acpin
Connecting knowledge and practice

MARCH 2021

Synapse

OFFICIAL JOURNAL OF THE **ASSOCIATION OF CHARTERED PHYSIOTHERAPISTS IN NEUROLOGY**

INSIDE

Synapse
MARCH 2021

Welcome

Dear members,

Happy New Year for 2021! Hopefully, our personal and professional lives will have a brighter and more positive feel following the recent government announcements to cautiously ease lockdown restrictions in the UK.

Despite the challenges, we have received some interesting studies for publication in *Synapse*. In this edition, in addition to peer-reviewed articles, we are fortunate to include an editorial from Dr Avril Drummond, occupational therapist and Professor of Healthcare Research at the University of Nottingham. Professor Drummond was invited to the UK Stroke Forum in December 2020 to present 'The Princess Margaret Memorial stroke keynote lecture' and her topic was 'Stroke rehabilitation: BIG results require BIG ambitions' which is inspiring to read.

The aim of *Synapse* – the official journal of ACPIN – is to provide its readership (nationally and internationally), including wider multi-disciplinary teams, an international, peer-reviewed platform for the publication, dissemination, knowledge exchange and discussion of recent developments and current research in the field of neurological rehabilitation.

The journal accepts original, quantitative and qualitative research reports, theoretical papers, systematic literature reviews, scoping reviews, service evaluations, quality improvement programmes, clinical case reports and technical clinical notes.

If you are interested in submitting your work for publication in *Synapse*, please follow the guidelines for manuscript preparation presented on page 37 and send your work for inclusion in the peer-review process. I look forward to receiving high-quality work for publication.

Praveen Kumar

Dr Praveen Kumar
EDITOR

Contents

Stroke rehabilitation: BIG results require BIG ambitions

The Princess Margaret Memorial stroke lecture

Avril Drummond Occupational Therapist and
Professor of Healthcare Research, University of Nottingham

In December 2020, I was honoured to be invited to give the Princess Margaret lecture at the UK Stroke Forum national conference. My key aim was to emphasis the central, essential and ongoing role of stroke rehabilitation. However, I also wanted to take the opportunity to share my reflections on over thirty years of working in the field as a clinician, an educator and as a researcher.

> *…but what is potentially more frightening is that the predictions for the burden of disease are set to double worldwide by 2035.*

We all know that the numbers of people having a stroke globally are huge – every two seconds someone has a stroke for the first time[1] – but what is potentially more frightening is that the predictions for the burden of disease are set to double worldwide by 2035[2]. It is almost an irony that as more people survive stroke because of advancing medical and surgical interventions (for example, using clot retrieval and the use of the so-called 'clot-busting' drugs), the more survivors require rehabilitation. Such a 'big' problem needs a 'big' result in three key areas: in building a robust evidence base through conducting high-quality trials and studies; in improving patient and carer outcomes; and in building and sustaining high-quality teams. These results will require 'big' ambitions across both our research agendas and in our clinical practice.

With regard to research, there is a need to have ambitions to reduce the current red tape and bureaucracy – just as we have done in fast-tracking recent COVID-19 trials and studies. At present there are just too many obstacles which both impede research and are off-putting to potential researchers. Clearly safeguards are important, but often much of the paperwork seems unhelpful and there seems much duplication and 'hoop' jumping.

We also need to be ambitious in the questions we ask – and to ask those questions that really matter. The James Lind Alliance research priorities have been important to guide researchers in the past[3] and we look forward to their new priorities which will be published in 2021. Bluntly, research endeavours addressing issues outside the first 20 priority areas need careful consideration. We must also address the difficult problems – the questions that stroke survivors and their carers need answers to – questions such as dose in testing interventions and how best to maximize upper limb function – not just tackle low-hanging fruit. This is an ambitious challenge which requires commitment and funding.

In 1994, Altman[4] noted that "everybody is so busy doing research, they don't have the time to stop and think about how they are doing it". Sadly, this observation is still true today. We need to think more about the methodologies we use and not just continue to roll out the same designs and ways of conducting our research. We must think outside the box. One example is the HOVIS feasibility trial of home visits[5]; we knew that some therapists were concerned about enrolling patients into a trial where they could be allocated to the control group (no visit). We therefore used a design previously used in surgery where clinicians had control of setting criteria for the trial and where data could also be collected on patients who were not part of the randomisation process. The recruitment graph and results from HOVIS show this was a successful strategy, that the numbers were achieved and that, interestingly as the trial progressed, the therapists were more likely to enrol patients into the main trial.

Finally, we need to have the bravery and confidence to report honestly and tell others of our mistakes and learning in research. We need to remember stroke rehabilitation advances by sharing intelligence around outcome measures which were problematic, difficulties with recruitment strategies, and problems in delivering the intervention being tested. One excellent example of this is the first large RCT in stroke rehabilitation – TOTAL[6]: here there were key issues around adherence to group allocation (that is, the fidelity) – and this was an important learning point for subsequent trials and studies. The ambition to share such knowledge widely and openly will improve and advance rehabilitation research.

With regards to clinical practice, we need to recognise that we have serious problems with implementation – that is, how we roll research out into clinical practice. One important issue is how we operationalise clinical guidelines: a recommendation may sound appropriate, but making it happen may be difficult. Let us consider the recommendation to assess patients with stroke for cognitive problems: this seems sensible and realistic – but when we start to investigate how this might be done practically[7] we find that there are significant challenges around choice of assessments and communication on the coal face. There are similar real problems in rolling out excellent research in practice – and this needs addressing.

There are also issues around setting clinical priorities and in striking the balance between providing treatment and attending ward rounds, handovers and completing paperwork. Clarke *et al*[8] reported on how units viewed as more successful in providing treatment balanced all these aspects. There is no rocket science here – the better units timetabled their patients and spent less time in all other activities than those units which were not considered so strong. There is a reminder here for us all in determining what the day job actually is and ensuring that this is where our priorities and ambitions lie. There are also important lessons to be recognised around not sleepwalking into new ventures which might sound excellent – but which have little support in terms of the available research. We must not just accept new ways of working without evaluation. To some extent we have had to do this because of COVID-19 – but post COVID we must have a stock check and ensure that what we are doing is effective.

Finally, we need to focus on our workforce and ensure it is ‘up to speed’. We must be ambitious in our disciplines and for stroke rehabilitation more broadly and we must recognise that skilled therapists and researchers are relatively expensive. We need to invest in this expertise and we need to prioritise the value of this. We are often quick to undersell what we do – and this is not helpful. It is frankly amazing that as soon as we appreciate the value of a skill, we seem to want to find out how we can do the same thing ‘on the cheap’: expertise rarely comes cheap.

