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| **Institution: Teesside University** |
| **Unit of Assessment: 3; Allied Health Professions, Dentistry, Nursing and Pharmacy** |
| **Title of case study: Changes to Healthcare Practice within the NHS: Prehabilitation, Rehabilitation, and Perioperative Care Research for Patient Benefit** |

## 1. Summary of the impact

In this case study we describe an interrelated collection of **impacts on healthcare in the NHS**; these are summarised in the Table below.

| Research | Impact | Reach and Significance |
|---|---|---|
| Observational study of the difference in blood pressure between arms in vascular surgical patients | ***Directly informed new care pathway for surgery to unblock a carotid artery*** | Patients across Durham Tees Valley and North Yorkshire; eliminates risk of clinical error in blood pressure monitoring during surgery thus reducing potential harm (stroke, heart attack) |
| Validation of the 6-min walk test (6MWT) in non-cardiac surgical patients | ***6MWT now included in the North East Care Pathway for Abdominal Aortic Aneurysm (AAA) Repair*** | Patients across the North East NHS; 6MWT is a useful low-cost addition to the battery of pre-operative screening/ risk stratification tests |
| Randomised controlled trial (RCT) of exercise prehabilitation in AAA patients | ***Exercise training now recommended to AAA patients awaiting surgery using brief negotiation in the clinical encounter*** | Patients across Durham Tees Valley and North Yorkshire; likely improved fitness for surgery |
| RCT of exercise rehabilitation in intensive care unit (ICU) survivors | ***Exercise training now recommended in ICU follow-up clinics via brief negotiation*** | ICU patients in South Tees Hospitals NHS Foundation Trust; likely accelerated return to adequate functional fitness |
| Diagnostic accuracy study of the STOP-BANG screening tool for obstructive sleep apnoea (OSA) in specialist weight management patients | ***Directly informed new pathway for referral of bariatric and specialist weight management patients into clinical Sleep Services*** | Patients across Durham Tees Valley and North Yorkshire; Improved accuracy of diagnosis of OSA likely to require medical intervention |

## 2. Underpinning research

***Context***

All of the research underpinning the impacts in this case study was co-produced with clinicians in the Department of Academic Anaesthesia at South Tees Hospitals NHS Foundation Trust. We have a well-established and successful anaesthesia research collaboration focusing on prehabilitation (before surgery), rehabilitation (following critical illness), and perioperative care for patient benefit. Our research programme is aligned with the highlighted topics identified by the National Institute of Academic Anaesthesia (NIAA) in the first UK-wide research priority setting exercise (*British Journal of Anaesthesia*, 108 (1): 42-52, 2012). These topics included **arrangements for preoperative assessment and the role of exercise training to improve outcome**. **Danjoux** (a Visiting Professor at Teesside, REF Category C entrant, and co-author on all of the research cited in this case study) was a member of the Expert Panel for the NIAA research priority setting exercise.

**Research and findings**

The key researchers for all of the work presented herein are **Batterham** (Professor at Teesside from June 2009, Principal Lecturer prior to this from 2005-2009) and **Danjoux** (Visiting Fellowship conferred September 2009 and Visiting Professorship from January 2012). All data collection took place at James Cook University Hospital, Middlesbrough and, for the RCT of exercise training in ICU survivors, also at Leeds General Infirmary. Our **observational study of the difference in systolic blood pressure between arms** in vascular surgical patients was based on a

