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ASSIGNMENT TITLE: DEVELOPMENT OF A PREOPERATIVE CARDIOPULMONARY
EXERCISE TESTING (CPET) SERVICE FOR ELECTIVE MAJOR
ABDOMINAL SURGERY AT THE PRINCESS OF WALES
HOSPITAL,BRIDGEND

MODULE NUMBER: BMPF7058

INSTITUTION: UNIVERSITY OF WALES TRINITY SAINT DAVID

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PROPOSAL

Cardiopulmonary exercise testing (CPET) is a clinical tool used to measure the performance of the cardiorespiratory system and assess an individual's functional capacity i.e. fitness level. CPET is a graded exercise challenge which through concomitant non-invasive measurements of gas exchange at the mouth, Electrocardiograph (ECG) trace observations, Heart rate analysis, blood pressure measurement and peripheral oxygen saturation, allows the cardiovascular and respiratory systems to be studied under the controlled stress of exercise.

CPET is usually conducted on a cycle ergometer. In basic terms, the patient is asked to cycle on a static bike to determine an objective measurement of fitness. Despite requiring a moderate to high level of exertion, CPET is well tolerated by patients and is safe to conduct on most patient cohorts (Snowden et al 2010, Wilson et al 2010).

The main variables utilised to describe functional capacity (fitness) in CPET are the anaerobic threshold (AT), the peak oxygen uptake (VO_2 peak) and ventilatory equivalent.

CPET is utilised as a diagnostic aid for a range of pathologies including unexplained breathlessness, evaluating heart failure and Chronic obstructive airways disease. However, our interest lies in its use as a tool for pre-operative risk stratification prior to surgery.

Older et al. (1999) first demonstrated that lower anaerobic threshold was associated with increased mortality in elderly patients undergoing intra abdominal surgery. Since then there have been multiple published case cohort studies reporting that CPET predicts post-operative morbidity and mortality (Wilson et al 2010; Carlisle and Swart 2007; Moran et al 2016).

The surgical patient population is becoming increasingly elderly with significant co-morbidities. This poses challenges to surgeons and anaesthetists. Surgery is associated with a substantial risk of perioperative morbidity which can have short-term and long-term impact on mortality (Khuri et al 2005; Moonesinghe et al 2014). Therefore, avoiding morbidity is essential.

The optimum perioperative management of high risk patients undergoing major surgery involves multidisciplinary collaborative decisions (Levett et al 2016). This cannot be done without accurate and objective risk stratification.

Therefore, CPET is increasingly forming part of preoperative assessment and enables us to provide an individualised risk assessment and allows a shared decision-making process with the patient to determine if surgery is appropriate and allows a fully informed consent process.

A recent national survey (Reeves et al 2018) concluded that there has been continued expansion in perioperative CPET services in the United Kingdom which has doubled since 2011. Approximately half of hospitals now provide this service. The vast majority of tests are conducted by anaesthetists. Colorectal surgical patients are the most frequently tested.

CPET is well recognised and guidelines from the Colorectal cancer clinical expert group (2017), state hospitals providing colorectal surgical services should provide a preoperative CPET service. Ethical committee approval would therefore be unnecessary to develop this service.

The main reason to introduce this service to Princess of Wales Hospital, Bridgend is due to the level of mortality in patients undergoing major surgery for bowel cancer. The National Bowel Cancer Audit(NBOCA) for the year 2017 reports our 90 day risk adjusted mortality at 6% compared to a national average of 3.1% and 2.1% at University of Hospital Wales, Cardiff. Our non risk adjusted 90 day mortality in the last year is 9%. I firmly believe this is due to patients being triaged to incorrect areas post-operatively i.e. patients that require critical care are not being identified and cared for on a general ward. Additionally, I believe that some patients are being operated on when risks would mean an alternative treatment to surgery would be more appropriate.

The preexisting pathway does not involve any formal risk assessment as recommended by the preoperative quality improvement programme (PQIP), nor shared decision making with the patient, apart from the initial discussions with the surgeon. The first time the patient encounters an anaesthetist, face to face, is often the morning of their major abdominal surgery. The anaesthetist will then have a discussion regarding risks, based on a subjective opinion relying on a general assessment. New risks may be identified or there may be need for optimisation. This may lead to postponement of the case with resulting distress for the patient and also loss of theatre efficiency (Pandit et al 2015). Alternatively, the risks may be significant and the patient is only informed of this minutes prior to surgery. This is obviously suboptimal. Finally, patients that are identified as being high risk and require critical care post operatively are either postponed due to a lack of a planned critical care bed, or are looked after on a general ward, which may result in inadequate care postoperatively.

