Institution: University of Hull

Unit of Assessment: A3: Allied Health Professions, Dentistry, Nursing and Pharmacy

Title of case study: Telehealth: From Research to Mainstream Practice

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

Academics from the University of Hull led a programme of research that demonstrated for the first time that telehealth (the use of technology to support remotely the delivery of healthcare) could improve clinical outcomes for patients with heart failure.

The University's Centre for Telehealth is now recognised internationally as a leader in this area, has been identified as an exemplar of best practice, and is highly influential in developing national and European guidelines. The Centre's activities have supported the development of telehealth services for thousands of patients within the UK and Europe. It is also a key player in initiatives devoted to the enhancement of telehealth services through supporting industry and training of the health and social care workforces.

2. Underpinning research (indicative maximum 500 words)

A systematic review of telehealth/telemonitoring in heart failure carried out by researchers from the University of Hull (see Ref 1) was preparatory work for a 426-participant randomised controlled trial led by Professor John Cleland (The Trans-European Network-Home-care Management System (TEN-HMS) - Ref 2). This was a seminal study in the development of telehealth services for heart failure patients as it showed that patients supported by home-based, remote monitoring of vital signs and symptoms (telemonitoring) had significantly lower one-year mortality rates than those receiving usual heart failure care (Usual Care one-year mortality of 45% *vs* Home Telemonitoring one-year mortality of 29%). This study was the first to demonstrate clearly the potential of telemonitoring for improving clinical outcomes in patients diagnosed with heart failure.

In addition to providing evidence to support the general approach of home-based telemonitoring in heart failure patients, subsequent data analysis from TEN-HMS yielded additional insight into how best to apply the new technology in practice. Jufen Zhang and colleagues from the University of Hull (Dr Kevin Goode and Professor Cleland) carried out retrospective analysis of TEN-HMS data to develop greater understanding of the effectiveness of weight monitoring algorithms in predicting the likelihood of heart failure hospitalisation (Ref 3). The study identified that a particular computer-based algorithm (moving average convergence divergence) is more specific but less sensitive than simple 'rule of thumb' approaches to weight monitoring in predicting heart failure hospitalisation. The study also identified the weaknesses of monitoring weight alone, highlighting the need for other indicators (e.g. pulse rate and symptoms) to be tracked in parallel.

Data from TEN-HMS continue to feed into the development of the evidence base and understanding of heart failure. Recent work based upon TEN-HMS data has provided insight into the stratification and identification of risk in heart failure patients, highlighting the importance of indicators such as NT-proBNP levels and recent history of myocardial infarction (Ref 4).

Academics from the University of Hull have also contributed to systematic reviews of telehealth in which findings from TEN-HMS have been included. For example, a Cochrane review of telemonitoring in heart failure - led by a University of Hull team - found that telemonitoring was associated with a 34% reduction in all-cause mortality and 21% reduction in heart failure related admissions when compared to usual care (Ref 5). A subsequent review of patients following discharge from hospital following admission with heart failure demonstrated beneficial trends in outcomes, including a 23% reduction in all-cause mortality, associated with telemonitoring (Ref 6).

The research in Hull was undertaken between 2003 and 2013, primarily by Professor John Cleland (Professor in Cardiology since 1999), Dr Kevin Goode (research fellow since 2001) and Jufen Zhang (Statistical analyst).

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

1) Louis AA, Turner T, Gretton M, Baksh A, Cleland JG. A systematic review of telemonitoring for

the management of heart failure. *Eur J Heart Fail.* 2003 Oct;5(5):583-90.

2) Cleland JG, Louis AA, Rigby AS, Janssens U, Balk AH; TEN-HMS Investigators. Noninvasive home telemonitoring for patients with heart failure at high risk of recurrent admission and death: the Trans-European Network-Home-Care Management System (TEN-HMS) study. *J Am Coll Cardiol*. 2005 May 17;45(10):1654-64.

3) Zhang J, Goode KM, Cuddihy PE, Cleland JGF. Predicting hospitalisation due to worsening heart failure using daily weight measurement: an analysis of the Trans-European Network-Home-Care Management System (TEN-HMS) Study. *Eur J Heart Fail* 2009; Apr;11(4):420-427.