retrospective review of clinical records for patients attending the vascular pre-assessment clinic between 2004 and 2012. We observed a high prevalence (26%) of a difference in systolic blood pressure between arms of ≥ 15 mmHg. If an arm were to be selected at random for monitoring blood pressure during a surgical operation **then a clinical error (using the lower-reading arm) would result once in every 7-9 patients**, increasing the risk of adverse events and harm in this high-risk group. Our **6-min walk test (6MWT) validation study** was conducted from 2008-2010. We showed that the 6MWT was a cheap, practical predictor of the anaerobic threshold (an objective measure of fitness for surgery), useful for screening and risk stratification pre-surgery and for tertiary referral for more precise tests if appropriate. The headline finding was the robust derivation of threshold 6MWT performance (distances) to inform clinical decision-making. **Patients walking > 563 m do not require more sophisticated exercise testing, whereas those walking < 427 m do.** Patients walking a distance in-between these cut-points are in a clinical 'grey zone' requiring further careful evaluation. **Our two exercise training RCTs** were both pilot/ exploratory studies that happened to produce a clear positive result for the primary outcome. Within the framework of the Medical Research Council (MRC) guidance for developing and evaluating complex interventions *(BMJ 2008;337:a1655)* these results must be confirmed in a larger trial within a phased approach; however, here we present interim impacts. Our **RCT of exercise prehabilitation in abdominal aortic aneurysm patients** was carried out from 2007-2008. The headline finding was that 6 weeks of supervised, moderate intensity cycle ergometer exercise **improved aerobic fitness by around 10%**. Similarly, **our RCT of exercise rehabilitation in ICU survivors** (conducted 2008-2011) showed that an 8-week supervised exercise training programme resulted in a **clinically relevant improvement in fitness at 9 weeks, accelerating the natural recovery process**. Finally, in **our diagnostic accuracy study in bariatric and specialist weight management patients** (conducted in 2012) we derived robust cut-points for the 0-8-point STOP-BANG screening tool **for 'ruling in' and 'ruling out' moderate-severe obstructive sleep apnoea.**

## 3. References to the research


1. Durrand, J. W., **Batterham**, A. M., O'Neill, B. R. and **Danjoux**, G. R. (2013). Prevalence and implications of a difference in systolic blood pressure between one arm and the other in vascular surgical patients. *Anaesthesia*. 68 (12): 1247–1252.

This article is submitted in REF2 (**Danjoux**; Category C).

2. Sinclair, R.C.F., **Batterham**, A.M., Davies, S., Cawthorn, L., **Danjoux**, G.R. (2012). Validity of the 6-min walk test in prediction of the anaerobic threshold before major non-cardiac surgery. *British Journal of Anaesthesia*, 108 (1): 30-35.

This article is submitted in REF2 (**Batterham**), and has been **cited 7 times (Scopus)** placing it in the top 10% for papers published in the same year in the Anesthesiology and Pain Medicine All Journal Science Classification (AJSC) code. The paper was also selected as the 'Editor's Choice' in that edition of the journal. The study was supported by a small grant (£11,750) from the South Tees Hospitals NHS Foundation Trust Grants competition, awarded to Sinclair, **Danjoux**, and **Batterham** (1 September 2008 to 31 August 2010; no allocated reference number).

3. Kothmann, E., **Batterham**, A.M., Owen, S.J., Turley, A.J., Cheesman, M., Parry, A., **Danjoux**, G. (2009). Effect of short-term exercise training on aerobic fitness in patients with abdominal aortic aneurysms: A pilot study*. British Journal of Anaesthesia*, 103 (4): 505-510.

This article is submitted in REF2 (**Danjoux**), and has been **cited 8 times on Scopus** – above the mean for 2009 papers in the Anesthesiology and Pain Medicine AJSC code. The work was supported by The Departmental Grant from the Association of Anaesthetists of Great Britain and Ireland; £21,500 awarded in December 2006 to **Danjoux** (no reference number provided).

4. Goodman, B.A, Bonner, S., **Batterham**, A.M. Wright, J. Hugill, K., Howard, P., Howell, S., **Danjoux**, G. (2012). Impact of an aerobic rehabilitation programme on fitness and QoL in ICU survivors. *Intensive Care Medicine*, 38 (1 Suppl) S90.

