

Institution: University of Northumbria at Newcastle		
Unit of Assessment: 24 (Sport and Exercise Sciences, Leisure and Tourism)		
Title of case study: Improving patient readiness for major surgery through prehabilitation		
Period when the underpinning research was undertaken: October 2014 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Garry Tew	Associate Professor	01/08/2015 – present
John Saxton	Professor	01/10/2014 – 28/02/2021
Gabriel Cucato	VC Senior Fellow	01/10/2019 – present
Jenni Naisby	Senior Lecturer	01/05/2016 – present
Period when the claimed impact occurred: 2017 – 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words)		
<p>Major surgery elicits a huge strain on the body. Exercise scientists from Northumbria University have demonstrated that exercise-based prehabilitation programmes can help vascular and cancer patients to cope with this strain by safely improving physical fitness and other risk factors in the weeks leading up to surgery. This research directly secured GBP1,900,000 in funding and led to the launch of the PREPARE-ABC clinical trial. This enabled 23 colorectal cancer hospital units across the UK to establish new prehabilitation services. By October 2020, 400 patients received exercise support through this programme, leading to improved health outcomes. In North East England, a new community-based service called PREPWELL was established in 2018 and over 30 clinicians from James Cook University Hospital, Middlesbrough, referred 171 patients for individualised prehabilitation support, leading to improved patient outcomes. Patients previously deemed as 'unfit' for aortic aneurysm surgery were able to improve fitness through prehabilitation, successfully undergo surgery, and recover without complications.</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>Around 1.5 million major surgical procedures are performed annually in the UK by the NHS. Despite ongoing improvements in perioperative (occurring at or around the time of an operation) care, patient outcomes are suboptimal: 3.5–4% of patients die within 30 days after major intra-abdominal surgery, and 15–40% of patients experience perioperative complications such as heart problems and chest infections. In collaboration with colleagues from health sciences, exercise scientists Dr Garry Tew and Professor John Saxton from Northumbria's <i>Promoting and Preserving Health and Wellbeing</i> research group have sought to improve the clinical outcomes of major surgery (vascular and cancer) through prehabilitation – preoperative interventions that aim to prepare patients for treatment through needs-based management of unhealthy behaviours (e.g. physical inactivity, smoking) and medical conditions (e.g. anaemia).</p> <p>Vascular surgery: in collaboration with colleagues from Teesside University and health sector partners, Northumbria's researchers published novel clinical trial data on the effects of a preoperative exercise programme for patients awaiting elective repair of an abdominal aortic aneurysm (enlargement of the main abdominal artery) [R1]. Funded by the National Institute for Health Research (NIHR), this randomised controlled trial investigated a condition that affects 5–8% of men and 1–3% women aged 65 years and over. Aneurysms are dangerous as often there are no symptoms until they rupture, causing huge internal bleeding with an overall mortality rate of 80%. This was the first study to demonstrate that people with large abdominal aortic aneurysms can exercise safely at moderate-to-hard intensities to improve their fitness before surgery, thereby helping to justify this population's inclusion in exercise-based prehabilitation and rehabilitation programmes (prior to this work, these patients were typically excluded from such programmes due to safety concerns). Tew designed and oversaw the delivery of the</p>		

exercise programme and led the publication of the protocol and results for the intervention [R1]. Tew also led the development of the world's first clinical guideline on preoperative exercise training for people awaiting major non-cardiac surgery [R2], which received an award as the most accessed paper of the *Anaesthesia* journal in 2018.

