Institution: University of Ulster

Unit of Assessment: 3A Allied Health Professions, Dentistry, Nursing and Pharmacy – Nursing and Health Science

Title of case study: Modified shuttle test (MST): Enabling exercise testing in clinical practice and research.

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

The modified shuttle test (MST), developed at the University of Ulster by Professor Bradley and colleagues, is an evidence-based exercise test that is having the following impacts:

1. Influencing practice through the availability of a robust easy to use exercise test.
2. Informing best-practice guidelines in cystic fibrosis (CF).
3. Shaping effectiveness evaluation.
4. Influencing training in exercise testing

2. Underpinning research (indicative maximum 500 words)

The research underpinning the MST was based at the University of Ulster over the last 10 years, and was led by Judy Bradley (Professor in Physiotherapy), facilitated by collaborations with Dr Brenda O'Neill (Senior Lecturer in in Physiotherapy), Dr Lisa Kent (Research Associate, European CF Society Standardisation Committee co-ordinator), Eric Wallace (Professor in Sport and Exercise Science), and external collaborations with Queens University Belfast and the Northern Ireland Regional Adult CF Centre (Professor Stuart Elborn).

Standardized exercise testing should be part of the regular assessment of patients with CF in order to shape their clinical management. Exercise testing facilitates the evaluation of physical limitations and symptoms, determines the exercise training recommendations, and helps with the evaluation of therapies and interventions.

The European CF Society Clinical Trials Network Standardisation Committee and the FDA 2009 (www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation /Guidances/UCM193282.pdf) highlight the importance of assessing the clinimetric properties of assessment tools. In our extensive research in the overall development of the MST we carried out rigorous assessment of the clinimetric properties[1-3]. The MST was developed by the University of Ulster research team through adaption of the original Incremental Shuttle Walk Test in Chronic Obstructive Pulmonary Disease (Singh et al 1992 doi: 10.1136/thx.47.12.1019) to enable use in CF. Adaptations included allowing subjects to run, and increasing the number of levels within the test from 12 to 15, with a maximum speed of 10.2km.h^{-1}. Our research findings highlighted that the MST has excellent test-retest repeatability, validity and responsiveness[1-4].

The large body of research from University of Ulster culminated in the production of the MST which is readily available in CD format via the University Hospitals of Leicester, Glenfield Hospital website. The vast impact of this research is verified as this test is embedded in international evidence based guidelines in CF, and therefore it is shaping international care of these patients and standard operating procedures designed by this team are available to provide guidance on how this test should be administered[5].

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

1. Bradley J., Howard J., Wallace E., Elborn S. Validity of a modified shuttle test in adult cystic fibrosis(1999) *Thorax*, 54 (5) , pp. 437-439 IF 8.376. Scopus Citation 39 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1763768/pdf/v054p00437.pdf

2. Bradley J., Howard J., Wallace E., Elborn S. Reliability, repeatability, and sensitivity of the

modified shuttle test in adult cystic fibrosis (2000) *Chest*, 117 (6) , pp. 1666-1671 IF 5.854. Scopus Citation 35
http://publications.chestnet.org/data/Journals/CHEST/21948/1666.pdf

3. JM Bradley, L Kent, B O'Neill, A Nevill, L Boyle, S Elborn 2010. Cardiorespiratory measurements during field tests in CF: Use of an ambulatory monitoring system. *Pediatric Pulmonology 2011; 3: 253-260* IF *2.375.* Scopus Citation 3
http://onlinelibrary.wiley.com/doi/10.1002/ppul.21360/pdf

4. Pryor J, Maine E, Agent P, Bradley JM (2006). Physiotherapy in CF In: Progress in Respiratory Research in CF. Editor: C.T. Bolliger, Cape Town, A. Bush, London, Co-Editors: E. Alton, London; J. Davies, London; U. Griesenbach, London, A. Jaffe, London.

5. Modified Shuttle Test for clinical trials within the European Cystic Fibrosis Society Clinical Trial Network (ECFS-CTN); Version 1: ECFS-CTN Standardisation Committee September 2012

Grants relating to the research

2004 Research and Development Small Grant Award. Cardiorespiratory measurements recorded by the LifeShirt™ system: Assessment of test-retest reliability, repeatability and responsiveness in CF [£15,000]. Awarded Prof Judy Bradley; Prof Stuart Elborn

2006 Is the LifeShirt a useful endpoint in clinical trials in cystic fibrosis? Co-operative Award in Science and Technology (CAST). [£34,860]: Awarded Prof Judy Bradley; Prof Stuart Elborn; Dr Brenda O'Neill; Lisa Kent (PhD student).

