Upper GI Surgeon

Yassar Qureshi, Clinical Research Fellow Upper GI Surgery

Thomas Keen, Clinical Researcher

Kirstie McPherson, Consultant Anaesthetist

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Part 1: Abstract

The ER-App project at UCLH was testing how giving the Oesophago-Gastric (OG) surgery multi-disciplinary team (MDT) better data on peri-operative quality metrics would influence the running of the unit and the outcomes of patients. The project was based around a mobile software platform that automated the analyses of peri-operative data points.

We began tracking the pathway in late October 2016 (following a pan-London merger of OG services earlier in the year). Our dataset comprised peri-operative pathway adherence, patient outcomes and efficiency metrics. Seeing our project in action met with a positive response, from March ’17 onwards we began feeding back data to the MDT.

We also worked through the data with individual specialties to explore areas where the pathway could be working better, for instance setting epidural failure procedures in stone, and reviewing physio rotas. This showed success in raising pathway adherence. For instance, adherence to the physio pathway rose from 67% to 77%. Splitting the data before and after our first feedback session in March, median length of stay fell from 13 to 10 days.

Further important patterns have emerged as the dataset has grown. For example, patients who fail to walk around on day 1 after surgery have a 300% chance of developing a serious complication (here defined as requiring re-operation or threatening life). While this tallies with the literature, it is striking to see these data for one’s own unit. Moreover, a patient who suffered a complication spend a median 21 days in hospital versus 9 days for those who did not**,** closely aligning improvements to patient outcome with reduced costs.

Based on these new insights, plans have been drawn up to pilot some significant changes to the unit, such as setting up pre-operative physiotherapy sessions for patients, with the app as the primary tool for evaluating. If those changes were adopted successfully, that would then be a clear endorsement of our approach to translating better data into patient benefit.

Part 2: Progress and outcomes

Clinical Background

The concept of 'Enhanced Recover After Surgery' was brought to mainstream clinical thought in the 1990s, after Kehlet published his seminal study assessing a multimodal approach on post-operative recovery. He demonstrated that a structured peri-operative pathway focused on quick resumption of drinking, eating and mobilising after surgery led to a reduction in complications and earlier discharge.

University College London Hospital (UCLH) is one of the major specialist oesophago-gastric (OG) units in London. Following the recommendation of London Cancer in 2015, OG services have been centralised across London and the UCLH service now incorporates patients from Barts NHS Trust. The unit comprises seven specialist OG surgeons, making it one of the largest and busiest units nationally.

Background at UCLH: Audit and the App

One benefit of centralisation is the scope high volumes present to raise the standard of peri-operative care, particularly when peri-operative management is complex, as in OG surgery. A top priority following the merger was to establish a structured peri-operative care pathway at UCLH.

A major barrier to launching a new pathway was the poor data on existing practice. While our records provided sufficient information for direct patient care, inconsistencies in documentation and missing notes made retrospective audit difficult and unreliable. As a result, decisions about how to structure a new pathway were made by consensus and clinical judgement rather than past data. Going forward, we were resolved to take a much more concerted approach to audit, and to really advance the ways that routine audit data can be used to propel care improvement.

Concurrently, work was ongoing at the time to pilot a mobile audit platform for Enhanced Recovery at UCLH. This project showed promise to enable prospective collection of audit data while also enfranchising patients in their recovery. Since care pathways tend to comprise a number of discrete elements, they lend themselves well to digital collection as data input is quick and data can be automatically analysed and fed directly back into patient care. The app seemed like a great fit for our audit requirement, and the OG unit became the principal pilot service for the Enhanced Recovery app at UCLH.

Preliminary steps to the work described below were pathway formation and then creation of a digital pathway on the Enhanced Recovery app. The pathway resulted from a series of meetings among the OG multi-disciplinary team, which spans surgeons, intensivists, anaesthetists, physiotherapists, nutritionists and nurses, calibrating the specific characteristics of the unit alongside best practice described in the literature. Then, once the clinical formulation of the pathway was agreed on, we set to building this into the Enhanced Recovery app. This involved crafting a user experience that would ultimately allow data collection to be distributed throughout the

team, while also defining the initial data dashboards that would be useful to establish the pathway into routine care.
The app was accessible over the internet, either through smart tablets or desktop computers. Over the course of the project, data on pathway adherence was completed prospectively by Yassar Qureshi in his role as project lead.

Project Aims

Our primary objective in investing the service's focus on the Enhanced Recovery app was to evaluate whether it constituted a beneficial and sustainable means of improving peri-operative care. Key dimensions of our analysis were:

- to prospectively capture data on peri-operative care to generate an accurate data set on existing practice, covering pathway compliance, patient outcome and economic measures such as length of HDU and hospital stay;
- to develop an understanding of how data collection and data review could be worked into clinical routine, with a view to cementing the Enhanced Recovery app into the long-term workings of the unit;
- to interrogate the peri-operative data set to uncover opportunities for quality improvement and to better stratify patients, with a view to proving the data set can translate into continuous improvement;
- to provide frequent feedback to the multi-disciplinary team on adherence to the structured care pathway, with a view to identifying and then tracking areas where we needed to improve; and
- to develop a specific patient-led application for OG surgery that can act as a motivation tool aiding patients in their recovery, while also recording how patients view their recovery process and clinical care in real-time.

We have recruited our intended target of patients into this study (*n*=58), in order to perform meaningful analyses and to assess our key objectives. However, the patient centred application is still in progress. Prior to establishing this digitally, we performed a survey of our post-operative patients to obtain their views regarding their diagnostic pathway and recovery process, and to seek their opinion on using technology as part of their recovery. Thus far, we have not achieved our intended target of responses, but will continue this project, as it forms a unique aspect of this recovery pathway.

Results - Capturing Data

Figure 1 shows the layout of the care pathway on the app. Each page represents a particular post-operative day or interaction, and lists the relevant milestones and targets for that day. Once the data has been entered, it is automatically stored and analysed to reflect the performance of the pathway. Since these data are hosted on a web-based system, analysis of the team's performance is immediately available to other members of the team. This facility to capture, store and analyse data in one streamlined unit is the unique feature of this technology that opens up new possibilities in how our unit approaches audit.