In summary, it is essential to utilise CPET for multiple reasons, providing an individual risk assessment to assess the decision to proceed to surgery, for collaborative decision-making and informed patient consent, to triage patients to the appropriate level of Care postoperatively (Carlisle and Swart 2017). Additionally, the amount of physiological data provided by CPET in the form of the Wasserman chart (Wasserman et al, 2015) can be utilised to guide intra-operative anaesthetic technique. Furthermore, it can be used to diagnose unexpected comorbidity and optimisation of pre-existing co-morbidities preoperatively. Finally the natural progression of CPET is to provide a baseline to direct individual preoperative exercise programmes (prehabilitation) which we also intend to develop (Levet and Grocott 2015).

Outcome measurements of morbidity, length of stay and ultimately mortality will hopefully improve, which is obvious prudent healthcare.

PROJECT DESCRIPTION



Cardiopulmonary exercise testing (CPET), as described in the proposal, is an ideal tool for preoperative evaluation, providing an objective measure of fitness or functional capacity. The rationale and evidence for bringing a CPET service to the Princess of Wales Hospital has been set out above. Preoperative assessment increasingly focuses on the functional impact of comorbidities and the evaluation of functional capacity overall, rather than the evaluation of each comorbidity independently.

Since Older et al (1999) first demonstrated that a lower Anaerobic threshold (AT) was associated with increased mortality in elderly patients undergoing intra-abdominal surgery, there have been more than 30 published case cohort studies reporting that CPET predicts post-operative morbidity and mortality (Wilson et al. 2010; Carlisle and Swart 2007; Moran et al. 2016; Snowden et al. 2010).

As mentioned in the proposal, CPET provides an individualised risk assessment that is used to apprise the decision to proceed to surgery, to inform collaborative decision-making and patient consent, to triage patients to the appropriate level of care perioperatively e.g. critical care versus surgical ward, to guide intraoperative anaesthetic techniques, optimise medical comorbidities preoperatively, to diagnose unexpected comorbidity and increasingly to direct individualised preoperative exercise programs (pre-habilitation) (Older and Levett 2017; Levett and Grocott 2015).

Two surveys in England reported the increasing use of CPET preoperatively, with the number of trusts offering a service, rising from 30 in 2009, to 53 in 2011 (Huddart et al 2013; Simpson and Grocott 2009). Reeves et al. (2018) have recently shown a rapid expansion across England of the development of CPET services in over half of hospital trusts.

Therefore, bringing clinician led risk stratification to the Princess of Wales Hospital would be a valuable addition to the foundation of a well resourced preoperative assessment service. At present, the service at the Princess of Wales Hospital pre-assess over 150 major colorectal cases and 20 upper gastrointestinal cases per year.

However, it has to be understood that this service would be an entirely new service and that none of the expertise, premises, infrastructure, nor equipment existed within the anaesthetic department. Therefore, as the expertise did not exist within the department, this would require recruitment of consultant anaesthetists accredited in CPET delivery and analysis, as well as other vital staff, such as a physiologist. These challenges would obviously require a huge amount of interaction, influence and negotiation on a multidisciplinary level, as well as interaction and persuasion within my directorate management team and of course multiple stakeholders within the health board.

Fortunately, my position as a clinical director within the health board provided a head start to gain access to the individuals and groups who needed to be engaged to ensure this project came to fruition.

There is often a polarisation or demarcation of the definitions of leadership versus management and such delineation can often be unhelpful, but it is obvious that any person in a position of responsibility or who wants to invoke change, must exhibit characteristics of both to ensure success. It must be remembered that 'manager' and 'leader' are often utilised as titles but really should be seen as behaviours.

Hersey and Blanchard (1969) conducted research looking at what constitutes a good leader, with the main factors being concern for people and concern for the task. One would expect those leaders that show high levels of concern for both people and the task would be the exemplary leader. However, extensive research involving over 15,000 subjects provided an interesting observation that a successful leader could not be 'pigeonholed' into one group and that the expected results showed no correlation with the actual results. The conclusion was that effective leadership is individually determined by the followers and their unique situations and is not a consistent characteristic of the leader. Furthermore effective leaders are those who are able to select and deliver a style or approach that meets the current needs of each follower, even if that differs for different people and at different times. In summary, to ensure success I would need to exhibit flexibility in my approach with regards my interactions with various groups and over time, within my own team, moving from directing to coaching to supporting and finally delegating.

The King's Fund (2011,2012) produced research that showed that top down leadership is counterproductive. Furthermore the King's Fund in 2014 moved to extol the virtues of collective leadership within the National Health Service: "Collective leadership means leaders and teams working together across boundaries within and across organisations, in the interests of patient care and community health, this requires us to change the way we think about leadership by seeing leadership as the responsibility of all ...".

Finally when undertaking such a project, it is important to understand the type of organisation. Charles Handy (1985) famously classifies various organisations into Zeus (Power), Apollo (Role), Athena (Task) and Dionysus (Person).