Cancer surgery: Northumbria's exercise and rehabilitation scientists (Professor John Saxton, Dr Gabriel Cucato, Dr Jenni Naisby) conducted the first trial to investigate the effects of vigorous intensity aerobic interval exercise in urinary bladder cancer patients prior to radical cystectomy (a surgical operation to remove the bladder) [R3, R4]. The intervention was optimised to accommodate the short time-window between decision to operate and surgery. This research demonstrated improvements in cardiopulmonary fitness following an interval training programme, including peak levels of oxygen pulse (heart rate × oxygen uptake; an index of stroke volume), minute ventilation and leg power. In addition, qualitative focus groups showed that patients experienced physical and psychosocial health benefits from participating in the pre-operative exercise programme. Based on expertise gained in this research, Saxton and others undertook a systematic review of 16 randomised trials which explored whether prehabilitation improves health outcomes at or beyond the first 30 days post-treatment and considered the use of prehabilitation before cancer treatment [R5]. In addition, Saxton and colleagues were awarded GBP1,900,000 for the NIHR-funded PREPARE-ABC trial (one of three large-scale cancer exercise prehabilitation trials in Europe) focused on prehabilitation for people undergoing major colorectal (bowel) cancer surgery (the project started in 2016, end date delayed due to the pandemic). Saxton is co-leading the trial with Mr James Herson, Consultant Surgeon at the Norfolk and Norwich University Hospital. It not only evaluates clinical outcomes, but also cost-effectiveness of the intervention in comparison with home-supported exercise and standard care. Northumbria's research has thus advanced proactive (rather than reactive, costly, and inflexible) treatment approaches to healthcare and optimisation of NHS treatments.

3. References to the research (indicative maximum of six references)

R1. Garry Tew, Batterham**, A.M., Colling***, K., Gray*, J., Kerr***, K., Kothmann***, K., Nawaz***, S., Weston**, M., Yates***, D., and Danjoux***, G. (2017) 'Randomized feasibility trial of high-intensity interval training before elective abdominal aortic aneurysm repair' *The British Journal of Surgery* **104**(13): 1791-1801 <https://doi.org/10.1002/bjs.10669>

R2. Garry Tew, Ayyash***, R., Durrand***, J., and Danjoux***, G.R. (2018) 'Clinical guideline and recommendations on pre-operative exercise training in patients awaiting major non-cardiac surgery' *Anaesthesia* **73**(6): 750-768 <https://doi.org/10.1111/anae.14177>

R3. Banerjee*, S., Manley***, K., Shaw**, B., Lewis**, L., Gabriel Cucato**, Mills***, R., Rochester***, M., Clark**, A., and **John Saxton** (2018) 'Vigorous intensity aerobic interval exercise in bladder cancer patients prior to radical cystectomy: a feasibility randomised controlled trial' *Support Care Cancer* **26**: 1515-1523 <https://doi.org/10.1007/s00520-017-3991-2>

R4. Banerjee*, S., Semper**, K., Skarparis*, K., Jenni Naisby**, Lewis**, L., **Gabriel Cucato**, Mills***, R., Rochester***, M., and **John Saxton** (2019) Patient perspectives of vigorous intensity aerobic interval exercise prehabilitation prior to radical cystectomy: a qualitative focus group study' *Disability and Rehabilitation* **14**: 1-8 <https://doi.org/10.1080/09638288.2019.1651907>

R5. Faithfull**, S., Turner**, L., Poole**, K., Joy**, M., Manders**, R., Weprin**, J., Winters-Stone**, K., and **John Saxton** (2019). 'Prehabilitation for adults diagnosed with cancer' *European Journal of Cancer Care* **28**(4): e13023 <https://doi.org/10.1111/ecc.13023>

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****External UK university collaborators:** Teesside University: A. Batterham, M. Weston. University of East Anglia: B. Shaw, L. Lewis, A. Clark, K. Semper. University of Strathclyde: L. Lewis. University of Surrey: S. Faithfull, K. Poole, M. Joy, R. Manders

*****Clinical collaborators:** K. Colling, K. Kerr, K. Kothmann, S. Nawaz, D. Yates, G. Danjoux, R. Ayyash, J. Durrand, S. Banerjee, K. Manley, R. Mills, M. Rochester, L. Turner

4. Details of the impact (indicative maximum 750 words)

4.1 Introduction of prehabilitation services into the NHS in England and Scotland

Research conducted by Saxton and the PREPARE-ABC team directly led to the launch of one of the largest cancer exercise prehabilitation trials in Europe, the establishment of prehabilitation services across 23 hospital units in the UK, the creation of a new pathway that clinicians can use to refer patients, and positive health outcomes for patients.