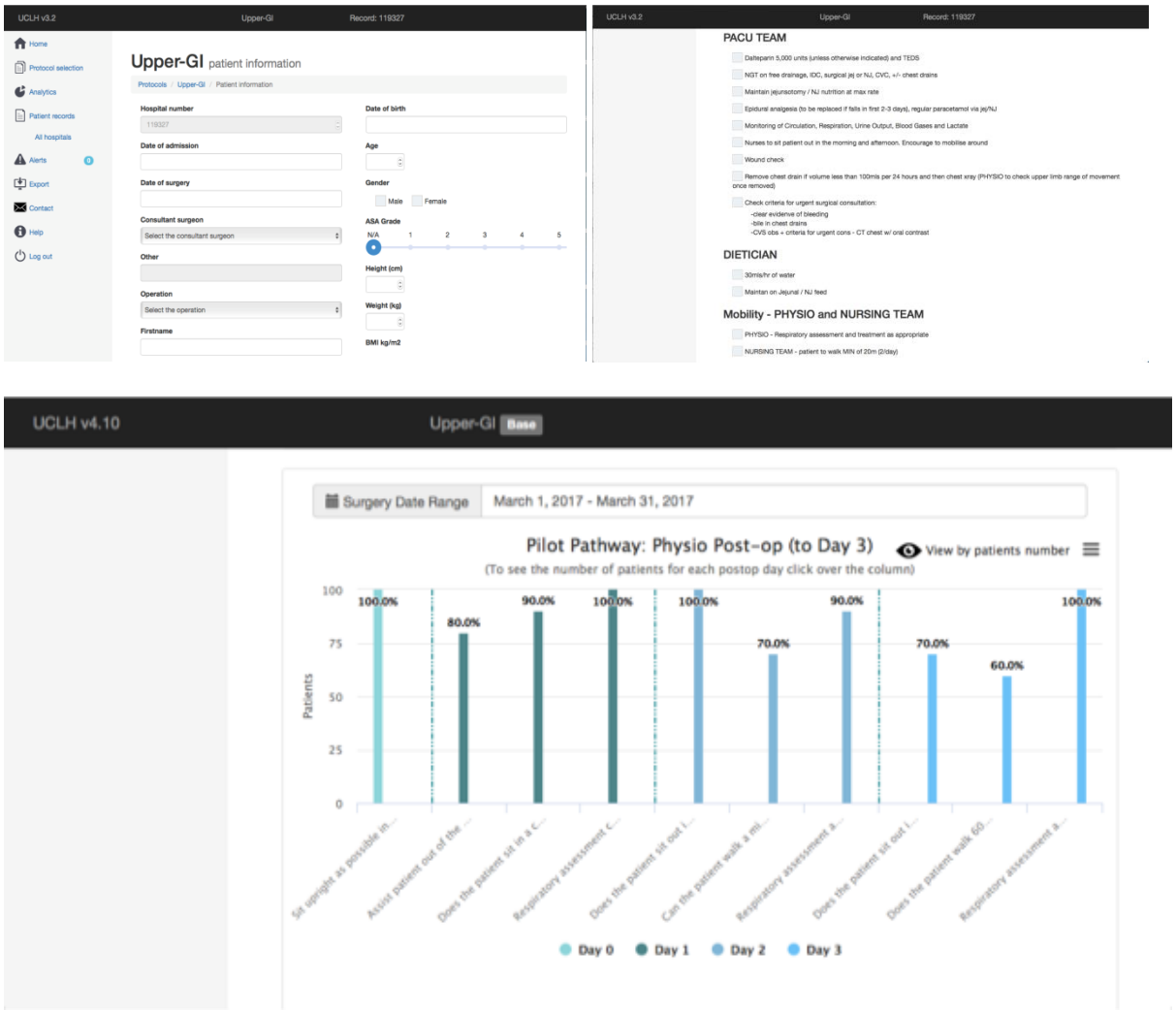

Figure 1: The digital Oesophago-Gastric Care pathway at UCLH showing key milestones and objectives to be completed, and an example of the instantaneous analytics function

Table 1 highlights overall figures for our major pathway milestones over the study period. Prior to this project, similar data would have been painstaking to put together and unreliable. This data will serve as a valuable benchmark for future comparison, to judge whether efforts at continuous improvement are succeeding.

Table 1: Milestones for patients (*n*-58) during the study period

	Overall	Oesophagectomy	Gastrectomy
n	58	18	40
HDU Stay (days; median and range)	3 (0-30)	6.5 (4-30)	3 (0-18)
NG Removal (days; median and range)	5 (0-28)	6.5 (0-28)	4 (0-18)
Final Drain Removal (days; median and range)	6.5 (0-26)	8 (4-26)	6 (0-64)
Independently Mobile (days; median and range)	7 (1-38)	8 (5-38)	7 (1-24)
Hospital Discharge (days; median and range)	11 (5-71)	13 (8-71)	10 (2-65)
Complications (*n*)	31 (53.4%)	11 (61%)	20 (50%)

Feedback Process

Multi-disciplinary engagement has been vital to the project. The OG pathway is a lattice of specialist interventions, and success depends on bringing the different disciplines into alignment. A major aim of our feedback approach was to provide clear data on how the work of each speciality fits into the performance of the pathway as a whole.

We began this process at the mid-point of our project in March 2017, by organising a formal presentation of our initial data to the whole team. This was the first time they saw data on the new pathway, and the intention was to reiterate which data points we were collecting, and to cement buy-in that the pathway represented our departmental standard of care. We timed our first feedback in March so that we had sufficient numbers for the data to be viewed as credible.

A month after that initial presentation, we crafted individualised reports on each team's practice and outcomes, highlighting where improvements could be made. This began our interaction with individual teams, focused in collectively understanding the data. To take an example, we had noticed compliance for physiotherapy inexplicably drop for patients over a specific two week-period. Several team members were on leave, and the covering staff were too stretched. In this way, the first round of feedback to individual teams shed light on a few simple improvements that could be made straightaway.

We also used this as a chance to survey each team on how they felt about the project, how they would feel using the app in day-to-day practise, and whether they would be interested in using the data for their own projects. The responses were very positive. For example, Miss Krupa Patel, our senior OG Cancer Nutritionist, felt that:

> *"…the digital pathway is great because it allows us to study the nutritional requirements of our patients as a group, which should be a great help in*

working out where we can improve."

Similarly, Dr Jamie Smart, senior OG anaesthetist, said:

> *"We seldom see our patients after the operation, so this allows me to monitor how patients are doing afterwards, and study why some fare better than others. I can use the app to see which of my patients have a good or bad epidural, and if the latter, can make some time to replace it, and hopefully avoid their suffering from a complication."*

Response to this individual team feedback (as opposed to waiting for a complete MDT meeting) was overwhelmingly positive, and indeed we had significant interest in opening up the tool for individual teams to use themselves. This represented a small technological/governance hurdle from our starting point of the feedback process being owned by the project team. So for the further feedback round, the project team checked back in directly with the individual teams; but now, in August, we are almost set to give them direct access to the platform.

Table 2 shows data on our key metrics from before and after our feedback to the MDT in March 2017. The metrics show some improvement, especially for length of hospital stay, as does Figure 2, which demonstrates the total number of complications per month. In the sections below, we analyse this data to give a sense of how it reflects the running of the unit. Although several causes are possible for the improvement since March, the awareness this project has already generated has improved clinical practise. Below we also delineate some of the further insights from our most recent analysis of the data, we hope they play a role in further embedding the app in clinical practice, and in catalysing new projects.

Table 2: Milstones pre- and post-feedback (our main feedback session was held in March 2017, where our intial data, results and analysis was presented to the multi-disciplinary team).

	Pre-Feedback	Post-Feedback
n	34	24
HDU Stay (days; median)	3	3
NG Removal (days; median)	4.5	5
Final Drain Removal (days; median)	7	6
Independently Mobile (days; median)	7	7.5
Hospital Discharge (days; median)	13	10
Complications (*n*)	19 (56%)	12 (50%)

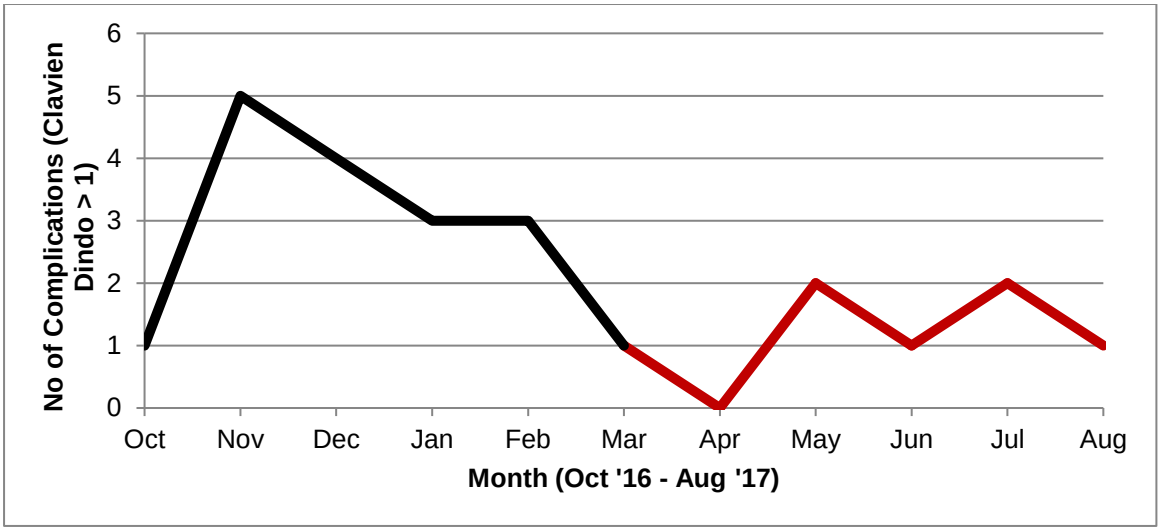

Figure 2: Complication rates (total number) over the course of the project. Our main feedback session with interval review of results was in March 2017.

