

Institution: University of Chester		
Unit of Assessment: 3 Allied Health Professions, Dentistry, Nursing and Pharmacy		
Title of case study: Research informed change in clinical exercise practice and policies which enhance staff delivery and improve patient care in cardiac rehabilitation, nationally and globally.		
Period when the underpinning research was undertaken: 2004 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): John Buckley	Role(s) (e.g. job title): Professor	Period(s) employed by submitting HEI: 2006 – ongoing
Period when the claimed impact occurred: 2014 – 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact (indicative maximum 100 words)

Cardiovascular disease remains the largest cause of morbidity and mortality globally. The World Health Organisation (WHO) has prioritised cardiac rehabilitation services in this matter, because of evidenced impact on: reducing morbidity and mortality, improving quality of life, and reducing healthcare costs. This case study details the impact of Professor John Buckley's research on national and international policies in cardiac rehabilitation, including his contributions to the WHO, the International Olympic Committee (IOC), the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR), the British Association for Cardiovascular Prevention and Rehabilitation (BACPR), the Association of Chartered Physiotherapists in Cardiac Rehabilitation (ACPICR), the Singapore Heart Foundation, the Ottawa Heart Institute of Canada, and Mumbai's largest hospital the Seven Hills Hospital. The focus of the research and knowledge translation impact focuses on simple and pragmatic exercise assessment and monitoring techniques that have been promoted as part of widening access, specifically for those in lower resourced settings, to cardiac rehabilitation. The research has revolutionised the training of frontline rehabilitation specialists, contributing to training materials on clinical practice procedures, not only for the key organisations noted above, but also at various large specialist clinical centres in the UK and overseas, benefitting thousands of patients each year. The impact has now attained a global reach as recognised by the WHO.

2. Underpinning research (indicative maximum 500 words)

Staff and Collaborating Bodies

Professor John **Buckley** has led on this research impact at the University of Chester. He has collaborated with key researchers at Chester [R3], at other universities in the UK and around the world, including the University of Ottawa, [R1], Keele University [R2], York University, Toronto [R5], the University of Essex [R4], and the University of South Australia [R6]. This work has then gone forth to influence education, training, practice standards, and policies of the BACPR, BASES, the IOC, the ICCPR, and the WHO.

Context: Why was this research needed?

In the early-to-mid 2000s in the UK, cardiac rehabilitation needed to broaden its access to patients by delivering services in the community and sometimes in home-based settings. Professor Buckley's leadership positions at the BACPR and BASES thus influenced his research to enhance the reliability and validity of field-based fitness tests, where more evidence was required on pragmatic measures to regulate exercise intensity in cardiac populations. It was through his research in 2004, further developed more recently [R1, R2, R4], that it has been accepted by the BACPR and BASES. This led to informing policy needs for widening global patient access to cardiac rehabilitation led by the ICCPR in 2016 [R5] and the WHO from 2017-2020, as discussed in Section 4. Whilst cardiac rehabilitation is multi-faceted, for the exercise component a patient cannot be given a safe and effective programme without first being fitness-tested to assess both risk stratification and exercise prescription. The very recent rehabilitation challenges posed by

COVID-19 have further augmented the need for pragmatic means of assessing patients in the community or at home.

Context: What is the research?

The focus of the research in this case report is on validating practical, low cost means of monitoring exercise intensity as part of pragmatic fitness testing protocols for use in community and home settings with cardiac rehabilitation patients. Professor Buckley first published on these concepts in 2004 on a practical step test (The Chester Step test), where the validity and reliability of heart rate, psychological effort perception and oxygen-use-energy expenditure were evaluated in healthy patients. Though for many years this test had been promoted by the BACPR, it was only recently, through collaboration with the University of Ottawa Heart Centre, that these principles have been properly validated with cardiac patients [R1]. In this instance the Chester step test used in cardiac patients was shown to be the most accurate compared with cycle and treadmill tests.

Professor Buckley and his colleagues at the University of Chester (Morris, Hayton, Lamb and Cotterell) had also been translating clinical/lab testing techniques into more practical methods, again by assessing psychological perceptions of breathing and muscle sensations during standardised clinical diagnostic treadmill tests, and translating these into use in the more practical setting of the rehabilitation gym [R2, R3]. During the period between 2005 and 2010, the use of shuttle-walking tests was increasingly being used, where >35% of BACPR-audited programmes were being delivered in the community. Similar to the Chester Step test, the BACPR had been promoting the use of a practical shuttle walking test, which was originally purposed for lung disease patients. This test needed appropriate validation for use with cardiac populations and the University of Chester team showed that there were distinct energy cost differences compared to the existing data on healthy populations, which had not yet been reported by lung disease populations [R4]. Given Professor Buckley's clinical experience and international respect for his practical research used to enable cardiac rehabilitation delivery in non-clinical settings, he consequently rose to leadership positions within BACPR, BASES and the ICCPR [R5]. As a result, he was invited to collaborate with a team in Australia on a systematic review and meta-analysis on the accuracy of assessing exercise intensity and fitness in cardiac populations, published in 2018 [R6].