4) Zhang J, Goode KM, Rigby A, Balk AHMM, Cleland JGF. Identifying patients at risk of death or hospitalisation due to worsening heart failure using decision tree analysis: Evidence from the Trans-European Network-Home-Care Management System (TEN-HMS) Study *Int J Cardiol* 2013 Feb 20; 163(2):149-156

5) Inglis SC, Clark RA, McAlister F, Ball J, Lewinter C, Cullington D,Stewart S, Cleland JG. Structured telephone support or telemonitoring programs for patients with chronic heart failure (Protocol). *Cochrane Database of Systematic Reviews*; 2010 Aug 4; (8): CD007228. Review.

6) Remote monitoring after recent hospital discharge in patients with heart failure: a systematic review and network meta-analysis. Pandor A, Gomersall T, Stevens JW, Wang J, Al-Mohammad A, Bakhai A, Cleland JG, Cowie MR, Wong R. *Heart*. 2013 May 16. [Epub ahead of print]

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

The findings of TEN-HMS and the subsequent systematic reviews have had a substantial impact on the development of telemonitoring and – more broadly – telehealth services locally, nationally and internationally[1]. Much of the impact since 2009 has been facilitated through the University of Hull's 'Centre for Telehealth', a cross-faculty collaboration established to further the development and delivery of remote care services.

The initial impact of TEN-HMS was the development of a telehealth service for heart failure patients in Hull. Not only was the development of this service a direct result of the benefits seen in the TEN-HMS study, but the clinical triage of remotely collected patient data was (and still is) carried out by clinical staff appointed jointly by the University of Hull and the NHS. Since July 2009, the heart failure telemonitoring service has been commissioned directly by NHS Hull, accounting for approximately £1million of healthcare spending. Between 2009 and 2011, telehealth services in Hull were co-ordinated through a multi-agency stakeholder group, led by Hull City Council and including Professor Cleland and other representatives from the University of Hull. This innovative and inclusive commissioning and governance arrangement has received national attention, notably being cited as best practice in a King's Fund publication on enhancing the adoption of telehealth[2].

Over 400 heart failure patients in Hull have benefited from telehealth services. Evaluations carried out on behalf of commissioners have suggested that for every 10 patients receiving the service, one all-cause hospital admission is averted every month. This reduction in admissions has yielded commissioners net savings of at least £100k/year[3].

The success of the Hull heart failure service provided the catalyst for long-term, larger-scale commissioning of telehealth services in the city. Hull's Clinical Commissioning Group now invests over £250k per annum into telehealth services, with a recruitment target of 1000 patients by 2015. As key players in the development, delivery and evaluation of telehealth in Hull, the University is represented on both the commissioning and delivery groups associated with this service.

The expertise and methodologies developed in local services have spread nationally. Evaluations of telehealth services – which are used to inform future service development and commissioning – have been carried out (or are being carried out) by the University's Faculty of Health and Social Care (FHSC) on behalf of NHS East Riding of Yorkshire, NHS Stoke-on-Trent, NHS South of Tyne

and Wear, NHS Durham and Merck Sharp & Dohme (MSD). Overall, these projects encompass over 1000 patients and healthcare investment of over £1M. Where these evaluations have been completed, they have informed the targeting of resources to provide greater efficiency in care delivery – for example, data from the NHS Stoke-on-Trent evaluation underpinned a shift in investment toward simpler, text-based telemonitoring services[3].

In 2011-12, the University's reputation for understanding and implementing telehealth led to participation in a £900k Yorkshire and the Humber Strategic Health Authority (SHA) funded project to develop a regional 'Telehealth Hub'. The University contribution - led by FHSC - involved support and evaluation of telephone coaching, video-consultation and telemonitoring services across Hull, Barnsley and Airedale. A full evaluation report was published by 2020Health, concluding that the hub benefitted 2100 patients and yielded over £500k in savings[4].