Results – Data Interrogation for Quality Improvement

Digging deeper into our Enhanced Recovery dataset, we have been able to identify several potential targets for quality improvement. We have also set up the requisite analytics on our software platform, so these metrics can be tracked going forward.

This deeper understanding of our patients' recovery has mainly revolved around assessing correlations between patient outcomes and upstream pathway compliance and patient demographics. With patients suffering a complication spending a median 21 days in hospital, versus 9 days for those without, surgical complications are the natural target not only to improve life for patients, but also to reduce costs.

Acting on these insights may simply be by being more vigilant with certain patient groups, or being aware of risks on specific days, but equally it may require more substantial changes, such as changes to the way we pre-operatively assess and optimise patients prior to surgery. **Table 3** highlights the actions prompted by data from the app.

Table 3: Key findings with potential quality improvement initiatives that will be introduced based on the data and analysis we have performed thus far.

Key Finding	Quality Improvement Intervention
Good pain control reduces risk of respiratory complications	-Consider use of intercostal blocks -Utilise epidural replacement pathway if indicated -Consider use of pre-operative Gabapentin
Early mobilisation reduces risk of significant complications	-Focused care to mobilise patients, increase resource allocation -Pre-operative individualised exercise regimes to optimise musculo-skeletal function
Fall in compliance related to mobilising from day 5 onwards	-Assessment of causative factors; increase resources on these particular days
Raised BMI associated with more significant complications	-Pre-operative nutritional review with tailored diet -Focus on early mobilisation -More vigilant monitoring of patients with BMI>30
ASA 3 compared to ASA 2 associated with higher complication rates	-Improved optimisation for these patients -More vigilant monitoring post-operative (*eg*. HDU outreach reviews daily once on ward

Figure 3 show the sort of analysis the app has opened up to us. These two charts show how the type and severity of post-operations differed between patients with pain scores < 5 and pain scores > 5. This simple segmentation makes it very clear that those with higher pain scores had a much higher complication rate, while those with lower pain scores typically had a Grade 0 recovery according to the Clavien-Dindo classification (which means their recovery in no way differed from the proposed pathway. See Appendix 1.) Equally it is challenging to see that Grade 4 complications (defined as life-threatening) were exclusively for patients with higher pain scores. The aetiology of this correlation could be manifold. Pain can prevent patients from breathing adequately after operations, which has been linked to respiratory infection. Equally, patients with high pain levels will struggle to mobilise after surgery, which as we explore below is another predictor of complication. But equally, post-operative pain may simply correlate with a more lengthy operation, or a more aggressive pathway. What this data shows us unequivocally is that high post-operative pain scores should not be treated as an inert marker: if a patient has high pain scores, this should be treated as a red flag.

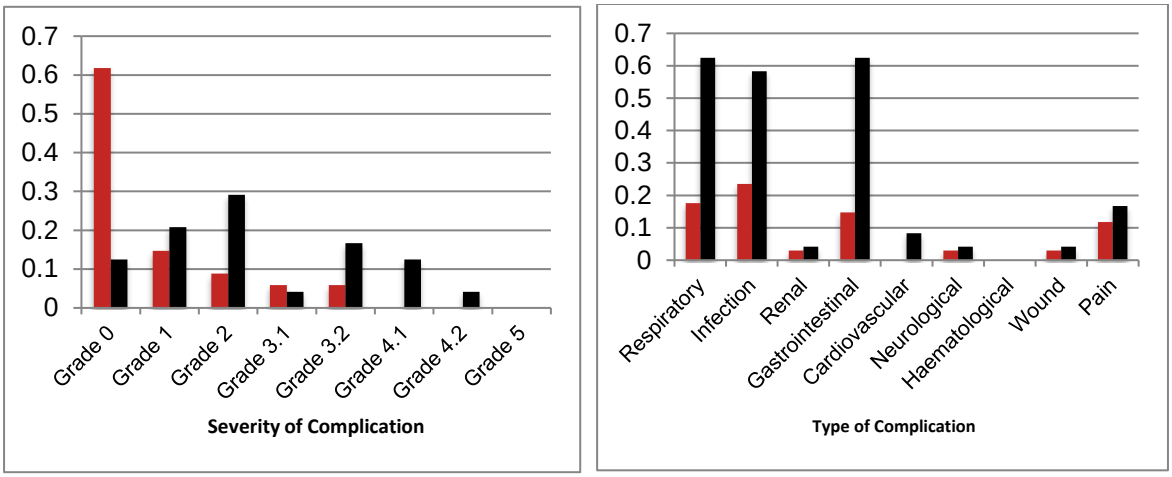

Figure 3: Correlation of post-operative pain scores and complications by Clavien-Dindo classification and organ system. Pain score <5; Pain score >5.

This data also raises the question of changing the analgesic pathway for certain patients. For instance, there is a growing evidence-base that intercostal blocks are as effective as epidurals, with a lower risk of complications. These have not been trialled in the pathway to date, but as we present this data next month this data will motivate carefully considering whether such a trial is worthwhile.

Closely related to analgesic regimen, Figure 4 demonstrates an increase in complications (especially chest infections) in patients not achieving early mobilisation targets. This tallies with our expectations: failure to mobilise promotes mucous retention and subsequent pneumonia, leading to downstream effects on a patient's recovery: longer in HDU, delayed removal of drains, longer to attain independent mobility and longer in hospital.

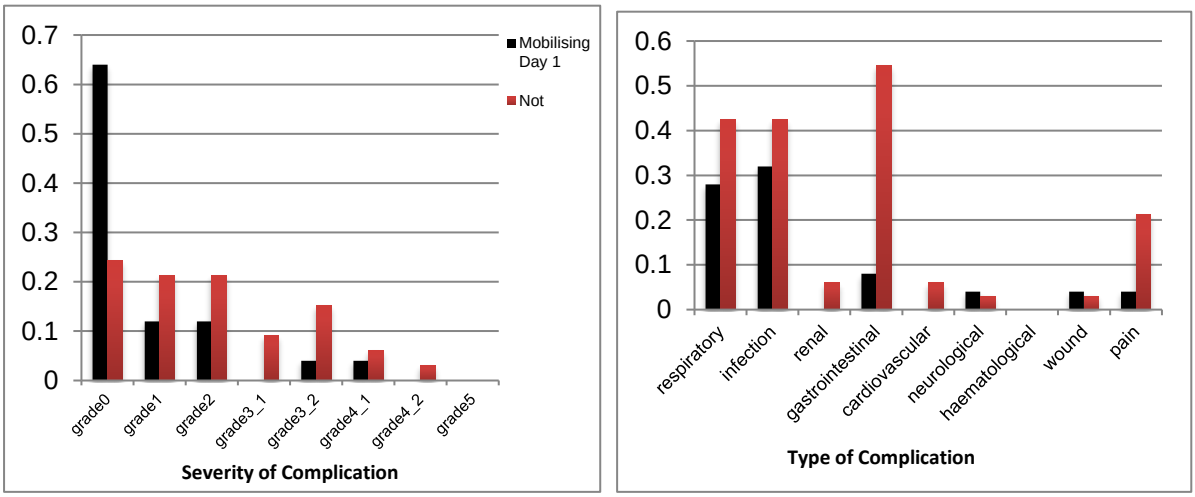

Figure 4: Complications correlated with early mobilisation targets.