To summarise, we need to be ambitious for stroke rehabilitation – for ourselves but also for our patients, their family and their carers. We have ‘big’ problems ahead and these need ‘big’ results – so we must be ready to meet the challenges. We need to be market disrupters in much the same way that companies are commercially – and not just accept the status quo. We have made excellent progress to date and there is much to be proud about, but we can do more and we can do better. As Michelangelo said – the greatest danger is not that we aim too high and miss it, but that we aim too low and reach it. Our ambitions must be BIG!

It is almost an irony that as more people survive stroke because of advancing medical and surgical interventions (for example, using clot retrieval and the use of the so-called ‘clot-busting’ drugs), the more survivors require rehabilitation.

REFERENCES

1. Stroke Association (2018) *State of the nation* Stroke Statistics.
2. Feigin VL, Forouzanfar MH, Krishnamurthi R *et al*, (2013) *Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study 2010* *Lancet* 383 pp245-255.
3. Pollock A, George BS, Fenton M and Firkins L (2012) *Top ten priorities relating to life after stroke* *The Lancet Neurology* 11 (3) p209
4. Altman DG (1994) *The scandal of poor medical research* *British Medical Journal* 308 p283.
5. Drummond A, Whitehead P, Fellows K, Sprigg N, Sampson C, Edwards C, Lincoln NB (2013) *Occupational therapy predischarge home visits for patients with a stroke (HOVIS): results of a feasibility randomized controlled trial* *Clinical Rehabilitation* 27 (5) pp387-397.
6. Parker CJ, Gladman JRF, Drummond AER, Dewey ME, Lincoln NB, Barer D, Logan PA, Radford KA on behalf of the TOTAL study group (2001) *A multi-centre randomized controlled trial of leisure therapy and conventional occupational therapy after stroke* *Clinical Rehabilitation* 15 (1) pp42-52.
7. Ablewhite J, Geraghty J, das Nair R, Drummond A (2019) *Cognitive Management Pathways in Stroke Services (COMPASS): A qualitative investigation of key issues in relation to community stroke teams undertaking cognitive assessments* *British Journal of Occupational Therapy* 82 (7) pp404-411.
8. Clarke D, Burton L, Tyson S, Rodgers H, Drummond A, Palmer R, Hoffman A, Prescott M, Tyrrell P, Brick L, Forster A (2018) *Why do stroke survivors not receive recommended amounts of active therapy? Findings from the ReAcT study, a mixed-methods case-study evaluation in eight stroke units* *Clinical Rehabilitation* 32 (8) pp1119-1132.

ACKNOWLEDGEMENTS

I would like to thank friends and colleagues for supporting the preparation for this lecture and those who have guided and inspired me over many years: Jo Ablewhite, Jon Barrick, Julie Bernhardt, Juliet Bouverie, Louise Clark, Geoff Cloud, Pam Enderby, Anne Forster, Nicola Hancock, Martin James, Fiona Jones, Peter Langhorne, Natasha Lannin, Alex Leff, Nadina Lincoln, Ellie McMullen, Fiona Nouri, Tom Robinson, Helen Rodgers, Fiona Rowe, Tony Rudd, Cath Sackley, Nikola Sprigg, Shirley Thomas, Pippa Tyrrell, Frederike van Wijck, Derick Wade, Marion Walker, Nick Ward, Caroline Watkins, Sammy Williams, and many, many stroke survivors’ carers. Also my special thanks to my family.

The effectiveness of mechanical insufflation-exsufflation in preventing respiratory complications for adults with spinal cord injury –
a systematic literature review

Jaime Wesemael BSc (Hons)[1], **Eleanor Van Dongen** BSc (Hons)[2],
Ebony Troy BSc (Hons)[3], **Catherine Tambling** BSc (Hons)[4],
Debbie Hubbard BSc (Hons)[5]

Spinal cord injury (SCI) is a complex condition that has a profound impact on individuals. Respiratory complications are the leading cause of mortality in this population. Consequently, optimal respiratory management is vital. Mechanical insufflation-exsufflation (MI-E) is a physiotherapeutic intervention utilised to prevent and treat respiratory complications following SCI.

> *In the UK, around half of all SCIs occur at the cervical level, with 84% of C1–C4 injuries resulting in respiratory complications.*

Spinal cord injury

The term spinal cord injury (SCI) refers to neurological damage of the spinal cord[1]. The spinal cord conveys sensory and motor messages between the brain and peripheral nervous system[1]. Therefore, damage profoundly affects individuals resulting in either temporary or permanent disability[2]. SCI is a life-changing condition considered to be medically complex[3].

Approximately 1,000 individuals sustain a SCI annually in the United Kingdom (UK) [4], most commonly from a traumatic cause[3]. This may result in substantial economic burden, although Kellezi *et al.*[5] recognised few UK studies reported on the costs to health services or patients. Individuals are likely to require action from multiple services due to the severity of the injury and added health complications that arise[6], accounting for additional health costs.

Secondary health problems are common following SCIs[7]. For example, during the acute phase, spinal shock can occur as a consequence of the loss of neural transmission resulting in reduced sensation, areflexia and flaccid motor paralysis[8]. Spinal shock can last for hours, weeks or even months, thereby increasing secondary risks such as respiratory complications[9]. Aiaansen *et al.*[10] reported secondary complications contribute to worsening quality of life (QOL) as well as decreased life expectancy.

Respiratory complications

In the UK, around half of all SCIs occur at the cervical level[11], with 84% of C1-C4 injuries resulting in respiratory complications[12]. Patients with thoracic SCIs are also at increased risk with 51% of T1–T6 injuries and 35% of T7–T12 injuries resulting in respiratory complications[13]. SCI can either be complete or incomplete; defined by the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI)[14,15]. The degree of respiratory compromise correlates highly with the level and completeness of injury. The higher the ISNCSCI classification, the more complex the treatment, with greater health complications and worsening QOL.

The leading causes of mortality in both acute and chronic SCI are the consequences of muscle paralysis, bronchoconstriction, excess secretions, and ventilation/perfusion mismatch[16]. In acute cervical and thoracic SCI, the most common respiratory complications are atelectasis (36%), pneumonia (31%) and ventilatory failure (23%) which all exacerbate these life-threatening symptoms[17,18]. Consequently, early and preventative respiratory management is of paramount importance for all individuals with an acute SCI above T12. Continued respiratory management is also highly recommended as pneumonia is the primary cause of mortality for patients with chronic SCI[19].

---

[1] Band 5 Rotational Physiotherapist, Great Western Hospital.
[2] Band 5 Rotational Physiotherapist, Whittington Health Trust.
[3] Grade 9 Rotational Physiotherapist, Jersey General Hospital.
[4] Band 5 Rotational Physiotherapist, Gloucestershire Hospitals NHS Foundation Trust.
[5] Senior lecturer in Physiotherapy at University of the West of England Bristol.