Saxton's research showed that vigorous intensity aerobic interval exercise improved preoperative fitness, had potential to improve post-operative recovery outcomes, and provided a feasible exercise model even for frail patients [R3]. These findings helped to secure GBP1,900,000 of funding for the 'supPorTive Exercise Programmes for Accelerating REcovery after major ABdominal Cancer surgery' (PREPARE-ABC). Although PREPARE-ABC is an ongoing trial and definitive results are to be determined, it allowed treatment centres to offer prehabilitation prior to colorectal cancer surgery (units signed up for the project receive a portion of funding to set up prehabilitation services). By October 2020, 23 colorectal cancer units across the UK had established prehabilitation services [E1 contains a full list of enrolled hospitals]. Saxton's role in PREPARE-ABC was instrumental in the establishment of a cancer prehabilitation service at the Royal Alexandra Hospital in Glasgow.

[text removed for publication]

Saxton's work as co-lead of the PREPARE-ABC team provided an opportunity for clinicians across the UK to have a prehabilitation referral pathway to which they can signpost patients. Following a decision to operate, patients diagnosed with colorectal cancer are approached to see if they are interested in joining the trial. If a patient agrees, they are randomly allocated to one of three options: hospital-supervised exercise, home-supported exercise, or standard care (treatment as usual). This means that two-thirds of all randomised patients receive exercise support. This service has become part of the Enhanced Recovery After Surgery perioperative care pathway.

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4.2 First *community-based* prehabilitation service in the UK improved patient outcomes

Tew was instrumental in setting up a novel prehabilitation service in Middlesbrough called PREPWELL [E5]. Launched in January 2018, this was the first comprehensive *community-based* prehabilitation service in the UK and was specifically designed to improve the health and wellbeing of patients awaiting planned major surgery. Within the service, clinicians from South Tees Hospitals NHS Foundation Trust refer patients to a one-stop facility in Middlesbrough, where a personalised lifestyle programme based on a risk factor profile is created for every patient, and targeted supervised exercise and lifestyle interventions are run on a twice-weekly basis to help patients achieve improved health before surgery. Northumbria's research [R1, R2] directly informed which patient groups can safely participate (e.g., aneurysm patients) and which exercise programmes to include for time-efficient gains in fitness (e.g., cycle-based interval training).

The service is highly innovative, as it is delivered as a partnership between Public Health and primary and secondary care. PREPWELL has been integrated into routine clinical care through cross-sector collaboration and support. Over 30 clinicians (surgeons, anaesthetists, specialist nurses) from the James Cook University Hospital, Middlesbrough, made referrals through five specialties (vascular, orthopaedic, upper gastrointestinal, urology, colorectal) [E5, E6]. The liaisons with community-based services have stretched the boundaries of traditional healthcare provision and impacted clinical practice. Rhiannon Hackett, Consultant Anaesthetist from James Cook University Hospital, stated:

'Engagement with the PREPWELL programme has changed my day-to-day pre-operative practice and has enabled me to better advise my patients preparing for surgery... The PREPWELL programme offers a timely, tailored route to improved fitness and well-being before surgery... These interventions aim to improve a patient's perioperative journey and recovery, by reducing the likelihood of adverse consequences for that patient. This, may, by default, facilitate perioperative care to run more efficiently by reducing short notice cancellations prior to surgery and unanticipated extended post-operative stays, or readmissions for clinical reasons' [E7].