Therefore, it is important to understand that the National Health Service and indeed any health board in such a large organisation. It is difficult to classify into one of these categories. In fact, it is more than apparent that when attempting to introduce any project, one will encounter various groups that could be classified into different categories. For example, my directorate team could easily be classified as Athena, which has a task culture, where team working is natural. However, the doctors and surgeons that need to be engaged, could easily be described as sitting in a Dionysus culture, whose initial reaction would be to reject anything they are told to do. Additionally, the NHS as a whole, could easily be described as having an Apollo culture, which is made up of varying committees which are slow to react and respond. Finally, interactions will need to be made with the health board executives, who may have individuals (Chief Executive, Medical director, Chief operating officer) or a culture that could be described as Zeus like, where access to the dominant individual may prove difficult.

Flexibility in approach would be essential to overcome these potential challenges. Additionally, to ensure that this project is successful, I had to ensure that I utilised my own characteristics appropriately when interacting with various groups.

The personal Myers-Briggs (MBTI Step II) analysis provided me with the summary of INTJ (Introvert, iNtuitive, Thinking, Judging). This may suggest that I am equipped to be independent minded and original, with a great drive for ideas and purposes and seeking theoretical explanations for problems that may arise while being critical and determined, as well as developing systems in areas of expertise and organising and carrying through on a project. These may or may not be attributes I possess.

However the most difficult characteristic that I would have to address, is my inherent introvert nature, which may well cause difficulties when attempting to engage with multiple groups.

The first challenge was to engage my own team and persuade individuals within that team that this project was worthwhile undertaking. The evidence and rationale, set out in my proposal, is overwhelming. However, a significant amount of funding would be necessary to develop such a service. Without funding, there would be no possibility of developing a wider team necessary to build this service, as the expertise did not exist. Fortunately, I had a very good relationship with the service director and directorate manager. I was able to present my case, but of course, further analysis and knowledge was required.

I therefore organised, with nearby local Hospitals, a number of visits to assess their preoperative assessment units, with a view to assessing and gaining knowledge of their CPET services. We visited the University Hospital Wales, Cardiff, Morriston Hospital, Swansea and Royal Glamorgan Hospital, Llantrisant. During the site visits, we were able to speak to clinical directors, lead clinicians, nursing staff, physiologists, managerial and support staff and ask numerous questions regarding the service they provided, informing us of the successes and the problems, gaining invaluable knowledge on how to set up and run such a service. It was also an opportunity for the service director and directorate manager to see the advantages of such a service and that, although a certain amount of funding would be required to set up the pilot service, ultimately this was an example of prudent healthcare.

Once I had gained support from the directorate and service manager, the next step was to gain support from the hospital unit director and unit medical director. Additionally, I was required to present my project proposals to the hospital medical committee, the quality performance and safety (QPS) committee, the theatre performance committee and of course to finance personnel. Finally, I had to gain executive approval through the Quarterly performance review.

Additionally, I had to present my proposal at a number of consultants meetings within our own department, to ensure support from the consultants who had pre-existing pre-assessment sessions. I also had to liaise with the surgical clinical director and multiple surgeons, to explain my proposals and ensure their support for this

service to their patients. This was essential, as the CPET assessment would become part of the patient pathway.

Finally once we had gained the necessary support we were in a position to begin recruiting and assembling the necessary team.

It is worth commenting, that the above paragraphs indicate support was easy to come by. Nothing could be further from the truth. It is understandable that managers within the NHS need to know all the possible disadvantages of such a project as they are financially accountable. However, surprisingly, the most amount of resistance came from clinical colleagues, despite the overwhelming and obvious evidence of the benefits of such a service. Most of these objections were overcome by influence, rather than dictat.

We immediately concentrated on recruiting two new consultants with experience of working within a CPET Service. They would need to be familiar with the necessary pathways, equipment and be accredited in performing, analysing and diagnosing with CPET. However, recruiting substantive consultants takes time. A full business case is required, along with the appropriate job plan, as well as the approval from the deanery and the Royal College of anaesthetists. While we put these plans in motion, we decided to advertise and interview for two consultants on a locum basis, which can be done in a significantly shorter time frame. We had a number of excellent candidates who were appropriately qualified and we appointed two ambitious and enthusiastic consultant anaesthetists both having the perioperative fellowship qualification, who would be invaluable in setting up service. This would enable us to set up a pilot service relatively quickly, giving us more credibility to secure funding for appropriate CPET sessions in the substantive Consultant anaesthetists' job plans.

Finally, we had the backbone of a team. Although the proposal and outline plan had been made, we now needed to start addressing the minutia to ensure our service would come to fruition. We arranged a number of meetings involving the service director, directorate manager, lead nurse for pre-assessment, the clinical lead for pre-assessment, the two new consultants anaesthetists and myself (Clinical director).

