



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

role as an adjunct to practical teaching but not an alternative to traditional live demonstrations.

**Impact:** The research suggests video tutorials have a role as an adjunct but not an alternative to traditional live demonstrations. Students stated that they prefer traditional live demonstrations, however, students level of skill increased following the use of video tutorials. Further research is required to ascertain the value of using interactive on-line tutorials as an alternative to face to face classroom teaching and the influence of learning via video tutorials on students future clinical practice and service user care.

**Funding acknowledgements:** None.

<https://doi.org/10.1016/j.physio.2021.12.010>

P005

**An artificial intelligence platform for movement analysis and rehabilitation: Clinical applications of stepsense to complex pain and long covid**

A. Pelah<sup>1,\*</sup>, V. Sarangi<sup>1</sup>, E. de Villiers<sup>2</sup>, N. Shenker<sup>3</sup>, T. Stone<sup>4</sup>, P. Estibeiro<sup>5</sup>, E. Barenholtz<sup>6</sup>, X. Levy<sup>7</sup>, G. Fields<sup>8</sup>

<sup>1</sup> *University of York, Department of Electronic Engineering, York, United Kingdom*

<sup>2</sup> *Addenbrooke's Hospital, Department of Physiotherapy, Cambridge, United Kingdom*

<sup>3</sup> *University of Cambridge, Department of Medicine, Cambridge, United Kingdom*

<sup>4</sup> *Addenbrooke's Hospital, Department of Medical Physics, Cambridge, United Kingdom*

<sup>5</sup> *Crucible Medtech Ltd, Glasgow, United Kingdom*

<sup>6</sup> *Florida Atlantic University, Center for Complex Systems & Brain Sciences, Boca Raton, United States*

<sup>7</sup> *Florida Atlantic University Medical School, Clinical Research Unit, Boca Raton, United States*

<sup>8</sup> *Florida Atlantic University, Institute for Human Health and Disease Prevention, Boca Raton, United States*

**Keywords:** Gait analysis; Long Covid; Artificial intelligence

**Purpose:** The study describes two exemplar clinical applications of the StepSense platform to virtual reality (VR) biofeedback rehabilitation in complex pain and to assessment of gait and balance in post-acute Covid-19 ('Long Covid').

**Methods:** StepSense is a low-cost, high performance gait and movement analysis system that uses machine learning (ML) to extract 3-dimensional (x–y–z) skeletal joints dur-

ing patient movement from plain 2-dimensional video. The captured musculoskeletal (MSK) movements animate a rendered avatar seen within a VR environment to provide a gamified biofeedback display in real-time. Examples will be given for each of the platform's three components: StepSense Clinic, deployed for MSK or neurological assessment and VR-rehabilitation in hospital or clinical settings; StepSense Home, a smartphone-based app for assessment and real-time VR rehabilitation in a person's home or in care-home facility; and StepSense Lab, a cloud-centred telemedicine infrastructure that provides clinicians with browser-based data visualisation, clinical evaluation and ML analytics to assist with decisions on diagnostics and therapy.

**Results:** Chronic pain conditions such as fibromyalgia, lower back pain (LBP) and complex regional pain syndrome (CRPS) share common features of motor neglect and affect hundreds of thousands of people in the UK that incur high costs to the economy and the National Health Service. In a single-site clinical trial using StepSense technology (*Brain Sci.* 2021, 11, 4), 10 participants with one or more of the above conditions were randomly allocated to intervention (VR biofeedback) or control (no VR biofeedback) groups and underwent a treadmill task three times per week for two weeks. Primary outcomes of distance walked (at baseline compared to the final 5-minute cycle of week 2) and the Lower Extremity Functional Index (LEFI) questionnaire were evaluated.

**Conclusion(s):** In the complex pain study, distance walked was significantly higher in the intervention group ( $p < 0.05$ ) with 33% (2/6) reporting clinically improved LEFI improvement at week 2 compared to 0% (0/4) in the control group. The intervention group received significantly higher satisfaction scores that controls on follow-up at week 24. Additional findings are reported on gait, balance and cognition effects in persons with Long Covid compared with healthy controls.

**Impact:** While signs of the UK emerging from the coronavirus pandemic are promising, a growing number of people continue to suffer from post-acute manifestations of the disease. According to the Office of National Statistics, over a million people report having symptoms after four weeks while 1 in 7 still report symptoms 12 weeks later; 20% of people report that symptoms such as chronic fatigue, joint pain and 'brain fog' are adversely affecting their daily lives. The growing prevalence of 'Long Covid' sufferers has prompted NHS England to launch about 70 specialist clinics, yet with over 20 distinct problems being observed the condition is poorly understood and treatments are illusive. The StepSense platform is an AI-driven technology that provides an end-to-end solution for the measurement, clinical evaluation, treatment and investigative analysis of gait and balance in conditions such as Long Covid as well as other manifestations of health and disease that cut across healthcare.