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

R1: Reed JL, Cotie LM, Cole CA, Harris J, Moran B, Scott K, Terada T, **Buckley JP**, Pipe AL. Submaximal Exercise Testing in Cardiovascular Rehabilitation Settings (BEST Study). *Front Physiol.* 2020 Jan 8;10:1517.

R2: **Buckley JP**, Sim J, Eston RG. Reproducibility of ratings of perceived exertion soon after myocardial infarction: responses in the stress-testing clinic and the rehabilitation gymnasium. *Ergonomics*, 2009 52(4):421 – 427

R3: Morris, M., Lamb, K.L., Hayton, J. et al. The validity and reliability of predicting maximal oxygen uptake from a treadmill-based sub-maximal perceptually regulated exercise test. *Eur J Appl Physiol* 109, 983–988 (2010). <https://doi.org/10.1007/s00421-010-1439-1>

R4: **Buckley JP**, Cardoso, F, Birkett, S, Sandercock, GRH. Oxygen costs of the Incremental Shuttle Walk Test in cardiac rehabilitation participants; an historical and contemporary analysis. *Sports Med*, April 2016, DOI 10.1007/s40279-016-0521-1

R5: Grace SL, Turk-Adawi KI, Contractor A, Atrey A, Campbell NR, Derman W, Ghisi GL, Sarkar BK, Yeo TJ, Lopez-Jimenez F, **Buckley J**, Hu D, Sarrafzadegan N. Cardiac Rehabilitation Delivery Model for Low-Resource Settings: An International Council of Cardiovascular Prevention and Rehabilitation Consensus Statement. *Prog Cardiovasc Dis.* 2016 Aug 17. pii: S0033-0620(16)30081-0. Review.

R6: Mitchell BL, Lock MJ, Davison K, Parfitt G, **Buckley JP**, Eston RG. (2018) What is the effect of aerobic exercise intensity on cardiorespiratory fitness in those undergoing cardiac rehabilitation? A systematic review with meta-analysis. *Br J Sports Med.* 2018 Aug 18. pii: bjsports-2018-099153. doi: 10.1136/bjsports-2018-099153.

4. Details of the impact (indicative maximum 750 words)**What is the overarching impact?**

The impact of this research is through improving practice and changing or adding to new policies in delivering the exercise component of cardiac rehabilitation in the UK, and globally through the WHO. Professor Buckley's route to translating his research into national and international policy started to gain traction around 2006, following presentation of his research (section 3) at conferences, which then led to invitations to author national standards for the British Association for Cardiovascular Rehabilitation (BACR) and the ACPICR. Coinciding with these roles, he gained influential positions such as President of the BACPR (2009) and in collaboration with the Canadian Association of Cardiac Rehabilitation (CACR), his research and authorship on policies and practice led to further collaborations in setting up the ICCPR in 2012. The policies and practice standards of the ICCPR, including this research from the University of Chester, became of interest to the World Heart Federation, especially in 2016 where he presented his research at their World Congress in Mexico, at which point he was a co-signatory of the "Mexico Declaration" for global heart health. The common thread running through these events and opportunities is that this research was valued by front-line practitioners, which has made the testing of fitness, and guidance of exercise, more achievable in non-clinical settings. This is a core aim of all countries (developed and developing), and especially the WHO, in wanting to widen access and uptake of the very cost-effective component of cardiac care well-known as rehabilitation and secondary prevention.

Overview of National and International Collaborators and Corroborators

Professor Buckley's collaborators and corroborators in the UK include the BACPR [S1], and the ACPICR [S2]. Front-line education and service impacts [S1d] are corroborated by testimonial statements from some of the UK's largest and leading cardiac rehabilitation services in Manchester, London and Caerphilly [S2, S3 and S4]. Similarly, internationally and globally, these include the IOC [S5], the ICCPR and the WHO [S6]. Service and patient impact testimonials are also included from Canada's largest and leading cardiac rehabilitation service [S7], two of India's leading authorities and service providers in Manipal and Mumbai [S8, S9] and the Singapore Heart Foundation [S10].