The cough reflex is imperative for secretion mobilisation and lung protection[20]. The cough mechanism is regulated at the brainstem through the stimulation of sensory nerves innervating the external intercostal muscles, abdominal muscles and the diaphragm[1]; all of which are innervated above T12. Without adequate innervation of these muscles, lung function measurements are reduced, specifically peak expiratory flow rate (PEFR) and peak cough flow (PCF)[21]. An ineffective cough leads to sputum retention; increasing airway resistance, decreasing pulmonary compliance, and occasionally resulting in respiratory failure[22]. Therefore, the patients who are at an increased risk of respiratory complications due to an ineffective cough, include both cervical and thoracic SCIs. Respiratory muscle innervation is spared in patients with lumbar spine injury meaning their cough is not affected.

Mechanical insufflation-exsufflation

Mechanical insufflation-exsufflation (MI-E) is a positive pressure device that stimulates airflow and facilitates the removal of sputum for those with reduced PCF[22]. MI-E delivers a positive pressure that encourages maximal inflation of the lungs, before abruptly switching to negative pressure that enhances expiratory flow[23]. MI-E serves to aid sputum clearance, increase chest wall and lung compliance and may reduce atelectasis[24]. Although suctioning also uses negative pressure to drive sputum clearance[25,26], MI-E has been found to be preferable as it causes less patient discomfort due to its decreased mucosal trauma[27,28]. Within clinical practice MI-E is used to facilitate airway clearance[22], prevent intubation[29], and to facilitate weaning and extubation/decannulation[30].

Current evidence

The overall quality of research for the efficacy of cough augmentation in the critically ill population is poor[31]. Sheel, Welch and Townson[32] identified a large body of evidence exploring cough augmentation techniques, including MI-E, for patients with neuromuscular disease (NMD) and multiple sclerosis[33]. However, there seems to be a paucity of literature in the SCI population, specifically for the prevention of respiratory complications.

Evidence investigating the use of MI-E for patients with SCI is particularly sparse. The lack of robust research results in limited guidelines for the use of MI-E for the prevention and treatment of respiratory complications in those with SCI. Therefore, MI-E is implemented in clinical practice based on best practice recommendations and the next best available evidence[34], which uses alternative populations, such as NMD[35]. The ability to generalise these findings to the SCI population is limited as the natural progression of respiratory complications for the two conditions differ[21].

Rationale for systematic literature review

To the authors' knowledge there is no existing systematic review evaluating the use of MI-E for patients with SCI. In the absence of high-quality reviews guiding physiotherapy practice[15], questions remain about the effectiveness of MI-E within the SCI population and for the prevention of respiratory complications. The research question this systematic review looks to address is: Does the use of mechanical insufflation-exsufflation prevent respiratory complications in adults with cervical or thoracic spinal cord injury?

Aims

The aims of this research are:

- To systematically review the effectiveness of MI-E in the prevention of respiratory complications in adults with SCI.
- To review the quality of the included studies.
- To build on the existing evidence to influence clinical practice.

To the authors' knowledge there is no existing systematic review evaluating the use of MI-E for patients with SCI.

Methodology

Throughout this systematic review, the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines[36] were followed. This review was not prospectively registered.

Study design

A systematic review of primary literature which investigated the effectiveness of MI-E for the prevention of respiratory complications in patients with SCI was carried out between September 2018 and April 2019.

Eligibility criteria

A modified population, intervention, comparison, outcome (PICO) framework was used for the development of the research question which guided the inclusion/exclusion criteria. For an article to be included within this review, all participants involved must have been over 18 years old, had a diagnosis of a SCI above T12, and they must have had MI-E intervention. All articles must be primary research, written in English and the full-text accessible for free. Respiratory complications are also important for inclusion. However, the involvement of outcome measures which may indicate the development of those respiratory complications will also be included to address the aim of this review.

Information sources

For the development of the search terms, the sole use of 'population' and 'intervention' were selected to broaden the findings due to the

Search number	Search terms
1	'spinal cord injur*' or 'spinal cord damage' or 'SCI' or 'Quadriplegi*' or 'Tetraplegi*' or 'Spinal cord compression' or 'SCC'
2	'cough assist' or 'MI:E' or 'MIE' or 'MI-E' or 'CAD' or 'mechanical insufflat* exsufflat*' or 'mechanical insufflat*-exsufflat*' or 'mechanical insufflat*/exsufflat*' or 'cough assist* device' or 'mechanical in-exsufflat*' or 'cough assist machine' or 'Cough augmentation' or 'Mechanical cough augmentation' or 'insufflation' or 'exsufflation' or 'Mechanical assisted cough'
3	Search 1 and 2

* denotes truncation

Table 1 Search Terms. A table showing the complete list of search terms used for the EMBASE, Cochrane Library and AMED literature searches.

paucity of relevant literature[37]. Synonyms were discussed within the research group through widely searching the literature for all differentials. During February 2019, the researchers searched all available articles within AMED, CINAHL, Cochrane Library, EMBASE, MedLine, PEDro, SPORTDiscus. The final search terms used for EMBASE, Cochrane Library and AMED searches (which included CINAHL, MedLine and SPORTDiscus) are displayed in *Table 1*.

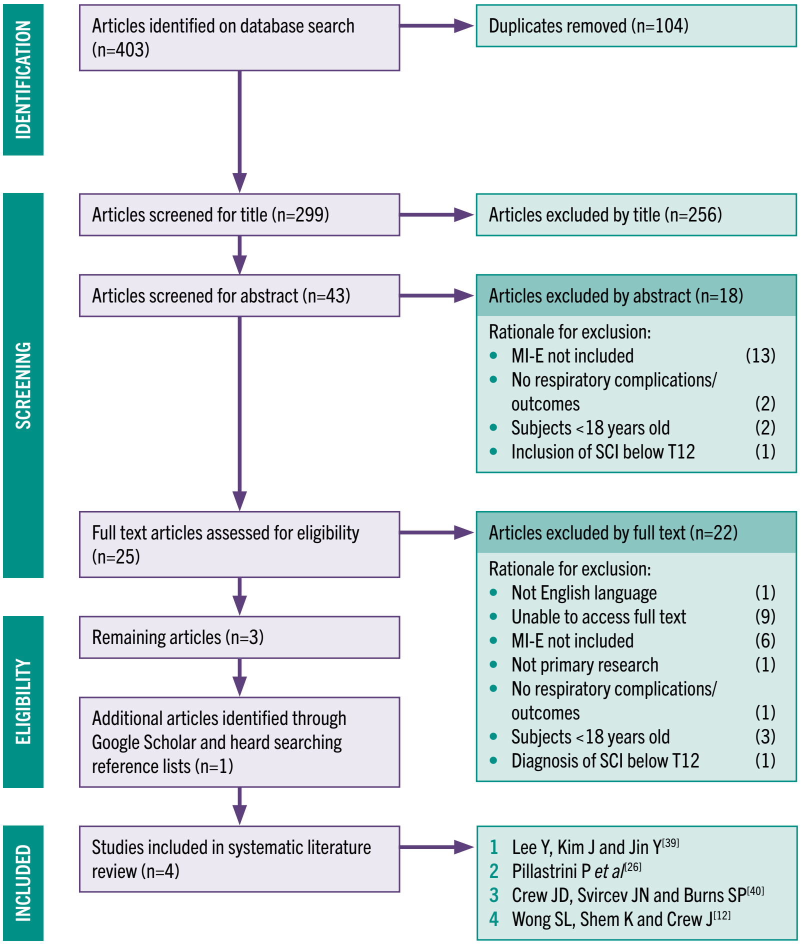


Figure 1 Modified PRISMA flow diagram (adapted from Moher *et al*[36]) showing the study selection process.