The aim of these meetings was to thoroughly explore various plans and options required to introduce the service. At various times, certain individuals would take on the role of 'devils advocate', which would enable us to assess and critique all options available and hopefully avoid fundamental errors. Although, I did not know this at the time, the methodology used was almost identical to the excellent action learning tool 'The six thinking hats' (de Bono 1985) and in retrospect, we had inadvertently utilised this method. Incidentally, at a later stage in the project development, after I had been formally introduced to this framework, we did utilise this method in a more formal and structured way, when exploring the natural expansion of CPET to incorporate pre-habilitation, which I will describe later.

Fortunately, the whole team was committed to the development of the service. However, there were many different personalities, but this was essential for a fully functioning team. Each member of the team had different strengths and weaknesses and fulfilled different roles and tasks. I have subsequently learnt that these different characteristics are essential for teamwork, as described by Belbin (2010).

We were aware that the cardiology department were in possession of CPET equipment that was not being utilised. This equipment was stored and standing obsolete in Neath Port Talbot Hospital. We approached the medical directorate regarding the possibility of utilising this equipment. Fortunately, completely coincidentally, the Cardiology directorate were considering developing a diagnostic CPET service. This was an excellent opportunity for collaborative working. We were able to work together, establishing appropriate premises within the Princess of Wales Hospital and looking at the appropriate infrastructure needed to develop the service. Fortuitously, the physiology department independently recognised a need for additional staffing to cover the rising numbers of sleep studies, which allowed collaboration on the business case for an additional full-time physiologist. We agreed to partly fund the recruitment of a physiologist, which the cardiological department was already in the process of the recruiting. Our assessment was that we would require two sessions per week of CPET access and support. We had a number of options regarding appropriate premises. The final two options came down to a room within our pre-assessment area, or an area within the cardiology department. We finally settled on the area in the cardiology department, as this had the required piped oxygen, suction equipment and rapid access to emergency cardiological care, if the need arose.

The basic infrastructure was now in place, attention now had to turn to developing the appropriate pathways for patients. Engagement from surgical colleagues was encouraging. Patients with a diagnosis of colonic carcinoma would be referred directly for CPET by the colorectal specialist nurses, following diagnosis and explanation, which is very early in the pathway. The CPET sessions were planned for a Thursday, and the anaesthetists over seeing the session would do a full pre-assessment and informed consent process, utilising the information provided by the CPET. They would then attend the surgical multidisciplinary team(MDT) meeting on the Thursday afternoon, feeding the relevant information from the CPET result and the pre-assessment immediately into the session, where a decision on treatment, surgical or otherwise, is made and whether post-operative critical care is indicated. As mentioned, CPET would be offered to all major colorectal surgical patients, but also upper Gastro intestine surgery and any other major abdominal surgery. From the CPET data, a number of parameters will be available that can be used for assessment. Ultimately, the MDT will be provided with a predicted mortality risk, which will guide treatment and whether critical care is required.

We needed to determine the thresholds for critical care admission. The Carlisle Study (Jan 2017) looked at complications of colorectal surgery in patients with different predictions of 30 day mortality. Those that were in the 1-4 % risk bracket resulted in surgical complications occurring in 14 out of 139 patients, if cared for on a general ward. However, those in the same risk brackets that were cared for in critical care, surgical complications occurred in 0 out of 68. On this basis, we recommended the threshold of planned critical care

to be a predicted mortality in excess of 1%. Since capacity to accommodate such patients in critical care is often insufficient, we also utilised a frailty assessment to be used to help further guide critical care requirement (Rockwood et al 2005).

Additionally while attending this session, patients would also receive dietary and smoking cessation advice, as well as encouraging exercise, prior to surgery. Any issues that may require further investigation and optimisation are also addressed. Furthermore, a summary of the CPET report and all appropriate parameters is placed in the patients' notes, uploaded to the clinical portal and also sent to the relevant surgeon and anaesthetist. It is then the surgeon's responsibility to book a critical care bed, if indicated.

With the infrastructure and patient pathway now in place, it was important to analyse the benefits, or otherwise of this service, as soon as possible. Although there would be inadequate numbers to assess any difference on a statistically significant basis, it was essential to determine the impact, if we wanted to secure funding for an ongoing service.

The anaesthetists would be present during the CPET session to oversee events. This is not always necessary, as the physiologist can often perform the test adequately and the data can be interpreted by the clinician at a later time. However, we felt it important to interpret the results immediately and provide the opportunity to perform a thorough pre-assessment and provide a clinician led risk stratification, in the form of a John Carlisle Risk index (Carlisle 2015) and a frailty score. This would allow delivery of an informed clinician-patient dialogue, which we hoped would improve the patient experience and also impact positively on their surgical journey and outcome.

This would obviously place pressure on the delivery of anaesthetic services elsewhere, as two full sessions per week were being utilised. Therefore, some meaningful information was essential to ensure we were not misdirecting clinical time and funds.