Figures 5 and 6 demonstrate the compliance with the physiotherapy pathway between October and March. The data clearly show that compliance with the targets around getting patients to walk on days 2 to 4 are proving hard to meet. Part of this challenge was able to resolved after our first feedback session (as covered in the

section below), but even then only 50% are walking 60m on day 4. **Figure 4** above clearly shows us that patients not walking around are far more susceptible to complications.

The natural question of how we can get more patients up and mobile after surgery is a challenging one. The analgesic pathway has already been calibrated to allow for early mobilisation, HDU is bought into the idea that obstructing lines may have to be moved to allow patients to walk around, and physiotherapists are consistently seeing patients. While we are sure that all of these areas can be optimised, it may be that a quite different approach is necessary.

One area we feel may show promise is targeting the pre-existing patient factors that delay moblisation, such as prior reduced mobility. Our physiotherapy lead has begun constructing a proposed framework for introducing pre-operative mobility assessments and individualised exercise regimes. The aim would be to optimise musculo-skeletal function as much as possible before surgery, as well as to reinforce the idea that quick mobilisation after surgery will lead to a far better outcome.

We have introduced our physio lead to Mr Moorthy at St. Mary's Hospital, who received a research grant from The Health Foundation to set up just such a service, helping patients to prepare for surgery. We are hoping that the combination of incise data on our own practice and a clear first steps informed by the work at St. Mary's will help us get this change, which we see could have major patient benefit, off the ground.

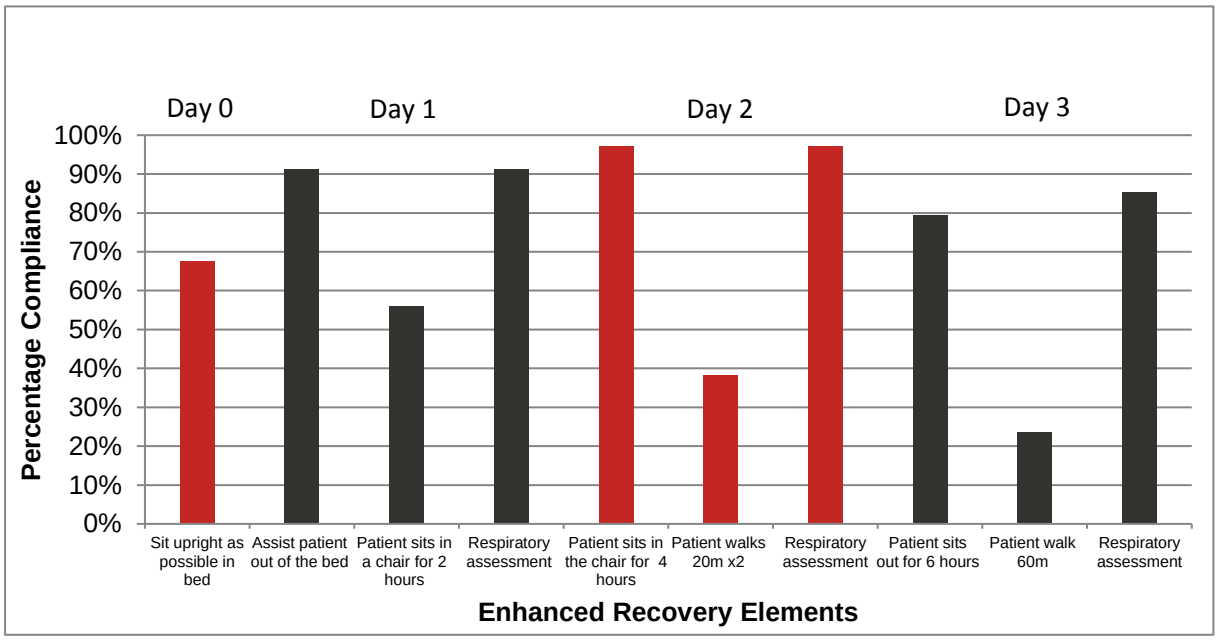

Figure 5: Physiotherapy task compliance days 0-3

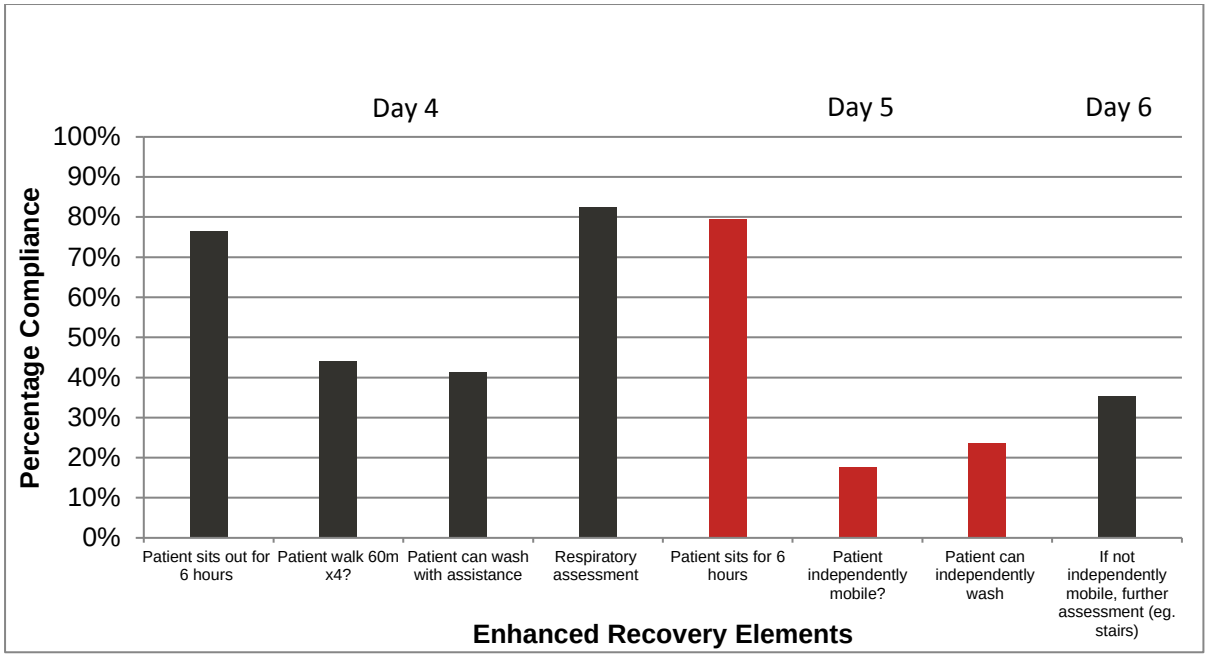

Figure 6: Physiotherapy task compliance days 4-6.

Figure 7 reveals interesting patterns in patients with a BMI greater than 30: they have a much higher gastrointestinal complication rate than those with a normal BMI. While we would have expected a higher complication rate in obese patients due to pre-existing co-morbidities, it is a surprise (and not immediately explicable) to see that they comprise such a high proportion of gastro-intestinal complications. On reviewing these findings, the nutrition team are now investigating the possibility of dietary manipulation pre-operatively, to optimise metabolic state and weight control. Such individualised protocols would be quite innovative in OG cancer surgery.