PEDro and Google Scholar required an adaptation of search terms due to the differing operating systems. PEDro allows a maximum of two terms to be used per search and does not accept any punctuation marks[38]. Therefore, all variations of Search 1 and 2 (*Table 1*) were conducted separately within the database. The agreed search constructed for Google Scholar was: 'spinal cord injury' *or* 'spinal cord injuries' *or* 'spinal cord damage' *or* 'SCI' *or* 'cough assist' *or* 'MI:E' *or* 'MI-E' *or* 'mechanical insufflation exsufflation' *or* 'cough assist device' *or* 'Mechanical assisted cough'.

Study selection

All duplicates within and between databases were removed systematically. The research group reviewed the eligibility criteria before splitting into two pairs leaving one researcher to be the impartial moderator for the preliminary sifting of articles on the basis of titles at this stage. Both pairs independently eliminated irrelevant titles before converging as a group to discuss findings. Any disagreement was put to the moderator to decide whether to include or exclude. The two pairs of researchers subsequently applied the inclusion/exclusion criteria to the abstracts before the fifth researcher moderated for the second time. The process was repeated for the exclusion of articles by full text. Numbers excluded were documented at each stage of the selection process according to PRISMA guidelines[36].

To ensure all published literature was considered, the reference lists of included full texts were hand searched by each researcher independently. The inclusion/exclusion criteria were applied to all articles within their reference lists.

Quality assessment

The quality of the final articles was scrutinised using the Critical Appraisal Skills Programme (CASP). When deciding which CASP tool to use for each article there was some ambiguity within the opinions of the research group due to the papers having unclear study designs. The research group conversed with library staff and the senior researcher (DH) to finalise the tool used. The research group individually appraised the final texts before meeting as a group to discuss the results and to agree the final CASP appraisals for each research paper. Any discrepancies were resolved by the allocated mediator.

Results

Study selection

The search identified a total of 299 records following the exclusion of duplicates. *Figure 1* illustrates the number of records eliminated at each stage of the selection process. The search of Google Scholar identified one additional paper resulting in four articles to be included within the systematic review. Hand searching the reference lists of these articles identified no new papers to be included.

Characteristics of included studies

Table 2 (overleaf) summarises the key information extracted from the four included articles, including participants, intervention (and comparison where relevant) and outcomes.

Description of studies

All four studies investigated the effects of MI-E for patients with SCI. Both randomised controlled trials (RCTs)[26,39] involved standardised treatment plans that both the control group (CG) and experimental group (EG) were engaging with. In addition to this treatment, the EG had been given MI-E to provide a comparison for results. The two cohort studies both used retrospective data to explore the effects of MI-E. Crew, Svircev and Burns[40] collated data for the prescription of MI-E for outpatient use alongside the rate of respiratory hospitalisations or complications. Wong, Shem and Crew[12] analysed the data of people who were treated with MI-E in a SCI speciality unit, alongside the incidences of pneumonia and other respiratory outcomes.

Participants

Lee, Kim and Jin[39] recruited 38 participants that all sustained a cervical SCI (C1–C7), whereas Pillastrini *et al*[26] recruited an unknown number of participants who had a cervical SCI alongside an American Spinal Injury Association (ASIA) Grade A classification. Crew, Svircev and Burns[40] included 41 patients with a diagnosis of paraplegia or tetraplegia. The previous three studies[39,26,40] have clear participant inclusion and exclusion criteria; however, Wong, Shem and Crew[12] did not. Wong, Shem and Crew[12] included 24 patients in their study with a SCI between C1–C4. The mean age of participants in the four included studies ranged from 31.5 to 58.3, with non-significant differences in ages between comparative groups[26,39,40].

Outcome measures

All studies reported on outcomes evaluating respiratory health. Only two studies[12,40] reported on the presence of specific respiratory complications. Wong, Shem and Crew[12] specifically reported on the incidence of pneumonia and bronchitis. Whereas Crew, Svircev and Burns[40] reported on respiratory complications measured by respiratory related hospitalisation before and after the introduction of MI-E. Both Lee, Kim and Jin [39] and Pillastrini *et al*[26] reported on surrogate measures, including lung function measurements: vital capacity (VC), forced expiratory volume in one second (FEV1), unassisted PCF, FEV1/forced vital capacity (FVC) ratio and PEFR. Pillastrini *et al*[26] also reported on arterial blood gas analysis and pulse oximeter measurements pre and post treatment.

Methodological quality

Lee, Kim and Jin[39] randomised the allocation of subjects according to the order of hospitalisation. Pillastrini e*t al*[26], however, did not report on any method of randomisation. In terms of blinding, it is likely that both RCTs were lacking due to information given to participants about the research during the process of gaining consent. Similarly, the blinding of participants to the research hypothesis was not described in either of the texts. In the cohort studies, Crew, Svircev and Burns[40] achieved researcher blinding to reduce bias, whereas Wong, Shem and Crew[12] did not report on this.

Main findings

Lee, Kim and Jin[39] showed a significant increase over time in unassisted PCF, VC and FEV1 within the EG. Pillastrini *et al*[26] similarly demonstrated an increase in FEV1 in the EG however, also saw a significant increase in PEFR and FEV1/FVC.

Crew, Scircev and Burns[40] reported significant reductions in hospitalisations for smokers after receiving MI-E. However, there were no significant differences in hospitalisation rates for people with pneumonia, sleep disordered breathing, or those who were ventilated. Out of the 24 patients treated with MI-E in the study by Wong, Shem and Crew[12], 23 patients were successfully weaned. The average time for somebody to be weaned to room air using MI-E as treatment was 16 days. The post admission number of subjects with pneumonia was not reported.

Critical appraisal of the individual studies

The CASP checklists for RCTs and cohort studies were used for critical appraisal[41]. All studies passed the initial screening questions as they address a clearly focused issue and all participants were recruited in an acceptable way.