Initially, only 2 to 3 patients would be tested per day, in the interests of thoroughness and accuracy. It was decided that we should look at the data after we had completed 40 patients. This would take approximately three months. The pilot trial was presented to the Quality, Performance and Safety (QPS) Committee, prior to starting, for the appropriate permission.

Although we were in the early stages, results far exceeded our expectations. Of the 40 patients that went through the process, all of them received an in-depth face-to-face assessment with a clinician and a discussion around informed consent, risks and expectations, based on an accurate mortality risk and frailty score.

Of these patients, a total of 21 required further intervention and optimisation following CPET, that would not have happened otherwise and could have had huge repercussions for morbidity and mortality if not identified.

Three patients decided not to go ahead with surgery due to high risks involved. Two of these were abdominoplasties and concurrent incisional hernias requiring repair, both involving the need for a £10,000 permacol mesh, plus a predicted prolonged critical care stay.

Two patients had the type of operation changed due to the risks involved.

Six patients were identified as requiring critical care post-operatively, that wouldn't have been identified otherwise.

Five patients were identified as requiring cardiological assessment, that also wouldn't have been identified otherwise. One patient required pulmonary assessment and Rehabilitation.

As mentioned, these results far exceeded our expectations and the potential repercussions for patient safety and outcomes were enormous, as well as the potential financial savings. Although the main aim was to improve the patient experience and reduce morbidity and mortality, this would directly reduce the financial burden and would be an excellent example of prudent healthcare.

A number of patients decide not to proceed with surgery following a fully informed consent process. A number of hospital units that deliver a CPET service have remarked on this issue and referred to the savings made. These savings are then described and often 'marketed' as a reason to fund CPET services. These savings are often referred to as ROT (Refusal of Treatment) savings and various CPET services quote rates of 10-25% of refusal of treatment (ROT), depending on the procedure.

Although Financial constraints are part of life within the NHS, we prefer to highlight the benefits of CPET in terms of an improved patient experience and outcome. In other words, the lower the morbidity, the lower the human cost and lower financial costs follow naturally. However, it would have been naive not to mention these facts when presenting our findings to the executive health board.

Subsequently, the next step was for me to present our findings to the Abertawe Bro Morgannwg University Health Board (ABMUHB) executives at the Princess of Wales hospital performance review and also to the Chief operating officer in the ABMUHB theatre efficiency meeting. The aim was to ensure continued support and funding. This also meant providing support to the cardiology directorate to obtain and update a new CPET ergometer(bicycle) and relevant software which would require capital expenditure. Fortunately, our data and plans were well received. Additionally, since the findings of the Andrews report (2009), the executive health board have been very keen to embrace innovative methods to improve outcomes. I then presented our information to the Quality, Performance and Safety (QPS) committee for our service to be ratified formally.

During this time we had managed to consolidate funding for our two potential substantive consultant posts and additionally obtained approval from the Royal College of Anaesthetists and Deanery for the substantive job plans, that we were planning to advertise. The job descriptions for the two posts had the requirement of the perioperative medicine fellowship which was essential for developing our CPET service. Although the two locum consultants in situ had been integral in the development of our service and were excellent

colleagues, it was impossible to ensure nor promise their positions. This was one of the more stressful times of the project, as I felt that the two locum consultants were now essential parts of the team. Their appointment was far from assured. There were 17 applications for the two posts, 12 of which met the criteria to be shortlisted. We shortlisted seven outstanding candidates. The interview panel was made up of two consultants, the medical director, the unit director, a representative from the Royal College of anaesthetists, a representative of the University and a chairman, all of whom had separate and differing opinions and all with a duty to impartiality, needing to adhere to a rigid marking/scoring system. Fortunately, our two incumbents both performed outstandingly and were unanimously appointed.

We were then able to look ahead and move on with our new service.

There were a number of outcomes that would need to be numerically assessed to determine if the CPET Service was making any difference to patient well-being and outcomes. As mentioned in the proposal, this involved assessing:

1. The number and proportion of patients receiving a fully informed consent process involving an individualised risk assessment compared to pre-service numbers
2. The number and proportion of patients receiving preoperative optimisation who wouldn't have otherwise.
3. Appropriate triaging of patients for post-operative care i.e. general ward versus critical care ward.
4. Length of stay in critical care
5. Length of stay in the hospital
6. Morbidity i.e. complications
7. Mortality

We collected data on the number of patients requiring major abdominal surgery that underwent CPET since starting the service and compared this to the exact same cohort of patients in the preceding 12 months that did not undergo CPET analysis.