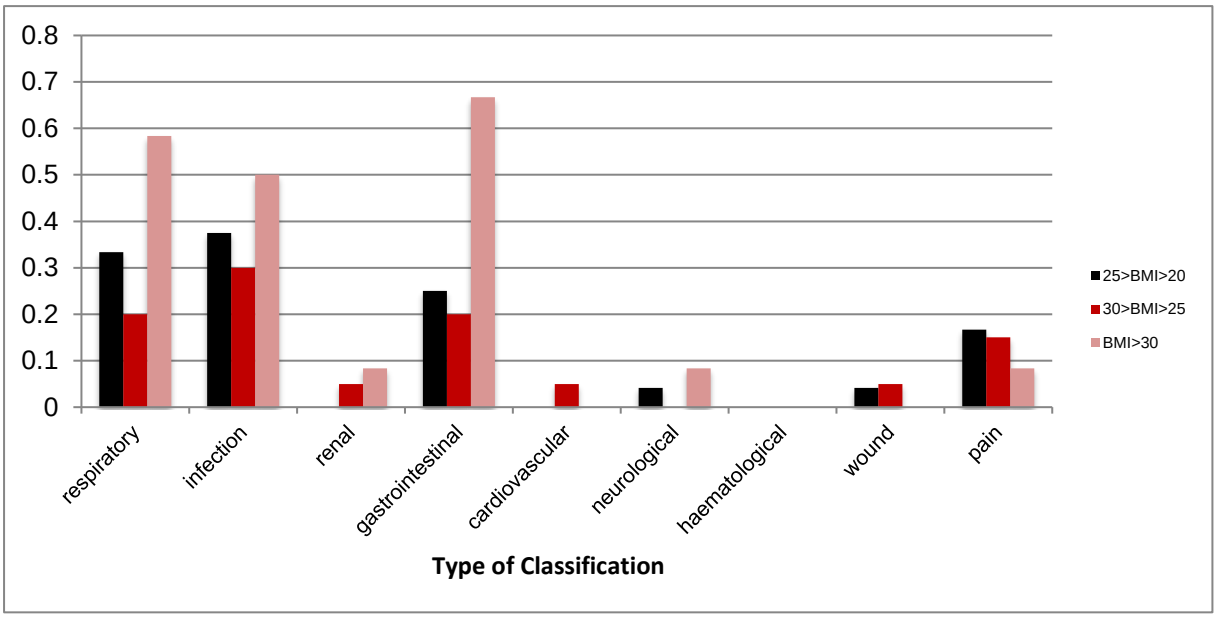

Figure 7: Organ system complications correlated with BMI.

Results – Feedback to the MDT

To date, the final results above have only been discussed informally, but since some of the conclusions are far-reaching we will present these data to the team as a whole. Nonetheless, we have been feeding back data on compliance and pathway milestones for some time, and there are some signs that this has influenced practice. For instance, among the physiotherapists, who were perhaps the most engaged group in the project, compliance went from 66% to 76%, as in the graph below (Figure 8). Our understanding of the mechanism here was that our initial feedback highlighted certain cycles of the rota where patients where consistently being missed, a problem which has now been resolved.

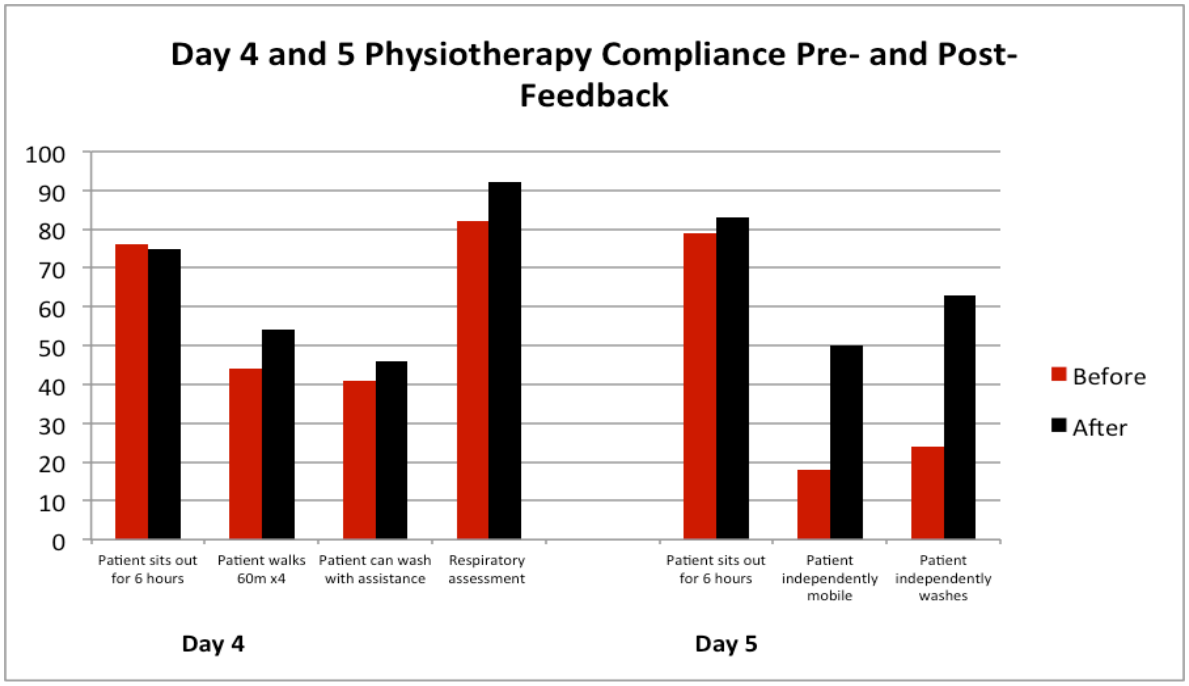

Figure 8: Compliance against the physiotherapy protocol on days 4-5, before and after feedback in March.

Figure 9 demonstrates the compliance of patients against our anaesthetic protocol. Notable here is that, alongside an improvement in compliance, several of the elements of the pathway have not been implemented at all, such as administration of gabapentin. These elements, although discussed when drawing up the pathway, do not form a consistent part of practice, and were removed from the pathway after our first round of feedback in March.

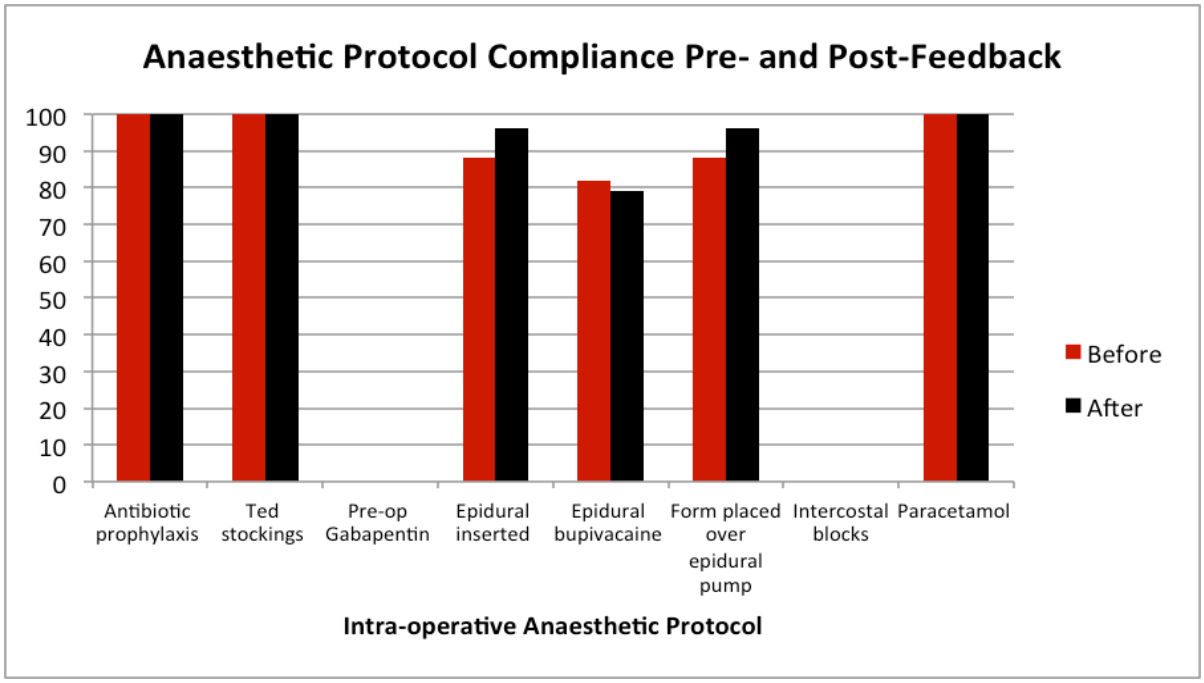

Figure 9: Compliance against the intra-operative anaesthetic protocol, before and after feedback in March.