Both RCTs[26,39] lacked clarity regarding their methods of blinding. Lee, Kim and Jin[39] started with very similar groups, both with vast age ranges. However, Pillastrini *et al*[26] had large differences in PEFR between the two groups and no significance was reported. Pillastrini *et al*[26] also indicated that both groups received ten treatments except for two participants and have not included a rationale for this. It is difficult to answer questions regarding the treatment effect as Pillastrini *et al*[26] seems to lack some methodological reporting. Not all outcome measures recorded

ARTICLE CITATIONS	LEE, KIM AND JIN[39]	PILLASTRINI *ET AL*[26]]	CREW, SVIRCEV AND BURNS[40]	WONG, SHEM AND CREW[12]
Study aim	To investigate the effect of pulmonary rehabilitation using MI-E and feedback respiratory training on cervical SCI patients.	To establish whether the use of MI-E leads to a significant improvement in tracheostomy subjects with upper SCIs, ASIA classification A and bronchial hyper-secretion.	To describe characteristics of persons with SCI who received MI-E devices for outpatient use and compare respiratory hospitalisations before and after MI-E prescription.	To examine the effectiveness of specialised respiratory management utilised in a regional SCI centre.
Study design	RCT	RCT	Retrospective cohort study	Retrospective cohort study
Participants	n=38 CG mean ± SD age: 50.1 ± 3.6 EG mean ± SD age: 45.7 ± 3.4	n=unknown CG mean ± SD age: 52.2 ± 17.6 EG mean ± SD age: 31.5 ± 16.1	n=41 Acute SCI: Mean ± SD age: 50.3 ± 11.2 Chronic SCI: Mean ± SD age: 58.3 ± 12.9	n=24 Mean ± SD age: 33.4 ± 16.6
Diagnosis	Cervical SCI	Cervical SCI with ISNCSCI A classification with a tracheostomy.	Veterans with cervical SCI or disorders of traumatic and non-traumatic etiologies.	High Cervical (C1-C4) SCI
Setting/location	Rehabilitation Clinic located in South Korea.	Spinal Cord Unit located in Italy.	Veterans Affairs Puget Sound Health Care System, 2000–2006. Located in USA.	SCI specialty unit. Unknown location.
Intervention (and comparison if any)	Central nervous system movement therapy performed in EG and CG twice a day for 30 minutes, five times a week for four weeks. EG had the addition of MI-E and expiratory muscle feedback respiration exercise, each for 15 minutes.	All but two patients given ten treatments of bronchial clearance methods, including postural drainage, uPEP, assisted coughing, Ambu bag, endoscopic bronchoaspiration. EG were given an addition of MI-E, for a maximum of five cycles, with a maximum of five insufflations/exsufflations per cycle. MI-E device was set to automatic mode.	Prescription of MI-E for outpatient use. No comparison.	Treatment in SCI specialty unit with HVtV, HFPV, and MI-E treatment. No comparison.
Outcome measures	• VC% • FEV1 • FVC • UPCF • FEV1/FVC	Four spirometry tests: • FVC • FEV1 • FEV1/FVC • PEFR ABGs Pulse Oximeter (SaO2)	• Pre- and post-MI-E respiratory hospitalisation rates • Pre- and post-MI-E respiratory complications	• Incidence of pneumonia • Incidence of bronchitis • Number of bronchoscopies • Patient's respiratory outcomes
Results	No significant differences between the characteristics of the two groups at baseline. EG significantly increased over time (p<0.05): • VC% (42.3±4.9 → 47.0±4.7) • FEV1 (1.3±1.1 → 1.5±0.1) • UPCF (153.4±29.0 →.1±38.6) CG no significant changes over time (p>0.05) VC%, FEV1 and UPCF were significantly different between groups following treatment.	No significant differences between the characteristics of the two groups at baseline. In EG: • FVC and FEV1 significantly increased (p=0001*). • PEFR significantly increased (p=0.0093*). • FEV1/FVC did not significantly change (p>0.05). In CG: • No significant change in any outcome measure (p>0.05). Both EG and CG: • No significant changes in ABGs	• No statistical difference in hospitalisation rates from pre- to post- MI-E (p=0.15). • No statistical difference in pneumonia hospitalisation rates pre- to post- MI-E (p=0.38). • Significant reduction in hospitalisations in smokers pre- to post- MI-E (p=0.03*).	• All 24 patients were treated with MI-E and 22 (92%) of those also treated with high frequency percussive ventilation. Pre-admission: 95% of subjects had pneumonia Post-admission: not recorded (No p value or confidence interval reported)

* denotes statistically significant p<

Abbreviations
ABGs (Arterial Blood Gases)
ASIA (American Spinal Cord Injury Association)
CG (Control Group)
EG (Experimental Group)
FEV1 (Forced Expiratory Volume in First Second)
FVC (Forced Vital Capacity)
HFPV (High Frequency Percussive Ventilation)
HVtV (High Tidal Volume Ventilation)
ISNCSCI (International Standards for Neurological Classification of Spinal Cord Injury)
n (Number)
MI-E (Mechanical Insufflation-Exsufflation)
PEFR (Peak Expiratory Flow Rate)
RCT (Randomised Controlled Trial)
SaO2 (Oxygen Saturation)
SCI (Spinal Cord Injury)
SD (Standard Deviation)
UPCF (Unassisted Peak Cough Flow)
uPEP (underwater Positive Expiratory Pressure)
VC (Vital Capacity)

Table 2 Characteristics of included studies in the results are conveyed within the design. Lee, Kim and Jin[39] report on all primary and secondary outcome measures within the methodological design and results, showing significant increase in lung capacity, FVC, and FEV1. However, with no hypothesis or confidence limits, the precision of estimate for treatment effects cannot be determined. Unfortunately, neither RCT considered all clinically important outcomes but it was agreed that the benefits of both studies outweighed the harms and costs due to their potential findings, supporting clinical practice.

Crew, Svircev and Burns[40] successfully measured their exposure and outcome to minimise bias by having a second blinded investigator and computerised calculations for the pre-recorded data. However, it was unable to be determined if Wong, Shem and Crew[12] accurately measured their exposure and outcome as it was not clear how patients were established and included/excluded. All outcome measures were also not considered for all participants. In regards to confounding factors, Crew, Svircev and Burns[40] identified these and took them into account within their design and analysis. However, Wong, Shem and Crew[12] reported no specific confounding factors despite mentioning their study could be limited by this. Both cohort studies[12,40] demonstrated good follow-up of subjects. The precision of results for Wong, Shem and Crew[12] cannot be determined due to confidence intervals not being reported on and the standard deviations being large and varied. Crew, Svircev and Burns[40], however, provide a range of confidence intervals with P-values also reported, increasing the precision of their results. Overall, the results of both studies fit in with other available evidence; however, no other evidence was found to explore the use of MI-E in the outpatient setting.