2012 PhAB Project: Patterns of Physical Activity in Patients with Bronchiectasis: Cross -sectional Study Using Qualitative Methodology [£52,477] Awarded Prof Judy Bradley; Dr Brenda O'Neill; Dr Lisa Kent; Prof Suzanne McDonough; Dr Mark Tully; Prof Stuart Elborn.

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

Influencing practice through the availability of a robust easy to use exercise test: Health care professionals nationally and internationally are using the MST in clinical practice (Sources 1,2,3). A large proportion of MSTs have been purchased by hospital organisations (84%) highlighting the accessibility and adoption of the test into clinical practice (Source 1).

In CF, the MST is used in 63% of UK CF centres using exercise testing (Source 2). These CF centres care for the total CF population in the UK, highlighting its direct impact on the total population of patients. Specialist clinician testimonies have indicated they can readily access the MST, have appropriate training to use the test via the protocols developed by our team and administer it efficiently within the clinical setting (Source 3). Clinicians indicated the MST enhanced the overall care of patients through assessment of exercise associated symptoms, evaluating physical limitations, prescribing exercise programmes and enabling clinicians to advise other exercise providers outside the healthcare sector e.g. school PE teachers (Source 3). Clinicians also have indicated that patients and/or parents/carers can easily understand the outcomes of the MST and how it applies to their home exercise programmes to promote overall patient care (Source 3). The MST has had the additional benefit of motivating patients to engage in treatment and promotes behavioural and lifestyle change resulting in long term patient impact (Source 4). Clinicians report using the MST with adults and children (above 7yrs) further highlighting the exposure and use of this test across clinical populations.

In CF, this research team leads a multi-lingual electronic platform - ECORN CF - which is accessible to CF patients, families, and the CF multidisciplinary team. The platform provides expert advice in CF internationally and is highly accessed by CF patients and clinicians. ECORN CF has provided a further mechanism to disseminate advice about the MST (Source 5).

Informing best-practice guidelines in CF: The research on the MST has contributed to and is

referenced within national and international guidelines (Source 6). These guidelines provide standards for delivery of CF care throughout the world and therefore have a direct influence on patient care and service provision. The Physiotherapy for Cystic Fibrosis in Australia: A Consensus Statement, Thoracic Society of Australia and New Zealand recommend that in CF an exercise test should be performed annually, used to assess response to treatment interventions and as an assessment tool in the prescription of exercise training programs. The guidelines indicate that the MST is appropriate to use in both children and adult CF populations for these purposes and provide a summary of the protocol for its use. The Standards of Care and Good Clinical Practice for the Physiotherapy Management of Cystic Fibrosis (First and Second edition June 2009/2011) also recommend clinicians consider use of the MST.

Shaping effectiveness evaluation: International researchers are using the MST in clinical trials in CF and other populations to evaluate the effectiveness of treatments (Source 7). The MST has been used in primary clinical studies (n=19) and reviews/surveys (n=3), and with different clinical populations including CF (n=16), cancer (n=3), obesity (n=2) and back pain (n=1). The MST has also been cited within international publications (originating from 9 countries) in CF literature (n=11) and other populations including cardiorespiratory (n=6), musculoskeletal (n=3), burns (n=1) and other (n=2). The international researchers have indicated confidence with the MST due to its ease of use, published clinimetric properties, good correlation between peak oxygen uptake and performance on the MST and its suitability for multiple clinical populations (Source 8).

Influencing training in exercise testing: Academic institutions have accessed the MST enabling undergraduate and clinical academic training on exercise testing. This research team has provided training on the MST at European and North American CF Conferences (Source 9). Physiotherapists also receive training on the test via local training programmes, ensuring that a larger proportion of the workforce are skilled in the use of this test. The test has been embedded in high quality postgraduate courses in the UK (e.g. ILH Pulmonary Rehabilitation Course) indicating how this test is being embedded in future CF care.

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

- Source 1: Sales and access to the MST.
- Source 2: Survey results of UK CF centres using the MST.
- Source 3: Clinician testimony on use of MST in clinical practice.
- Source 4: Patient and carer semi structured interview on the use of the MST.
- Source 5: ECORN CF- expert advice on CF: MST query.
- Source 6: International guidelines and standards that recommend the MST.
- Source 7: Studies which have used and/or cited the MST.
- Source 8: Researcher testimonies on the MST.
- Source 9: International training on the use of the MST.