Outcomes from PREPWELL have been very positive. An evaluation of the first 12 months (Jan-Dec 2018) of the service identified that PREPWELL was successfully implemented within existing preoperative pathways [E8]. During this period, 75 patients received individually tailored prehabilitation support. The vast majority of patients improved their risk profile preoperatively, with >70% experiencing clinically meaningful improvements in their functional capacity (6-minute walk distance) and quality of life (EQ-5D utility score). Interviews and exit questionnaires also showed that participants were very satisfied with the service [E8, p5]. By October 2020, 171 patients had received prehabilitation support through PREPWELL [E6].

In relation to health benefits, patients with an abdominal aortic aneurysm warrant specific attention. During the initial phase of PREPWELL, patients with abdominal aortic aneurysms were deemed too high risk for surgery. Northumbria's research into exercise for patients with abdominal aortic aneurysm [R1, R2] persuaded a multidisciplinary evaluation team to reconsider this decision and incorporated this patient group into the programme. Esther Carr, PREPWELL Project Manager, stated:

'As the expert in exercise science, Dr Tew has been instrumental in devising the exercise programmes... Dr Tew's research has directly informed which patient groups can safely participate in the programme... [P]rior to PREPWELL patients with aneurysms were excluded from referrals to exercise clinics by clinicians due to high risk. Dr Tew's research into safety and feasibility of exercise for this patient group has demonstrated that this is not the case. Since the beginning of the PREPWELL project, 51 aneurysm patients have taken part in the programme, 2 of these patients were initially deemed too high risk to undergo surgery' [E6].

After completing the programme, the two 'unfit for surgery' patients were successfully re-classified as 'fit for surgery' and underwent surgery without any complications [E5, p17; E8, p8]. One of the patients with an aneurysm who participated is Bill. In a video filmed by the PREPWELL team, he talked about how, before taking part in the programme, he was told that the chance that he will survive surgery was small. Bill was very worried and informed his family that he was not likely to survive surgery. Participating in PREPWELL motivated him to improve his health and provided him with a sense of community and peer support network. Bill stated that as a result of participating in PREPWELL, he was able to put his mind at ease and not worry about the aneurysm, and that helped him to go through surgery and recover afterwards [E9].

PREPWELL's success was recognised nationally, when the team was shortlisted for the 2020 BMJ Award in the 'Anaesthesia and Perioperative Medicine Team of the Year' category [E10]. Through Sport England and Macmillan Cancer Support, funding for the PREPWELL has been secured until 2025, showing commitment to continue and expand the service, and enable more people to take part and improve their health.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Ref.	Source of corroboration	Link to claimed impact
E1	PREPARE-ABC newsletters from 01/07/2017, 15/03/2019 and 01/10/2020	Lists hospital units that established prehabilitation services, confirms number of patients enrolled in the programme

Impact case study (REF3)

E2	[text removed for publication]	[text removed for publication]
E3	[text removed for publication]	[text removed for publication]
E4	[text removed for publication]	[text removed for publication]
E5	Preparing for Surgery: The PREPWELL Project Report (November 2019)	Corroborates factual information about the PREPWELL programme: dates of establishment, number of participants, health improvements
E6	Testimonial - Esther Carr, PREPWELL Project Manager	Confirms Dr Tew's instrumental role within the PREPWELL, and impact on patients
E7	Testimonial - Rhiannon Hackett, Consultant Anaesthetist from James Cook University Hospital, South Tees NHS Trust	Confirms number of patients referred to the PREPWELL, and change in clinical practice
E8	PREP-WELL Quality Improvement Report (2020)	Corroborates improved health outcomes for patients
E9	Patient feedback, Bill's story – video produced by the PREPWELL	Confirms the difference participation in the programme made for a patient with abdominal aortic aneurysm
E10	The BMJ Award 2020 list of finalists	Corroborates that PREPWELL was shortlisted as finalist for 2020 'Anaesthesia & Perioperative Medicine Team of the Year'