Discussion

The effectiveness of MI-E was solely explored within single sites for all four papers with findings only representing those specific service contexts. All four studies found MI-E to be of benefit to patients with cervical SCI. However, future multi-centre studies should be considered to develop current research. The overall quality of the included studies for review appeared to be poor due to a number of methodological flaws discussed below.

Key interventions

Multiple respiratory interventions were utilised within Wong, Shem and Crew's[12] study as this was the service's standard treatment protocol for respiratory care. The direct effect of MI-E therefore cannot be established. Further research by Torres-Castro *et al*[42] found greatest significant differences in respiratory function when combining respiratory techniques and, therefore, provides support to Wong, Shem and Crew's[12] conclusions. Despite this, for the purpose of evidence, it could be considered superior to investigate the effectiveness of interventions exclusively with high-quality studies before studying the overall effectiveness of multiple interventions.

Methodological quality of studies

All studies included relatively small samples with the highest reported being 41[40]. Unfortunately, Pillastrini *et al*[26] did not clearly report the number of participants. Small samples create low statistical power to detect a clinically significant difference which may discredit the validity of findings and make the results invariably inconclusive[43]. Crew, Svircev and Burns'[40] study was the only one to complete a sample size calculation; however, they failed to recruit to this target and so the possibility of a type II error needs to be considered[44]. It is, however, essential to recognise the difficulty in conducting large-scale trials exclusively for patients with SCI, as multiple service inputs and vast amounts of funding would be required.

All four studies included patients with cervical SCI only. This may be due to those with thoracic SCIs not requiring MI-E as often or due to the acute settings not routinely using MI-E for individuals with thoracic SCI. It is important to revisit the fact that patients with thoracic SCIs are also at risk of developing respiratory complications[13] due to disruption of abdominal innervation. Therefore, there is a need for this research to guide its use within this specific patient subgroup.

Both RCTs[39,26] included various outcomes to measure lung function with none being direct measures of respiratory complications. The statistically significant results observed in lung function measurements may therefore be considered as surrogate measures of respiratory complications and may not necessarily translate into improvements in the rates of respiratory complications. Crew, Svircev and Burns[40] was the only study to have respiratory complications as a primary outcome measure; however, they failed to report these in their results. Furthermore, there are inconsistencies in the outcomes utilised between studies due to the variability in study designs. Consequently, it is difficult to make direct comparisons.

Both cohort studies[12,40] lacked detail when reporting on the results of the primary outcome measures. There are multiple discrepancies between the outcomes reported throughout their methodologies, compared to their results. This heightens the risk of publication bias disturbing conclusions as it seems some of the results were not expressed within the papers, potentially leaving out some negative data.

> *All four studies found MI-E to be of benefit to patients with cervical SCI.*

Pillastrini *et al*[26] did not disclose any method of randomisation. In contrast, Lee, Kim and Jin[39] did report on randomisation through the allocation of subjects according to the order of hospitalisation. Beller, Gebski and Keech[45] suggested this method of distribution may not be reliably random as recruiter concealment is difficult and allocation sequences are predictable. Due to the nature of this topic of research, optimal randomisation such as a stratified method may not be feasible, and therefore it is very difficult to ensure a treatment balance of prognostic factors between groups.

No inclusion/exclusion criteria were reported by Wong, Shem and Crew[12] and therefore it is unclear how participants were selected. As for Crew, Svircev and Burns[39], convenience sampling was utilised as all individuals with SCI who entered the specified service were included. Therefore the samples are likely to under-represent their target populations, limiting the ability to generalise their findings.

The ethical considerations of both retrospective cohort studies were not clearly reported on, thereby the level of informed consent cannot easily be established. A lack of consent could lead to ethical concerns with regards to patient's medical records being used for research as this is a founding principle of research ethics[46]. However, it should be recognised that for retrospective data consent can be difficult, if not impossible, to obtain due to the nature of SCIs with some leading to mortality.

Both RCTs[39,26] stated that informed consent was gained;, however, it is unclear whether blinding was used in both these papers. One may assume that there was a lack of blinding because a participant must have known a certain amount of information about the research in order to be able to consent. Despite this, it may have been possible to conceal the research hypothesis from the subjects and therapists; however, this degree of blinding was not described.

Blinding is less applicable in cohort studies[12,40] due to their retrospective nature. However, Crew, Svircev and Burns[40] achieved researcher blinding for part of their methodology, decreasing the potential of a biased result, thus increasing the likelihood for a causal relationship. In comparison, Wong, Shem and Crew[12] did not report any researcher blinding despite the possibility of utilising a similar method as Crew, Svircev and Burns[40]. The assessors of both cohort studies were not reported as being blinded to the research aims which would have further reduced bias.

The limited and poor-quality evidence presented highlights a definite need for continued research on this topic. As mentioned previously, there is a lack of research investigating the use of MI-E for patients with thoracic SCIs who are also at risk of developing recurring respiratory complications.

Implications for practice

This review highlights there is very limited evidence available to endorse or refute the use of MI-E within clinical practice for the prevention of respiratory complications in adults with SCI. All of the available studies are limited in their ability to stand up to scrutiny against a test of best practice. This reduces the ability for clinicians to extrapolate findings with confidence. The main limitation when comparing and contrasting evidence on this topic was the heterogeneity between methodological designs. This accounts for the differing outcome measures where direct comparisons are unable to be made, as well as the differing methods of treatment delivery. As a result, clinical expertise and patient preference need to be considered equally when clinically reasoning the prioritisation of interventions for the purpose of preventing respiratory complications.

Implications for future research

The limited and poor-quality evidence presented highlights a definite need for continued research on this topic. As mentioned previously, there is a lack of research investigating the use of MI-E for patients with thoracic SCIs who are also at risk of developing recurring respiratory complications. Furthermore, all included studies did not exclusively focus on the use of MI-E for the prevention of respiratory complications such as atelectasis, pneumonia and respiratory failure. The inclusion of relevant outcome measures enabled conclusions to be drawn from the data specific to the topic of this review. However, research specifically exploring the effectiveness of MI-E solely on preventing respiratory complications would be of great importance to strengthen the argument for the use of MI-E in practice. Additionally, it has been highlighted that all studies investigated the use of MI-E within singular services. To increase the quality for future research, studies investigating the use of MI-E within multiple centres would be beneficial to aid the implication into clinical practice.

Large-scale, high-quality RCTs are needed to provide the evidence required to influence practice. However, where this is not feasible it could be argued that observational studies need to be prioritised to provide the evidence currently required, which may be achieved through clinicians taking the initiative to record more individual case studies.

Strengths and limitations of this review

One of the main strengths of this review is the systematic method used to conduct the search strategy. The process was organised and efficient with bias mitigated through the use of multiple researchers.