As mentioned, the reason CPET was introduced was to provide standardised physiological assessment of our major gastrointestinal surgical patients, to introduce the opportunity to optimise surgical cancer patients early in their work up, to achieve some of the recommendations of the National Preoperative Quality Improvement Project (PQIP) and to objectively advise on post-operative destination with the ultimate aim of reducing morbidity and mortality. The driver for this project being the relatively high mortality(6%) for colorectal surgery at the Princess of Wales Hospital, compared to the national average (3%), according to the national bowel cancer audit (NBOCA) 2017.

Since starting, we received 174 referrals to the CPET clinic and we performed CPET on 174 patients, of which 93% were urgent cancer referrals (162 of 174). Most of these patients were for colorectal disease and a few for upper gastro-intestinal disease. Of these patients, 70% proceeded to surgery.

The aim was to determine each of these patients' physiological markers(peak oxygen consumption, anaerobic threshold, ventilatory equivalents) which are traditionally used to quantify risk. We assessed predicted mortality and morbidity using the 'John Carlisle' perioperative mortality calculator and the American College of Surgeons National Surgical Quality Improvement Programme (ACS NSQIP) surgical risk Calculator. Additionally, the patients received a 'Rockwood' frailty assessment, respiratory muscle training, nutritional assessment including dietary advice and supplement prescription, if necessary. If anaemia was identified, the patient would be started on oral or intravenous iron. Finally, if indicated, the patient would be referred to single organ specialists for assessment and optimisation.

An individualised risk assessment would be provided to these patients. It should be noted that the concept of risk is notoriously difficult to explain and indeed understand. A significant proportion of the population often struggle to comprehend the significance of a percentage when used to explain risk. It is therefore essential to provide a narrative and comparative when explaining risk. Increasingly, clinicians are becoming medico-legally challenged, unless evidence of a comparative and narrative have been provided. Most importantly, it is the patient that suffers, having not been provided with a fully informed and explained consent process prior to surgery. Individualised risk assessment allows our clinicians to provide a comprehensive explanation utilising clear tools such as an 'icon array', as well as a realistic assessment of the likelihood of the patient returning to independent living.

We looked at the number and proportion of patients receiving an individualised risk assessment after CPET was introduced and compared this to the proportion of patients with evidence of any sort of risk assessment(p-possum,NELA), made in the year prior to CPET.

We found that less than 20% of patients undergoing major surgery, prior to the introduction of CPET, received any sort of risk assessment, compared to 100% after CPET was introduced. This is one of the pillars of the PQIP recommendations.

We then looked at the number of patients that required review by an alternate specialty or required optimisation of some kind. We found 64 patients required input prior to surgery. This consisted of 13 patients requiring referral to a speciality, such as cardiology and 51 patients requiring iron transfusion for anaemia. We reviewed adherence to the recognised management algorithm for intravenous iron transfusion administration(Munoz et al 2018). We looked at the incidence of preoperative anaemia and the percentage of patients that were appropriately investigated (ferritin, C- reactive protein) . This more thorough preoperative analysis of anaemia, resulted in an increase in appropriate treatment, from 2 cases prior to the CPET clinic, to 51 cases. This large increase in the number of patients receiving appropriate intravenous iron, despite the fact that the incidence of anaemia found in both the pre-CPET group (54%)and the post-CPET group (52%) were similar.

In summary 37% of the patients referred to the CPET service were identified as requiring optimisation which wouldn't have necessarily been identified and addressed through the normal pre-existing pathway.

The analysis of comparison of patients that progressed to surgery, provided a surprising observation. We looked at the number of patients referred for colorectal surgery due to cancer from the NBOCA data. This consisted of 36 not proceeding to surgery out of 146 patients pre-CPET and 26 not proceeding out of 130 patients post-CPET. The reasons for not proceeding are due to patient refusal, advanced disease, unfit or 'other'. As mentioned earlier, CPET is thought of as an excellent example of prudent healthcare for a number of reasons. It is believed and indeed promoted by certain centres that CPET identified patients unfit for surgery and alternative treatments being more appropriate with resulting financial savings. Our findings suggests that some patients, who would normally undergo a subjective preoperative assessment and would perhaps be deemed inappropriate for surgery, were found to perform more than adequately on the objective CPET and be considered fit for surgery. I, therefore, agree that this is prudent healthcare, but not due to refusal of treatment, but due to the fact that the right patients are having the right treatment. Only 2 patients were deemed to be unfit after the introduction of CPET and it must be stressed, that the decision to deny surgery is never taken on the basis of the CPET results alone, but always in conjunction with the other factors. There were 10 patients that had been deemed to be unfit in the group prior to CPET, so I would suggest that CPET provides an objective guide, that would allow certain patients to be considered for surgery who may not have otherwise.

Obviously, the main reason for setting up the service was the marked discrepancy in mortality at the Princess of Wales hospital (6%) compared to the national average(3%), according to NBOCA 2017 figures. I felt ,one of the main reasons responsible for this discrepancy was that patients were not being cared for in the appropriate post operative area. Therefore, we used the predicted 30 day mortality score to decide on critical care use for colorectal surgery care (Carlisle and Swart 2017). We needed to evaluate if the advised post-operative destination was being adhered to. Additionally we needed to evaluate if the risk prediction model we were using accurately predicted which patients were high or low risk.