The Telehealth Hub has been recognised as a Reference site for the European Innovation Partnership on Active and Healthy Ageing. The hub is one of 32 reference sites across the EU, and one of only 13 who received a three-star rating – the highest awarded during the evaluation process[5]. Further international recognition has been gained by staff from the University of Hull being invited to participate in a best practice telehealth exchange programme between the UK Department of Health and the Veterans' Health Administration in the USA[6].

The University's telehealth research also continues to have a major impact on policy and international guidelines for heart failure management. Studies stemming directly from TEN-HMS (Ref 2 and 3) are heavily cited within European Society of Cardiology guidelines on the self-care management of heart failure[7], and were included in a recent NIHR Health Technology Assessment that highlighted the clinical benefits of telemonitoring in heart failure patients[8].

The impact of Hull's telehealth research has also enhanced the delivery of care through work with industry partners, educational organisations and skills sector bodies. Philips Healthcare was an industry partner in the TEN-HMS study, through the use of their Motiva telehealth system. The study gave Philips a platform for developing and marketing Motiva, thereby building sales and enhancing services. Motiva is now one of the market-leading telehealth systems and was used within the Department of Health's flagship telehealth RCT, the Whole System Demonstrator. Philips have a Master Research Agreement with the University of Hull. This agreement not only enhances current telehealth products and services, but also maintains a strong collaboration between industry and academia facilitating effective and on-going knowledge transfer[9].

FHSC has an on-going relationship with Virtual College; a private provider of online education. Staff from FHSC contributed to the development of an eLearning module focusing on Telehealth, which was made available nationally. This module has now been accessed by over 1000 students nationwide. FHSC has continued to work with Virtual College on developing a new Assistive Technology learning and development framework (and associated learning resources) on behalf of Skills for Care[10]. In addition, the University is working closely with Skills for Health to review and refresh National Occupational Standards for Assistive Technologies – new standards will be published early in 2014.

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

1. HEFCE cited the impact of the University of Hull in developing telehealth services in its 2011 review of HEIF case studies - www.hefce.ac.uk/media/hefce1/news/hefce/2011/HEIFcasestudies_2011.pdf

2. The multi-agency approach to telehealth delivery is cited as good practice in; Clark M, Goodwin N (2010) Sustaining innovation in telehealth and telecare. King's Fund, London (p24).

3. Evaluations of local services, such as those in Hull and the East Riding of Yorkshire, can be found at; http://www2.hull.ac.uk/administration/business/centrefortelehealth/evaluations.aspx. These reports were commissioned and approved by local services, but developed and written by David Barrett from FHSC.

4. The independent evaluation of the Telehealth Hub project by 2020Health (with activity and outcome summaries by the University of Hull) can be found at;
http://www.2020health.org/2020health/Press/latest-news/Yorkshire-Telehealth.html

5. A full list of reference sites and their star ratings can be found at http://europa.eu/rapid/press-release_IP-13-633_en.htm and a full description of sites is available at http://ec.europa.eu/digital-agenda/en/news/excellent-innovation-ageing-european-guide-reference-sites-european-innovation-partnership

6. Details of the best practice exchange of which the University is part can be found at
http://www.2020health.org/2020health/Press/latest-news/Making-Connections.html

7. Findings from TEN-HMS data are cited in European Heart Failure guidelines:
Lainscak M et al. Self-care management of heart failure: practical recommendations from the Patient Care Committee of the Heart Failure Association of the European Society of Cardiology *Eur J Heart Fail* 2011: 13(2): 115-126.

8. The Health Technology Assessment of telemonitoring in recently discharged heart failure patients (which includes findings from TEN-HMS) can be found at
http://www.journalslibrary.nihr.ac.uk/__data/assets/pdf_file/0007/76588/FullReport-hta17320.pdf

9. A letter of support from Philips Healthcare.

10. Skills for Care Assistive Technology Workforce development resources developed in partnership with the University of Hull can be found at;
http://www.skillsforcare.org.uk/developing_skills/assistedlivingtechnologyresourcehub/assisted_living_technology_resource_hub.aspx