However, we felt that this was significant, as, for the remaining elements, these have now been acknowledged as the expected standard of care to be carried out across the department. Equally, if new therapies are trialled, such as intercostal blocks, these changes will be made from a starting point of departmental consistency, which we feel is important: rather than a completely heterogeneous set of care regimens, this is the beginning of developing a unit-wide standard.

Another interesting point emerging from the anaesthetic data was around epidurals. 88% of patients have an epidural inserted (see Figure 3), and an effective, functioning epidural is pivotal to early mobilisation. Epidurals can also negate the requirement for opiates, which can cause drowsiness and have negative effects on gut motility. However, further data from the app showed that, of the five patients whose epidural failed, only one patient had it replaced. This was despite there being a replacement pathway in place. Our data here provided ground to ensure that the surgical, anaesthetic and HDU teams were all aware of this pathway, and would use it if required.

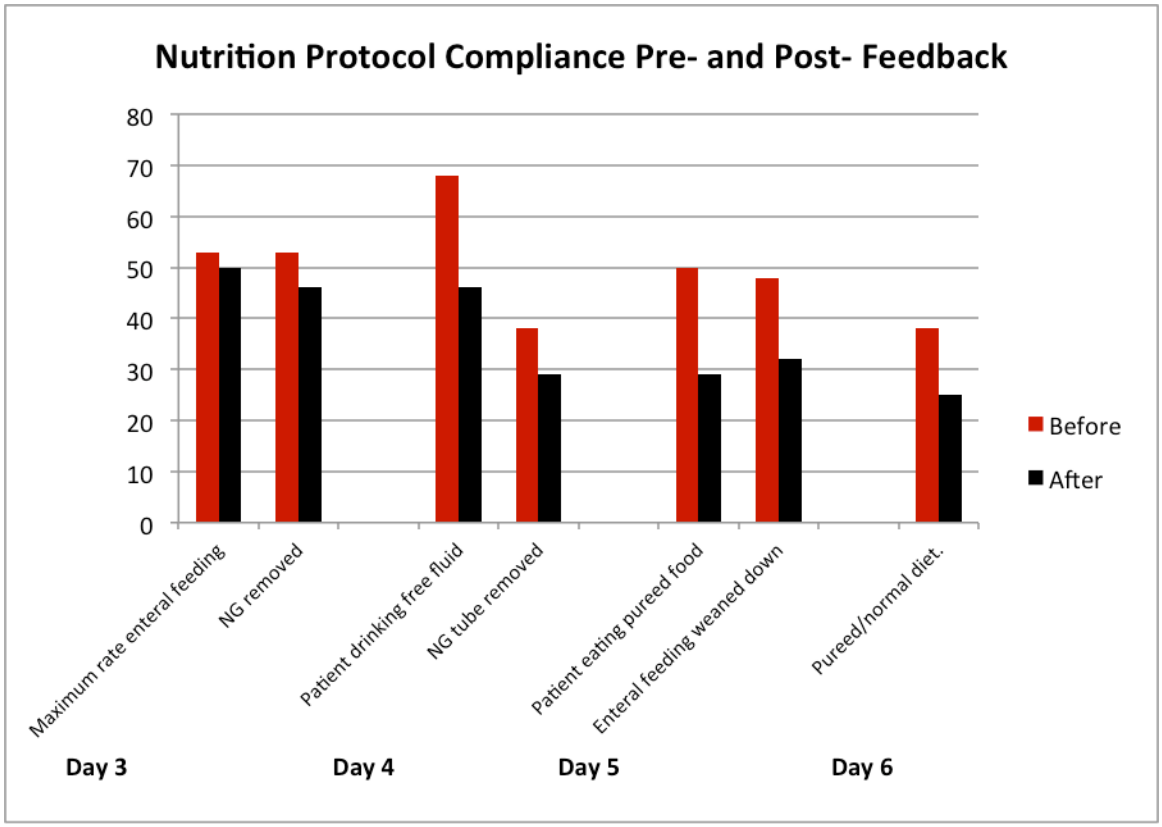

Figure 10: Compliance against the post-operative nutrition protocol, before and after feedback in March.

The nutrition component of the pathway was where we made least headway throughout the course of the project, with pathway compliance falling in several important areas (Figure 10). Just after our initial feedback of the data, the lead nutritionist left on a sabbatical, which may account for the change, but this highlighted for us the importance of enlisting support for the project among junior members of the team, as much as the departmental leads.

Nutrition is also an area where substantial variation in practice between surgeons, as highlighted by the low overall nutrition compliance rates. Some surgeons encourage oral intake quicker than others. Going forward, here too we are keen to move towards consensus across the department, but differences here are somewhat deep set, so have been hard to change quickly. One avenue that that we are beginning to pursue is simply to record which approach patients are being treated according to (early vs. late oral intake) to see if this seems to have an impact on outcomes.

Part 3: Cost impact

- Our initial results show a substantial drop in length of stay following feedback of data on pathway adherence. With a £500/day proxy cost on a ward bed, a 3 day reduction in length of stay represents a substantial saving, particularly as the per patient costs of the software are negligible and we anticipate data collection to form part of routine audit practice (and so require no additional resourcing.)

- However, at this stage it would be premature to attribute this saving to the Enhanced Recovery app alone (given the noise in length of stay as a signal.) Our aspiration as we work towards the 100 patient mark is to demonstrate continuous improvement through time-series analysis, and also to provide qualitative evidence of how data from the app has spurred major change in the unit (such as a pre-operative physiotherapy programme for patients.)

- After all, data can only ever provoke and guide improvement. Making these improvements will often carry it's own cost-benefit balance. What we hope to demonstrate is the app's role in developing a culture of continuous improvement. If we can do that, it will more than justify the comparatively small costs of using the software.

Part 4: Learning from your project

Overview

At the core our project is an exploration of how data could be better used in peri-operative quality improvement. The innovative angle we took was to use a mobile software platform that sped up data collection and then automated its analysis for rapid feedback to the MDT.

As detailed above, we had success implementing the software platform at UCLH. At the end of this first year, we can look back at nine months' worth of data, far exceeding the detail and accuracy of any we had before. More than this, we feel that this data has begun to prove value to our OG unit well beyond the cost of its collection: first through improved compliance, and second through a deeper understanding of our patients' pathways.

Taking compliance first (as detailed in the section above) there is a signal that feedback of data from the app has had a positive impact on clinical practice, particularly within the subsections of the MDT more strongly engaged in the project (such as the physiotherapists). We can see a clear uptick in compliance with our pathway following feedback, and there is also an indication that length of stay has been reduced as a result of our digital quality improvement approach.

Reflecting on how this bears on our initial question around data and quality improvement, these pockets of increased compliance alone have left us confident that timely, credible data has the potential to improve practice, particularly in areas that are straightforward to remedy, such as lagging compliance due to minor resourcing issues. However, as can be seen from the analysis in the previous section, the work we have done to date gestures towards further improvements that will likely require more radical changes to the unit's working. The question of whether data can bring us over the activation energy necessary to making these changes remains unanswered.