This was a peer-reviewed conference communication at the European Society of Intensive Care Medicine 25th annual congress. The full paper – "The effect of supervised aerobic exercise rehabilitation on physical fitness and quality of life in survivors of critical illness: an exploratory minimised controlled trial (PIX study)" – has been accepted for publication in the *British Journal of Anaesthesia* (No DOI available yet). The work was supported by funding from the National Institute for Health Research, Research for Patient Benefit Programme: £206,965, PB-PG-0407-13274, 1 July 2008 to 30 June 2011.

5. Pearson, F., **Batterham**, A.M., **Danjoux**, G. Evaluation of the STOP-BANG screening tool in diagnosis of obstructive sleep apnoea in specialist weight management patients. *http://www.edinburghsleep2013.co.uk/downloads/clinical-adult-abstracts.pdf* (Abstract number 20).

This was a peer-reviewed conference communication presented at the prestigious 25th Anniversary Scientific Meeting of the **British Sleep Society** in October 2013. We have only very recently completed this project and the full manuscript is in preparation.

## 4. Details of the impact

This case study describes a collection of impacts on healthcare practice within the NHS, resulting directly from our successful programme of research for patient benefit.

**Process of research⟹ impact**

A central plank of our impact strategy is the **co-production of knowledge**, with an emphasis on ***practice-based evidence*** (of real-world problems faced by clinicians) to ***evidence-based practice*** (knowledge translation leading to rapid changes in policy and practice in healthcare based on robust research findings). All of the research cited herein could be translated very rapidly, as the clinicians co-creating the evidence were either the decision makers for policy/practice enhancements or were key players in influencing those decisions. Consequently, in all cases the evidence produced by the cited underpinning research **led directly to the impact reported**.

**Impacts**

**Three of our five impacts** are evidenced by ***documented changes to clinical guidelines*** in the regional NHS.

1. **A new care pathway was established in February 2013 for the Carotid Endarterectomy surgical procedure** (unblocking a carotid artery), providing pre-operative guidelines for ward, medical, and nursing staff. Based on **our research on inter-arm differences in blood pressure**, medical and nursing personnel are now required to check and record blood pressure in both arms. All subsequent measures should then be taken from the higher-reading arm. At least 1 hour before the patient is due to go to theatre the nursing staff must clearly mark the arm to be used for blood pressure measurement. The anaesthetic team will place the arterial blood pressure line into this arm to monitor and guide patient management in surgery. The Carotid Endarterectomy pathway applies initially to NHS surgical patients across the Durham Tees Valley and North Yorkshire, but we envisage that post-publication it will be adopted widely given the clinical readership of the journal. Our data indicate that a clinical error – selecting at random an arm with a clinically significant lower (false) blood pressure reading – would result for one in every 7-9 patients. Carotid endarterectomy is performed to reduce the risk of stroke. Selecting a lower-reading arm for blood pressure monitoring would misguide patient management during surgery potentially leading to inadequate blood flow to heart and brain. The potential harm is therefore stroke or heart complications during surgery. Therefore, **the impact is significant**, as this simple, inexpensive change to the care pathway **eliminates the risk of this clinical error in blood pressure monitoring during surgery**, and thus substantially reduces the potential for harm.
2. From August 2011, **the 6-min walk test (6MWT) was included** in the battery of preoperative screening tests **in the North East Care Pathway for abdominal aortic aneurysm repair**, based on the evidence produced in our validation study. This pathway applies to NHS patients across the North East of England. **The impact is significant, as in a cash-strapped NHS the 6-min walk test is a robust practical alternative** where more sophisticated cardiopulmonary exercise testing (CPET) resources are unavailable. Moreover, **the 6MWT can now be used as a simple initial test within a tertiary referral model**; those patients walking > 563 m are not referred for CPET, whereas those walking < 427 m are.
3. A new clinical pathway was established in June 2013 for the **referral of Bariatric and Specialist Weight Management patients into clinical Sleep Services**. There is a known strong association between morbid obesity and risk of developing Obstructive Sleep Apnoea Syndrome (OSAS), but OSAS remains undiagnosed in the majority of patients presenting for bariatric surgery. Untreated OSAS is associated with increased prevalence of cardiovascular disease, type 2 Diabetes Mellitus, and memory and cognitive dysfunction, with life expectancy decreased by up to