Time and resource restraints limited this review due to the nature of it being part of an undergraduate degree. Financial resources were also restricted, limiting the primary research available to those free electronically or via the University of the West of England's library. For example, the inclusion of grey literature and unpublished literature was not feasible within this systematic review due to issues with access and time restraints. Studies that have produced negative results are often harder to publish [47], causing positive research to occasionally be exaggerated within published literature. Therefore, the risk of publication bias within this review is heightened as findings may be misrepresented.

Additionally, the potential of publication bias is increased due to the use of differing CASP tools based on study design. The study designs of the included literature were unclear, which led to some debate around which CASP tools to apply for critical analysis. The decision was confirmed through group collaboration and, therefore, this decision may differ between other researchers. However, the researchers were in strong agreement for the identification of study designs, reducing the heightened risk of publication bias.

Conclusion

In conclusion, there is very little primary research exploring the effectiveness of MI-E for the prevention of respiratory complications in adults with SCI. The results of all four studies reviewed concluded MI-E to be relatively beneficial and effective. However, significant flaws were found relating to the quality of the studies, including relatively small sample sizes and a lack of blinding. There is a definite need for larger, more rigorous primary research to be undertaken to explore this topic. Further suggestions are made within this systematic review to enable the implementation of statistically significant findings into clinical practice, with confidence. The need for future research is vital to improve the care for patients with SCI who suffer the consequences of respiratory complications secondary to this life-threatening injury.

REFERENCES

1. Harvey L (2008) *Management of Spinal Cord Injuries: A Guide For Physiotherapists* London: Churchill Livingstone.
2. Gundogdu I, Ozturk EA, Umay E, Karaahmet OZ, Unlu E, Cakci A (2017) *Implementation of a respiratory rehabilitation protocol: weaning from the ventilator and tracheostomy in difficult-to-wean patients with spinal cord injury* *Disability and Rehabilitation* 39 (12) pp1162-1170.
3. WHO (2013) *Spinal Cord Injury* [cited 2019 July 04].
4. NICE (2016) *Spinal Injury: assessment and initial management* [cited 2019 July 04].
5. Kellezi B, Baines DL, Coupland C, Beckett K, Barnes J, Sleney J *et al* (2015) *The impact of injuries on health service resource use and costs in primary and secondary care in the English NHS* *Journal of Public Health* 38 (4) pp464-471.
6. Middleton JM, Sharwood LN, Cameron P, Middleton PM, Harrison JE, Brown D *et al* (2014) *Right care, right time, right place: improving outcomes for people with spinal cord injury through early access to intervention and improved access to specialised care: study protocol* *BMC Health Services Research* 14 (1) p600.
7. Joseph C, Wikmar LN (2015) *Prevalence of secondary medical complications and risk factors for pressure ulcers after traumatic spinal cord injury during acute care in South Africa* *Spinal Cord* 54 (1) pp535-539.
8. Ko H *Revisit Spinal Shock: Pattern of Reflex Evolution during Spinal Shock* *Korean Journal of Neurotrauma* 14 (2) pp47-54.
9. Winslow C, Bode RK, Felton D, Chen D, Meyer Jr PR (2002) *Impact of respiratory complications on length of stay and hospital costs in acute cervical spine injury* *Chest* 121 (5) pp1548-1554.
10. Adriaansen JJE, Ruijs LEM, van Koppenhagen CF, van Asbeck FWA, Snoek GJ, van Kuppevelt D *et al* (2016) *Secondary health conditions and quality of life in persons living with spinal cord injury for at least ten years* *Journal of Rehabilitation Medicine* 48 (10) pp853-860.
11. NSCISB (2012) *The initial management of adults with spinal cord injury* [cited 2019 Sep 18].
12. Wong SL, Shem K, Crew J (2012) *Specialized Respiratory Management for Acute Cervical Spinal Cord Injury: A Retrospective Analysis* *Topics in Spinal Cord Injury Rehabilitation* 18 (4) pp283-290.
13. Cotton BA, Pryor JP, Chinwalla I, Wiebe DJ, Reilly PM, Schwab CW (2005) *Respiratory Complications and Mortality Risk Associated with Thoracic Spine Injury*. *The Journal of Trauma: Injury, Infection, and Critical Care* 59 (6) pp1400-1409.
14. ISNCSCI (2018) *International standards for neurological classification of spinal cord injury* [cited 2019 July 04].
15. Harvey L (2016) *Physiotherapy rehabilitation for people with spinal cord injuries* *Journal of Physiotherapy* 62 (1) pp4-11.
16. Tollefsen E, Fondenes O (2012) *Respiratory complications associated with spinal cord injury* *Tidsskr Nor Laegeforen* 132 (9) pp1111-1114.
17. Berlly M, Shem K (2007) *Respiratory management during the first five days after spinal cord injury* *The Journal of Spinal Cord Medicine* 30 (4) pp309-318.

Declaration of interest statement

The authors declare there is no conflict of interest.

Disclosure statement

No financial assistance was received.

18. Jackson AB, Groomes TE (1994) *Incidence of respiratory complications following Spinal Cord Injury* *Archives of Physical Medicine and Rehabilitation* 75 (3) pp270-275.

19. McKingley EO, Gittler MS, Kirshblum SC, Stiens SA, Groah SL (2002) *Spinal cord injury medicine. 2. Medical complications after spinal cord injury: Identification and management* *Archives of Physical Medicine and Rehabilitation* 83 (3) pp58-64.

20. Fontana GA, Lavorini F (2006) *Cough motor mechanisms* *Respiratory Physiology and Neurobiology* 152 (3) pp266-281.

21. Stokes M, Stack E (2011) *Physical Management for Neurological Conditions* 3rd edition Edinburgh: Churchill Livingstone.

22. Homnick D (2007) *Mechanical insufflation-exsufflation for airway mucus clearance* *Respiratory Care* 52 (10) pp1296-1305.

23. Chatwin M (2008) *How to use a mechanical insufflator-exsufflator “cough assist machine”* *Breathe* 4 (1) pp320-329.

24. Benditt JO (2018) *Mechanical Insufflation-exsufflation: More Than Just Cough Assist* *Respiratory Care* 63 (8) pp1076-1077.

25. Reid WD, Brown JA, Konnyu KJ, Rurak JM, Sakakibara BM, The SCIRE Research Team (2016) *Physiotherapy Secretion Removal Techniques in People With Spinal Cord Injury: A Systematic Review* *The Journal of Spinal Cord Medicine* 33 (4) pp353-370.

26. Pillastrini P, Bordini S, Baszzocchi G, Belloni G, Menarini M (2006) *Study of the effectiveness of bronchial clearance in subjects with upper spinal cord injuries: examination of a rehabilitation programme involving mechanical insufflation and exsufflation* *Spinal Cord* 44 (1) pp614-616.