Following CPET assessment, patients with a predicted mortality of less than 1% were classified to be managed post-operatively on the general surgical ward.

Those patients with a predicted mortality of between 1% and 4% were classified for planned care on the critical care unit/ High Dependency Unit (HDU), if there was availability, although ward care may suffice if appropriate.

Those patients with a predicted mortality of more than 4% should be managed with planned care on the critical care unit/HDU, but postponed if a bed was unavailable.

During this time we had 112 patients that had undergone CPET and also completed their surgery. We looked at the number of patients in each of the three groups according to the predicted mortality and where they were looked after post-operatively.

There were 40 patients with a predicted mortality of less than 1%: 8 patients were cared for on HDU, 32 patients cared for on the ward.

They were 47 patients with a predicted mortality of between 1% and 4%: 22 patients were cared for on HDU, 25 patients cared for on the ward.

There were 25 patients with a predicted mortality over 4%: 21 patients were cared for on HDU, 4 patients cared for on the ward.

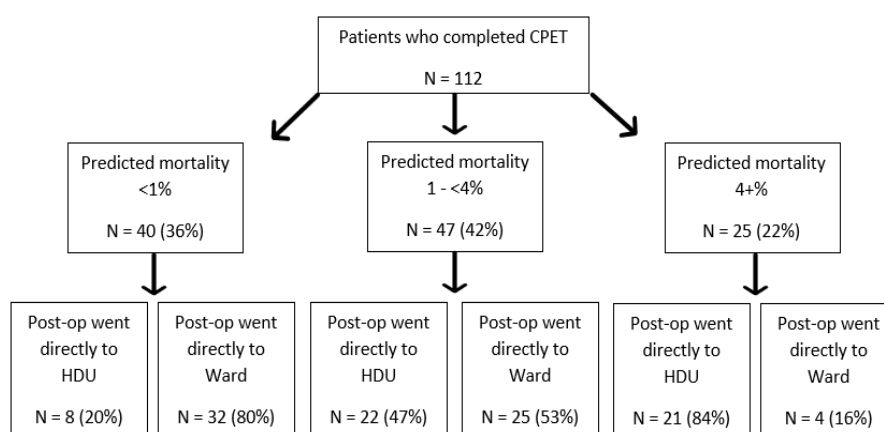


Figure 1. Flow chart of triaged patients

We looked at whether the recommendations provided by the CPET clinic were being adhered to which is summarised in the table below

% predicted mortality	<1	4+
CPET recommended destination followed	87.5%	84%

Figure 2. Table of adherence to CPET recommendations

The table shows that the advice from the CPET clinic was largely followed in the group with predicted mortality of less than 1% and the group with mortality of more than 4%. It must be noted that there are other reasons for admission to HDU in the low mortality group, such as high Body mass Index(BMI). There may

be reasons why patients in the high mortality group were not admitted to HDU, such as bed unavailability, but the advice may not have been taken.

As previously mentioned, the group with the predicted mortality of between 1% and 4% would be cared for either on HDU or general ward depending on the subjective assessment of the clinical team and bed availability.

We also compared the critical care usage and length of stay in HDU and overall Hospital length of stay between the pre-CPET and post-CPET populations.

The median overall length of stay of surgical cancer patients after starting CPET is 9.7 days compared to 11 days in the year prior to CPET.

We found that the intermediate risk group (1%-4%), direct admission to HDU reduced the average hospital length of stay to 7.7 days, compared to patients that went to the ward, which was 8.8 days. Paradoxically, the data showed that patients with direct HDU admission in this group, the complication rate was 41% resulting in hospital length of stay more than 10 days, compared to 24% in patients admitted directly to the ward post-operatively. This is difficult to explain and maybe due to heightened observation and recording of complications on HDU, an increase in complications due to inadequate enhanced recovery, or potential difficulties in discharge from the critical care area and flow within the hospital. Alternatively, the subjective assessment of the clinical team correctly identified the higher risk patients within that group, prior to surgery.

Obviously, the number of cases admitted to HDU have greatly increased, following the introduction of the CPET clinic by 59% from 39 admissions to 62 , although the average length of stay overall on critical care is reduced. This may be explained by the pre-planned nature of admission rather than emergency admission.

We found the patients with higher predicted mortality have an increased median length of stay (below)

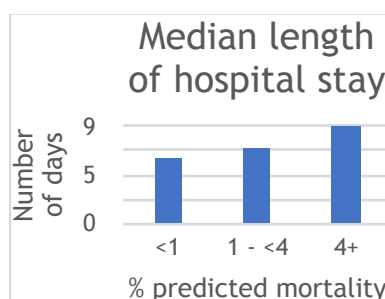


Figure 3. Increased length of stay with higher predicted mortality

Furthermore, if CPET predicted higher mortality then the corresponding total length of stay and rate of complication was higher in each group. Therefore, our data suggests that CPET can predict length of stay and rate of complications.