National Impact

The British Heart Foundation's (BHF) annual audits of cardiac rehabilitation, dating back to 2007 (<http://www.cardiacrehabilitation.org.uk/>), have shown a clear evolution of service delivery increasingly being shifted towards community and home (nearing 50%). In ~60% of cases, an exercise capacity test is not performed and in >85% of cases not performed at discharge to evaluate both programme effectiveness and support patient's on-going exercise behaviour change as lauded by the WHO. The need for pragmatic exercise assessment and monitoring tools, are thus of increasing significance, which begins with the training of front-line practitioners. Since 2006, the BACPR has therefore rolled out specific training courses based on Professor Buckley's research into practical field-tests and improving exercise intensity monitoring with heart rate and ratings of perceived exertion.

In 2019/20, to determine the impact of these BACPR education courses and demonstrate translation into practice and policy change in the UK, a BACPR national survey on Practitioner and Patient benefits was performed [S1d]. This survey was sent to 210 of the 350 NHS cardiac rehabilitation programme service providers throughout the UK, where 51 surveys were returned. This represents 15% of the cardiac rehabilitation patient services offered in England, Wales and Northern Ireland (BHF National Audit data), representing the care of ~15,000 patients (BHF National Audit Data). The main results were that 75-84% of BACPR course attendees felt that the CPD training programmes had a 'good to very significant' impact in three areas: i. the development of professional skills to more accurately assess fitness and prescribe exercise; ii. it enhanced quality of their service delivery; and iii. it directly benefited patients' improvements.

To support the learning and teaching described above, Professor Buckley's research has impacted on the creation of new evidenced-based education and training materials, guidelines,

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and standards for the BACPR [S1] and the ACPICR [S2]. The testimonials confirm that, as a result, there has been an enhanced consistency of quality procedures and guiding practice throughout the UK. The Chair of the ACPICR, who is also clinical lead physiotherapist at the Wythenshawe Hospital in Manchester, stated *“The knowledge gained from these two courses, both by myself and my cardiac rehab colleagues, have ensured that exercise prescription and exercise delivery for the UK cardiac population is effective and safe”* [S2]. To further substantiate this, the BACPR Executive Director stated *“Over the last 15 years John has developed and delivered face-to-face BACPR CPD courses based on his research on Monitoring Exercise Intensity and Assessing Functional Capacity. These courses have been delivered to a wide audience of exercise and health professionals working in cardiovascular rehabilitation and have become key learning for professionals who are involved in the exercise component of cardiac rehabilitation”* [S1].

Key examples of the evidence of impact on policy and practice in individual cardiac rehabilitation services are demonstrated at the University Health Board, Ystrad Fawr Hospital, Ystrad Mynach, Caerphilly, Gwent, Wales [S3], and the Imperial College Hospitals Trust London [S4]. The Senior Exercise Practitioner in Cardiac Rehabilitation of Aneurin Bevan University Health Board stated [S3] *“Since attending these days I have been able to improve the quality of service delivery by standardising our clinical exercise protocols and procedures across all 4 cardiac rehab sites within the health board. As a result, all our exercise staff now assess functional capacity, prescribe exercise and monitor intensity in the same individualised way, as thought by John.”* The Senior Physical Activity Specialist at Imperial College NHS Healthcare Trust stated, *“The structure of the course was clear, logical and effective, which gave me the confidence to implement new techniques into my clinical practice immediately.”* [S4]

International and Global Impact

Following on from the known success and research in the area of pragmatic ways to assess fitness in non-clinical settings, he received an invitation from the IOC to author the chapter on cardiac rehabilitation in their Manual of Sports Cardiology [S5]. His research, noted in section 2 [R2, R3 and 4], was instrumental in his contributions to an international statement in 2016 on delivering exercise rehabilitation in low-resource settings of low-middle income countries, which obviously became of great interest to the WHO. This became a main lever of his invitation in 2017 to become part of the WHO's first meeting of the Rehabilitation 2030 initiative, linked to “rolling out” their Universal Health Care policy. Hence, between 2017 and 2020 Professor Buckley contributed to the new WHO Standards for Cardiac Rehabilitation, alongside only 9 other panel members from around the world. The Unit Head for Sensory Functions, Disability and Rehabilitation at the WHO stated that the *“work is very valuable and contributes to the development of a high quality and evidence-based Package of Interventions that will help to increase global access to cardiac rehabilitation”*. [S6]. (<https://www.who.int/rehabilitation/rehab-2030/en/>)