Based on early conversations, we have drawn up plans to pilot several of our recommended improvements. These will be presented at our next full departmental meeting, which is to focus on risk factors for major complications (based around data from the project). Uptake of these recommendations would show that our digital quality improvement approach has the potential to motivate major changes in practice, based on the locally relevant data on an OG unit's care. Our intention is to report on the departmental response to our plans at the presentation day in October.

What is more, we feel that the outcome of our work here could have implications more broadly in surgical quality improvement. With the movement towards digitization of acute care finally looking primed to take off, the moment when surgical services have much better data on the care they provide is foreseeable. Nevertheless, practical steps to put this data to work are scant. Both through the lessons learnt exploring how real-time Enhanced Recovery data can be most effective, and through the value the tool itself can offer in the hospital IT ecosystem, our work has the potential to play a role in translating burgeoning digitisation into better care.

Lessons for the OG Community

Some key lessons stand out as particularly relevant as we try to spread our approach among OG units (and they may also have applicability to others running audit projects in related disciplines).

One powerful driving force in our project was that, where the app dataset helped groups of the MDT pursue their own audit interests, they immediately became engaged supporters of our project. While at times this meant expanding our collected dataset (which, broadly speaking, we tried to resist), the dividends in support and interest were vital. For instance, part of our success engaging the physio team was that the app offered an easy way to collect the audit data they wanted, and to get that data in front of the whole team. In a world, where data can often seem like a threat, finding questions that independently interested the different specialties was a great way to give them some ownership over the project.

Another way we have discovered to draw momentum into the project is from requirements for data adjacent to the running of the service. Two examples of this are: the NOGCA (the National OG Cancer Audit) registry and clinical revalidation. The Enhanced Recovery app looks able to cut the audit-based graft to get these things done, which, as you might imagine, is popular.

Another strong message from the project was the value of local data. We were surprised by was the extent to which, in certain areas, our data diverged from received wisdom gleaned from the literature. We expect the level of insight (and surprise) in what we found to awaken the curiosity of other units to dig into their own local data. This is particularly promising given we have now developed all the analytics functions into the Enhanced Recovery app, making it a ‘plug and play’ tool for other units. In light of the large amount of time dedicated to reaching this point (in collaboration between the technical and clinical leads on the team), this represents a valuable asset to present to new units.

A Technical Aside

One area where we experienced some challenges was in coordinating the technological development schedule with the clinical requirements of the project. There were times when unavoidable delays on technical work slowed down the process of feeding back data.

As much as possible, we recommend making sure all structures are in place to work an agile-like development methodology, with the technology team delivering incremental changes on a week-by-week basis. Larger deliveries and delays tend to stem the feeling of rapid alterability of the platform, which can take a little bit of pace out of the design process.

Lessons for Other Innovators

Many of the pieces of advice we got on starting the project were beguilingly simple. But many of them had quite specific effects on our project, which may be of some use in helping others see why they are so crucial.

Having the support of proven innovators helped because in difficult moments, like changes in the team or tightening timelines, they had the perspective to see what needed to be done.

The support of leadership within our organisation was vital. The reality of work at an NHS acute trust is that everyone is stretched before you start: you are making changes to a moving vehicle! To do this without the help of those that set the agenda (at the wheel to extend the metaphor) would be impossible. Time and time again, when we needed to get things done, we had to return to the service lead for support.

Following on from this, the advice to constantly communicate equally bore out as crucial. The more we spoke about the project, the more it felt things were gathering pace. I think this has something to do with momentum; the more pervasive the awareness of your innovation, more rapidly new opportunities appear. The big breaks we had in the project came in sharing what we had been working on with a broad network of people in the hospital.

We also benefited hugely from the input of Louise, our Health Foundation advisor. She helped us across the spectrum: from making sure we had an achievable plan for our 12 month project, to raising our gaze to what would happen after the 12 months concluded.

Part 5: Sustainability and spread

Sustaining our Innovation

At the outset of the project, we identified the main factors that would determine the sustainability of the project. These were: finding resource to carry out data collection, capturing departmental interest in the project, covering the cost of licensing the app and demonstrating patient benefit.

Taking these factors in turn, above we have outlined our approach to data collection. In short, we now have support to have the surgical house officers fill in the data for the next year. This will fulfil our departmental duty to audit our care, while also providing a good source of data for publications and automating our submissions to the NOGCA registry. However, our plan is for surgical responsibility only to from an intermediary step, proving the ease of distributing data collection throughout the team. In the long term, we envisage that individual specialties will own data collection for their own specialty.

Of course, simply having support to collect data will not suffice to maintain momentum. That is why our efforts to get teams to look into their own data, and get interested by what it shows are so important. By getting this data in front of as many of the MDT as possible, we hope to develop a cultural understanding that this information is a prerequisite for the unit's continuous improvement.

With respect to licensing fees for the software, since the tool was initially piloted at UCLH, the app team are currently in the process of fundraising for the expansion of the pilot to more pathways and more centres. Part of the raise is hoped to come from within the UCLH charitable network, with the intention that this would cover software-licensing fees for UCLH in lieu.

Finally, with respect to demonstrating patient benefit, we hope that on collection of data across a population of 100 patients to be able to demonstrate a significant patient benefit based on time series analysis (see section on publication below.) In addition, we hope for the data to motivate taking first steps towards a new pre-optimisation programme for our patients, which would add qualitative support to our approach.

Spread – at UCLH & Beyond

In parallel to the work in OG at UCLH, a number of new specialties are starting to track data using the Enhanced Recovery app. In particular, we have now extended our work out from GI services to urology, which is a major specialty at UCLH. We are also beginning to track data in head and neck cancer services. We are hoping the lessons learnt in how to capture the interest of different groups in the OG MDT, will

have some transferability to these other specialties.

By the end of the year, we plan to have reached an agreement with senior leadership in the hospital to expand the app's use across all Enhanced Recovery specialties.

Then, beyond the walls of UCLH, several hospitals have now begun to use the app for auditing their colorectal Enhanced Recovery practice. The Whittington have now tracked over 150 patients on the system, and two further trusts in our rotation are running pilots of the system. We also plan to start pilots of the system in three London tertiary referral hospitals before the close of the year.

With respect to OG surgery in particular, we have been reaching out via departmental contacts to Southampton, who we feel might be a good second pilot centre. Our vision is to start building a quality improvement network for OG cancer (with a view to eventually benchmarking results between centres.) One facet of this will be to encapsulate our experience from our first 12 months into a 'starter-kit' for new centres.

Publication and Presentation

To date, we have included 58 patients in this study, and have already submitted a manuscript to the *British Medical Journal* discussing development of streamlined care pathways for OG surgery patients. By April 2018, we will reach 100 patients, which should place us well for a prominent publication on the results of the project, especially as no major study has been published on using digital technology to track OG care pathways. This on-going work will also form part of the surgical lead's thesis for MD.

In July, we had the opportunity to deliver a short lecture at the Digital Healthcare Congress hosted by The King's Fund. This was a great experience in meeting other innovators, and we received some very positive feedback. The congress also surfaced potential collaborators from Guy's and St Thomas's and the North Middlesex Hospitals, which was exciting.

Appendix 1: Resources and appendices

1. Suggested Reading

1. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth* 1997; **78:** 606-17.
2. Kehlet H, Wilmore DW. Evidence-based surgical care and the evolution of fast-track surgery. *Ann Surg* 2008; **248:**189-198.
3. Kuo EY, Chang Y, Wright CD. Impact of hospital volume on clinical and economic outcomes for esophagectomy. *Ann Thorac Surg* 2001; **72:** 1118-1124.
4. Low DE, Kunz S, Schembre D, *et al*. Esophagectomy-It's not just about mortality anymore: Standardized Perioperative Clinical Pathways Improve Outcomes in patients with Esophageal Cancer. *J Gastrointest Surg* 2007; **11:**1395-1402.
5. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004; **240(2):**205–13.