20 years. Untreated OSAS is also associated with a significantly increased risk of adverse outcome and increased length of hospital stay in patients undergoing surgery. **Based directly on the evidence from our diagnostic accuracy study, robust cut-points for the STOP-BANG screening tool** (an 8-item questionnaire with yes/no answers) are built in to the referral pathway. Patients complete the STOP-BANG questionnaire at the point of referral, that is, bariatric surgical or specialist weight management evaluation clinics. Further actions depend on the patient's score between 0 and 8:

**0-2** = no referral required; **3-4** = refer to Sleep Clinic for review – history and sleep oximetry will be assessed prior to a decision on any requirement for sleep consultation; **≥ 5** = refer directly to Sleep Clinic for further assessment.

Our research revealed that a score of ≤2 effectively rules out OSAS, whereas 7/10 patients with a score of ≥ 5 will have OSAS. James Cook University Hospital Sleep Services (**Danjoux** is Head of Sleep Medicine, since 2011) is a tertiary referral centre covering bariatric and specialist weight management programme patients from Durham Tees Valley and North Yorkshire. **The impact is significant; the new referral pathway streamlines referrals by identifying individuals at high likelihood of having OSAS, whilst excluding those at low risk**. Prior to the implementation of the new pathway, the Sleep Services department was inundated with referrals of patients for sleep consultation and assessment – an inefficient model for utilisation of valuable resources.

*Exercise training advice to patients*

Our two exercise training RCTs have resulted in **interim impacts on the clinical encounter**. These impacts were put in place further to the analysis of the trial data, before any subsequent research output (December 2008 for AAA patients and December 2011 for survivors of critical illness). Both research studies revealed a clear increase in fitness after the exercise intervention. Although these findings must be confirmed in a larger multicentre RCT, on the premise that the probability of benefit substantially outweighs the risk of harm, recommendations are now made to patients to engage in exercise of the same frequency, intensity, and duration adopted in the trials. These recommendations are made within a *brief negotiation* model; a patient-centred counselling method for enhancing motivation for health behaviour change in brief clinical encounters. In the vascular pre-operative assessment clinic at James Cook University Hospital Middlesbrough, exercise is recommended for every patient being considered for repair of an AAA to improve fitness for surgery. Physiotherapists in the ICU follow up clinic make the same exercise recommendations for survivors of critical illness. Both impacts apply to NHS patients seen at James Cook University Hospital, which provides a tertiary care service for Durham Tees Valley and North Yorkshire NHS. **These interim impacts are significant**, as they are likely to result in increased fitness for surgery (AAA) and accelerated recovery from critical illness. In addition, the clear positive effect on the primary outcome in both RCTs is impact in and of itself. Indeed, Main Panel A recognise that it takes a long time for trialled interventions to be fully rolled out, and the demonstration of clear efficacy of an intervention in a patient population is an interim impact, within the spirit of the MRC guidance on developing and evaluating complex interventions.

## 5. Sources to corroborate the impact

All impacts detailed above may be corroborated by the Research and Development Director and the Research and Development Manager at the South Tees Hospitals NHS Foundation Trust, The James Cook University Hospital, Middlesbrough.

The North East Care Pathway for Abdominal Aortic Aneurysm (AAA) Repair may be found at http://www.aaaqip.com/files/aaa-care-pathway-guidance-august-2011-final.pdf.

The documents describing the carotid endarterectomy care pathway and the referral pathway for bariatric and specialist weight management patients into clinical Sleep Services are stored on the Trust intranet and are available from the South Tees Hospitals NHS Foundation Trust Research and Development Manager on request.