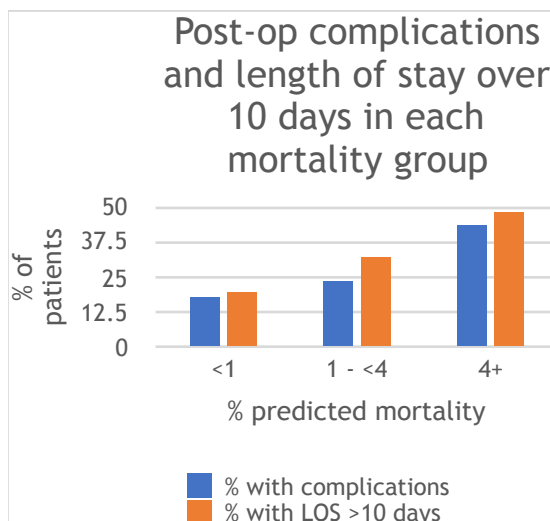


Figure 4. Increased complications and length of stay with higher predicted mortality

Finally we compared mortality in the pre-CPET and post-CPET populations. Each group contained 112 patients. This similarity in numbers was entirely coincidental.

We found that the non-risk adjusted 90 day mortality for laparotomy in the year before the introduction of CPET was 8.9%. However the non-risk-adjusted 90 day mortality for laparotomy in the year after introduction of CPET was 3.5%.

Although it must be remembered that this is raw data and has not been subjected to statistical analysis, this data is incredibly encouraging and suggests that the introduction of the CPET clinic appears to be playing a significant role, as all other factors have remained constant. However, full and accurate assessment of mortality will not be available until publication of future NBOCA figures which assess retrospectively. Therefore, the benefits of CPET may not be seen until publication in November 2019 (and more so in 2020) of accurate risk adjusted 90 day mortality.

In summary:

All patients undergoing major abdominal surgery are receiving an individualised risk assessment and fully informed consent process.

Approximately, 37% of patients have been identified as receiving pre-optimisation, which would not have happened prior to the CPET.

Risk prediction allows appropriate and accurate triaging of patients for post-operative care.

Clinicians are following advice regarding the need for post operative critical care.

There has been an increase in the number of planned admissions to critical care by 59% (39 admissions to 62)

However, there has been a reduction in median hospital length of stay from 11 days to 9.7 days.

There is an increase of complications in the intermediate risk group that are admitted to critical care compared to ward admission.

Overall 90 day mortality has reduced from 8.9% to 3.5% since introduction of CPET.

Finally, our risk prediction model appears appropriate to our cohort of patients. Furthermore, patient care has been improved in accordance with PQIP standards and patient outcomes appear to be improving.

However, our data has unearthed some interesting questions. The main question regards the appropriate understanding and comprehension of treatment in the intermediate risk group. The debate around whether high-risk patients should stay longer on HDU against the obvious benefits of the enhanced recovery and mobilisation on the general ward. Additionally, as there is a significant increase in critical care admissions, this will have repercussions for future capacity and funding. This may be addressed by the introduction of a designated Post Anaesthetic Care Unit (PACU) for colorectal cases, which is now being explored.

The natural progression of CPET is the development of a pre-habilitation service, with the aim of preparing patients for surgery by improving fitness, which has been shown to have further benefits for morbidity and mortality (Older and Levett, 2017). We are in the early stages of developing the service and gaining funding and the use of ‘six hats of thinking’ method (de Bono 1985) and the OSCAR coaching methods (Gilbert and Whittleworth 2009) have been invaluable in addressing problems and challenges to the team.

Furthermore, as the Princess of Wales Hospital has transferred to Cwm Taf University Health board from ABMU Health board, we intend to extend our service to incorporate all colorectal cases from Royal Glamorgan Hospital and Prince Charles hospital.

Obviously, the development and introduction of this project is a result of excellent teamwork. Although I was initially unaware, it has become increasingly apparent that different members of the team have taken on roles classically described by Belbin. My role, following initial inception of the project, which fits with my “monitor/evaluator’ profile has been one of attempted influence and delegation.

As most doctors are guilty of being individuals who wish to control their environments, colloquially described as ‘control freaks’, this is not always helpful for showing leadership and embracing the concept of delegation. Hopefully, I have come some way to embracing this and, indeed, this project would not have come to fruition without the excellent work and efforts of all team members.

“The best leader is the one who has sense enough to pick good men to do what he wants done, and the self restraint to keep from meddling with them while they do it.”

Theodore Roosevelt

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