2. Clavien-Dindo Classification Of Complications

0	Standard Recovery
1	Any deviation from standard recovery *without* the need for pharmacological intervention
2	Any deviation from standard recovery *with* the need for pharmacological intervention
3a	Complication requiring Surgical, radiological or endoscopic treatment (LA)
3b	Complication requiring Surgical, radiological or endoscopic treatment (GA)
4a	Life-threatening complication (single organ dysfunction)
4b	Life-threatening complication (multiple organ dysfunction)
5	Death

3. Supplementary Data

Presented below are additional data that was collected and analysed, which will enable us to dissect our practise, assess our performance, and instigate change where indicated. This data is very interesting from a clinical perspective, and will enable us to study specific cohorts of patients in more detail than was previously possible. Using this data, we anticipate that over time, several further projects and audits can be developed to further study our patients.

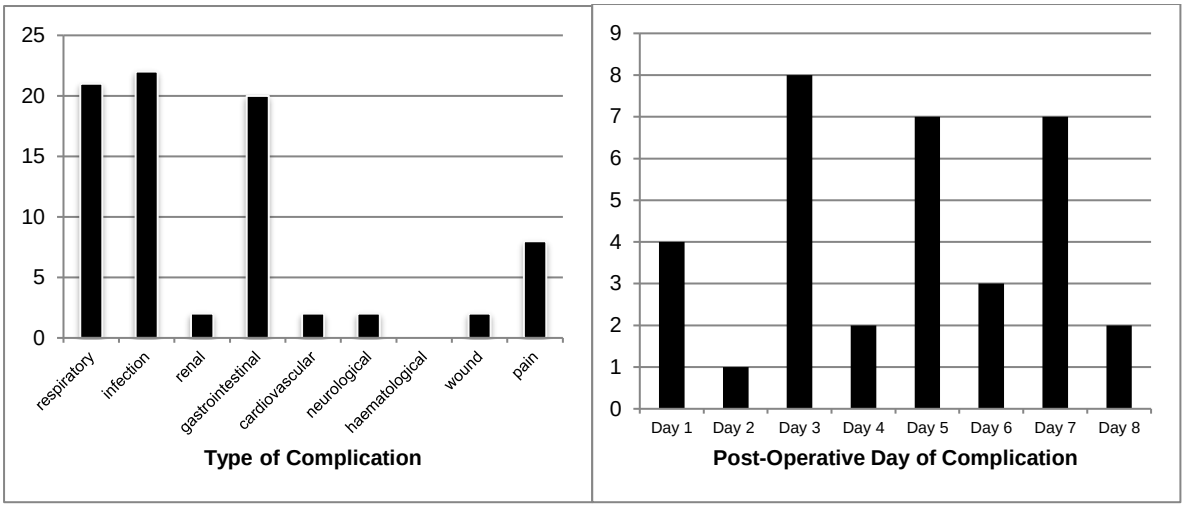

Figure 11: Complications according to organ system and by post-operative day

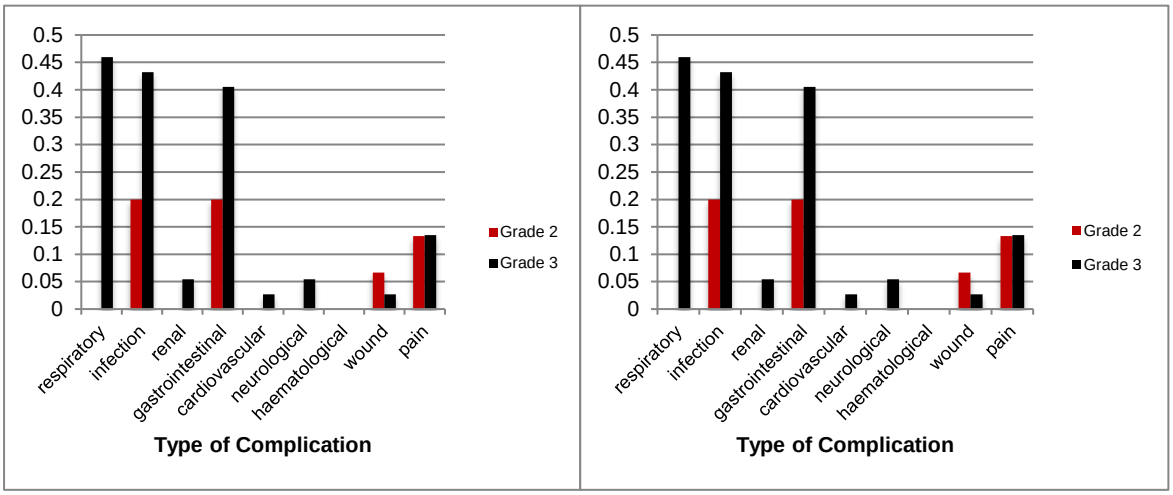

Figure 12: Complications (organ system and Clavien-Dindo) correlated with pre-operative ASA score.

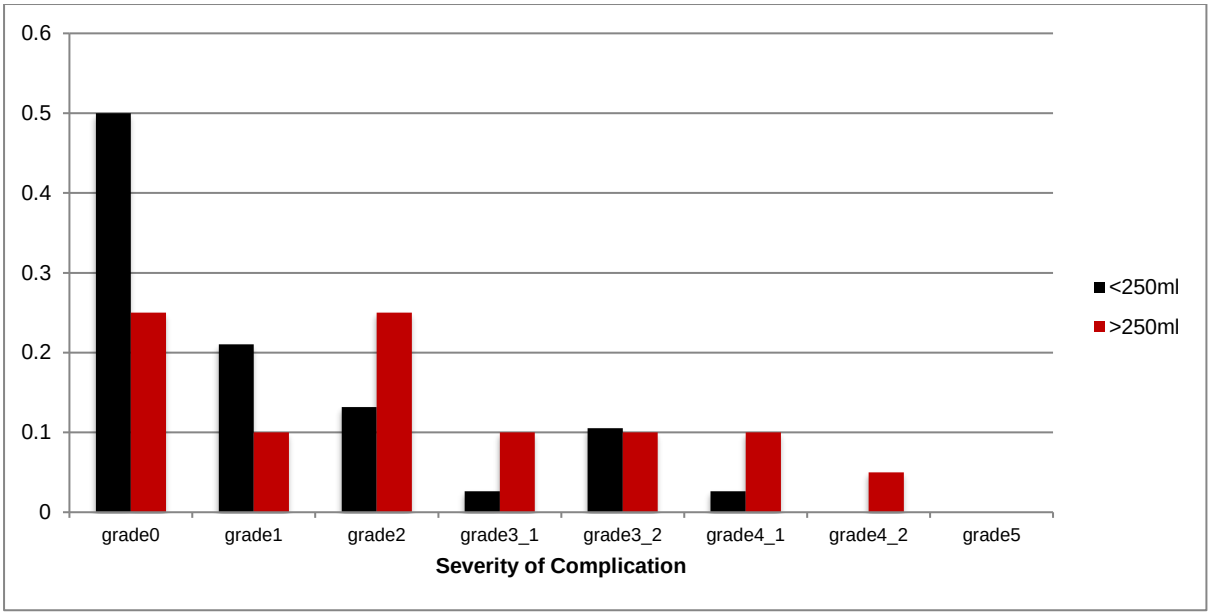

Figure 13: Intra-operative blood loss correlated with Clavien-Dindo classification. Patients with lower rates of blood loss are more likely to have a standard recovery (Grade 0), with increasing blood loss associated with increasing severity of complication.

4. Link to King's Fund Presentation (July 2017, London, *Mobile-Enabled Quality Improvement in Upper GI Surgery*

https://www.kingsfund.org.uk/sites/default/files/media/W2C_Y%20Qureshi.pdf