International examples of Professor Buckley's work with the IOC, ICCPR and the WHO include statements from a number of leading authorities from Canada, India and Singapore. A leader in Exercise Physiology and Cardiovascular Science at the University of Ottawa Heart Institute stated, *“These findings [R1 in section 3] sparked substantial discussions and action in promoting and integrating submaximal exercise testing in the cardiovascular prevention and rehabilitation program at the University of Ottawa Heart Institute, Canada's largest and foremost cardiovascular health centre.”*[S7]. This centre directly serves about 2,000 of the 63,000 Canadian patients attending rehabilitation per year.

The testimonial evidence at S8-S10 has demonstrated practice/policy implementation at Manipal College of Health Professions (India), the Sir HN Reliance Foundation Hospital (Mumbai, India), and the Singapore Heart Foundation, respectively. A Senior Lecturer at the Department of Physiotherapy at the Manipal College of Health Professions stated that the work *“has been important to not just me professionally, but also in the academic realm, where I teach my students cardiac rehabilitation”* [S8]. Similarly, the Director of the Department of Rehabilitation and Sports Medicine at the Sir HN Reliance Foundation Hospital stated, *“I am happy to say, that I have*

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implemented several of these in the clinical protocols we use at our hospital, where we treat close to 200 patients a day, in our out-patient rehab unit” [S9].

Following on from Professor Buckley’s invitation to deliver workshops and present his research to Singapore Hospitals at the Singapore Prevention and Cardiac Rehabilitation Symposium and their Sports Medicine society (between 2015 and 2018), the senior Cardiac Physiotherapist of the Singapore Heart Foundation stated “*As a result we have adopted these procedures into our standard protocols at the Singapore Heart Foundation including incorporating these into our use of the Chester Step Test” [S10].*

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

- S1:** The British Association for Cardiovascular Prevention and Rehabilitation
- Executive Director and Education Director, The British Association for Cardiovascular Prevention and Rehabilitation. C/O British Cardiovascular Society, 9 Fitzroy Square, London
 - Reference Table Booklet:
<https://www.bacpr.com/resources/BACPR%20Reference%20Table%20Booklet%20April%202019.pdf>
 - British Standards and Core Components for Cardiovascular Prevention/Rehabilitation:
<https://pubmed.ncbi.nlm.nih.gov/30700518/>
http://www.bacpr.com/resources/6A7_BACR_Standards_and_Core_Components_2017.pdf
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.982.8360&rep=rep1&type=pdf>
 - Impact Survey of frontline Practitioners and Patients attending training with Professor Buckley
- S2:** Clinical Lead Physiotherapist/Team Manager Cardiac Rehabilitation Outpatient Services Wythenshawe Hospital, Manchester University Hospital NHS Foundation Trust and the Association of Chartered Physiotherapists in Cardiac Rehabilitation www.acpicr.com
- S3:** Senior Exercise Practitioner, Cardiac Rehabilitation, Aneurin Bevan University Health Board, Ystrad Fawr Hospital, Ystrad Mynach, Caerphilly, Gwent.
<http://www.wales.nhs.uk/sitesplus/documents/866/PIU710%285%28ABUHB%29%28Active%29%28March%202019%29%20-%20Cardiac%20RehabilitationInformation%20%26%20Advice%20on%20Exercise%20.pdf>
- S4:** Lecturer and Practitioner Brunel University and Imperial College NHS Healthcare
Lecturer in Physiotherapy (Nov 2019 to present); Senior Teaching Fellow Imperial College London (Oct 2012 to Sept 2018); Senior Physical Activity Specialist Imperial College NHS Healthcare Trust (July 2011 to Nov 2019)
- S5:** Buckley, JP. International Olympic Committee Manual of Sports Cardiology, Chapter 6; *Physical Activity in the Prevention and Management of Atherosclerotic Disease*. Wiley-Blackwell, Oxford, 2016; pp 53-61.
- S6:** Unit Head, Sensory Functions, Disability and Rehabilitation, Department of Non-Communicable Diseases, World Health Organisation, Geneva, Switzerland
- S7:** Exercise Physiology and Cardiovascular Scientist, University of Ottawa Heart Institute, Ottawa, Canada
- S8:** Senior Lecturer Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India
- S9:** Director- Dept of Rehabilitation and Sports Medicine Sir HN Reliance Foundation Hospital, Mumbai, India
- S10:** Physiotherapist, Singapore Heart Foundation