**Funding acknowledgements:** Funded in part by a grant to AP under the Grow MedTech Proof of Feasibility programme, supported by UKRI Research England's Connecting Capability Fund [project code: CCF11-7795].

<https://doi.org/10.1016/j.physio.2021.12.011>

**P006**

### An evaluation of the safety of telephone first consultations in physiotherapy MSK practice



C. Clarkson<sup>1,\*</sup>, Y. Gibbons<sup>1</sup>, A. Roe<sup>1</sup>,  
E. Whitby<sup>1</sup>, H. Carter<sup>1</sup>, A. Williamson<sup>1</sup>,  
R. Yerburch<sup>1</sup>, R. Smith<sup>1</sup>, B. Smith<sup>1,2</sup>

<sup>1</sup> *University Hospitals of Derby and Burton NHS Foundation Trust, Derby, United Kingdom*

<sup>2</sup> *University of Nottingham, School of Medicine, Nottingham, United Kingdom*

**Keywords:** Telephone; Safety; Avoidable-harm

**Purpose:** The rapid introduction of telephone first physiotherapy provoked questions regarding the safety of this consultation approach. A number of studies examine the diagnostic challenges associated with telephone consultations, and primary care research has exposed diagnostic error as the most prevalent cause of avoidable harm. This queried whether physiotherapy patients were being exposed to avoidable harm linked to the diagnostic difficulties associated with the telephone first consultation. Could this be explored by tracing adverse clinical events and using a retrospective physiotherapy case notes review to investigate a link between potential avoidable harm and the telephone first intervention?

**Methods:** Hundred physiotherapy new patients were randomly sampled from a total population of 323 receiving a telephone first physiotherapy consultation between 01/06/2020 and 30/06/2020. Six physiotherapists searched the hospital electronic database to explore Emergency Department attendances and/or hospital admissions following the initial consultation up to 01/01/2021. In all cases identified, a panel of five physiotherapists carried out a retrospective physiotherapy notes review. Cases were highlighted where escalation in care could have been minimised by more appropriate and timely physiotherapy intervention. Levels of harm and avoidability were assigned to each case, taken from a validated classification system. Contributory factors were discussed with emphasis on the telephone first consultation.

**Results:** There were 52 Emergency Department attendances and/or hospital admissions in 24 of the 100 sampled patients during the six month period following the initial physiotherapy telephone consultation. One case of significant harm with evidence of possible avoidability linked to the physiotherapy telephone assessment was identified; a 50 year old male patient with a four month history of lower back pain was admitted to hospital with pyogenic spondylodiscitis

six weeks following their initial physiotherapy telephone consultation. A more expedient diagnosis may have minimised the need for extended clinical intervention.

**Conclusion(s):** The exclusion of a physical examination in the identified case may have contributed to the diagnostic error leading to avoidable harm. The absence of patient observation, lumbar mobility testing, neurological and palpation assessment may have led to the omission of appropriate flagging and escalation in care. Inadequacies in the telephone first assessment including the lack of systemic red flag screening and safety netting and the possibility of structural discrimination in this intra-venous drug user may also have been contributing factors. Using a larger sample size and comparing with a similar face to face first group would have provided more robust evidence regarding the relative contribution of the telephone first consultation leading to avoidable harm.

**Impact:** Identifying and understanding avoidable harm will inform targeted mitigating measures to ensure safe MSK practice. Appropriate screening during the initial telephone assessment in those individuals requiring a physical examination and/or escalation is essential in limiting future avoidable harm. Regular clinical training regarding red flag screening and safety netting, in line with evidence based practice and discussion regarding unfamiliar presentations is advocated. Ensuring parity of care across ethnic and deprived socio-economic groups and providing a safe venue for open discussion where MSK management has been inadequate is considered imperative to promote constructive change and optimise safe service delivery.

**Funding acknowledgements:** The work was not funded, 30 physiotherapist working hours were approved by the Therapy Clinical Team Lead to conduct this service evaluation.

<https://doi.org/10.1016/j.physio.2021.12.012>

**P007**

### An investigation of mobile health (mHealth) applications available to support knee arthroplasty rehabilitation and recommendations for implementation: A scoping review



S. Wilcox<sup>1,\*</sup>, K. Cook<sup>1</sup>, J. Drunis<sup>2</sup>

<sup>1</sup> *University of Winchester, Faculty of Health and Wellbeing, Winchester, United Kingdom*

<sup>2</sup> *The Royal Hampshire County Hospital, Orthopaedic Department, Winchester, United Kingdom*

**Keywords:** mHealth; Applications; Arthroplasty

**Purpose:** Length of hospital-stay following total knee arthroplasty (TKA) is approximately 1-3 days, with associated costs of revisions around £75,000 per patient. Patient control of recovery, self-management and compliance to home-based rehabilitation is therefore of utmost importance.