27. Garstang SV, Kirshblum SC, Wood KE (2016) *Patient Preference for In-Exsufflation for Secretion Management with Spinal Cord Injury* *The Journal of Spinal Cord Medicine* 23 (2) pp80-85.

28. Gregg K (2013) *Physiotherapy use of Cough Assist Devices or Mechanical Insufflation-Exsufflation* Belfast Health and Social Care Trust 1 (1) pp1-8.

29. Servera E, Sancho J, Zafra MJ, Catala A, Vergara P, Marin J (2005) *Alternatives to endotracheal intubation for patients with neuromuscular diseases* *American Journal of Physical Medicine and Rehabilitation* 84 (11) pp851-857.

30. Bach JR, Sinquee DM, Saporito LR, Botticello AL (2015) *Efficacy of Mechanical Insufflation-Exsufflation in extubating unweanable subjects with restrictive pulmonary disorders* *Respiratory Care* 60 (4) pp477-483.

31. Rose L, Adhikari NK, Leasa D, Fergusson DA, McKim D (2017) *Cough augmentation techniques for extubation or weaning critically ill patients from mechanical ventilation* *The Cochrane Database of Systematic Reviews* (1).

32. Sheel AW, Welch JF, Townson AF (2018) *Respiratory Management Following Spinal Cord Injury* 6th edition London: SCIRE [cited 2019 July 05].

33. Auger C, Hernando H, Galmiche H (2017) *Use of Mechanical Insufflation- Exsufflation Devices for Airway Clearance in Subjects with Neuromuscular Disease* *Respiratory Care* 62 (2) pp236-245.

34. Schreiber J, Stern P (2005) *A Review of the Literature on Evidence-Based Practice in Physical therapy* *The Internet Journal of Allied Health Sciences and Practice* 3 (4) pp1540-1580.

35. Chatwin M, Ross E, Hart N, Nickol AH, Polkey MI, Simonds AK (2003) *Cough augmentation with mechanical insufflation/exsufflation in patients with neuromuscular weakness* *European Respiratory Journal* 21 (3) pp502-508.

36. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009) *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement* *PLoS Med* 6 (7).

37. NICE (2014) *Developing NICE guidelines: the manual* [cited 2019 July 05].

38. Michaleff ZA, Costa LO, Moseley AM, Maher CG, Elkins MR, Herbert RD *et al* (2011) *CENTRAL, PEDro, PubMed, and EMBASE are the most comprehensive databases indexing randomized controlled trials of physical therapy interventions* *Physical Therapy* 91 (2) pp190-197.

39. Lee Y, Kim J, Jin Y (2012) *The Efficacy of Pulmonary Rehabilitation using a Mechanical In-Exsufflator and Feedback Respiratory Training for Cervical Cord Injury Patients* *Journal of Physical Therapy Science* 24 (1) pp89-92.

40. Crew JD, Svircev JN, Burns SP (2010) *Mechanical Insufflation-Exsufflation Device Prescription for Outpatients with Tetraplegia* *The Journal of Spinal Cord Medicine* 33 (2) pp128-134.

41. CASP (2018) *CASP Checklists* [cited 2019 July 05].

42. Torres-Castro R, Vilaro J, Vera-Uribe R, Monge G, Aviles P, Suranyi C (2014) *Use of air stacking and abdominal compression for cough assistance in people with complete tetraplegia* *Spinal Cord* 52 (5) pp354-357.

43. Button KS, Ioannidis JPA, Mokrysz C, Nosek BA, Flint J, Robbinson ESJ *et al* (2013) *Power failure: why small sample size undermines the reliability of neuroscience* *Nature Reviews Neuroscience* 14 (1) pp365-376.

44. Nayak BK (2010) *Understanding the relevance of sample size calculation* *Indian Journal of Ophthalmology* 58 (6) pp469-470.

45. Beller EM, Gebski V, Keech AC (2002) *Randomisation in clinical trials* *EBM: Trials on Trial* 177 (1) pp565-567.

46. Schroter S, Plowman R, Hutchings A, Gonzalez A (2006) *Reporting ethics committee approval and patient consent by study design in five general medical journals* *Journal of Medical Ethics* 32 (12) pp718-723.

47. Phan K, Tian DH, Cao C, Black D, Yan TD (2015) *Systematic review and meta-analysis: techniques and a guide for the academic surgeon* *Annals of Cardiothoracic Surgery* 4 (2) pp112-122.

Investigation into the suitability and acceptance of online-delivered exercise classes for people with Parkinson's

Dr Bhanu Ramaswamy OBE DProf FCSP[1]
Laila El Haddad[2]
Leanna Schoch[3]

Two fundamental abilities of physiotherapy clinical practice include the art of observation and the capacity to adapt intervention to suit the needs of individuals (Health and Care Professions Council 2013, Chartered Society of Physiotherapy 2012).

The Coronavirus disease 2019 (COVID-19) outbreak from early 2020 created a period where clinical placement offers were withdrawn to students, with higher education institutes requiring alternatives so students could continue to acquire key skills.

The imposed restrictions (self-isolation, social distancing and remaining indoors for non-essential activities) curtailed access to exercise for people with Parkinson's (pwP) beyond the time scales enforced on less vulnerable members of society (Simpson *et al* 2020). Exercise for pwP is necessary in managing symptoms (Ramaswamy *et al* 2018), so changes were sought in delivery of exercise across health and voluntary sectors to keep pwP fit and active during the lockdown.

Digital technology as a concept is neither new in healthcare (World Health Organization, WHO 1998), nor in undergraduate education of physiotherapists (Røe *et al* 2019). Until the COVID-19 outbreak, however, it was more common in the United Kingdom (UK) that exercise for people with a long-term condition was accessed through physically-present classes based at a single venue; multiple users engaging in synchronous, online classes was a seldom-adopted approach.

A project opportunity arose for two students in physiotherapy programmes in different countries (LEH in the UK and LS in Switzerland) to observe the newly established Zoom exercise classes run by a physiotherapist (BR) for pwP in Sheffield.

It was assumed that these classes would run for a three-month period, but in June 2020 the charity extended the suspension of single-venue events until October 2020. Prior to lockdown, five weekly exercise classes were offered, but only two class leaders (also referred to by class participants as instructors, or tutors) had tried the online classes in the short term. The uptake of the Zoom classes suggested to the Branch Committee that there was scope to run most of its classes via the digital platform until such time people could gather at single-venue classes.

In addition to considering their own learning via this setting, the authors agreed to explore the perspective of the Zoom class participants, prompting two clear project questions:

- This article responds to the question whether the online-delivered exercise classes for people with Parkinson's in Sheffield were a suitable and acceptable undertaking. The outcome, through a survey and observational research methods, would inform the establishment of other classes, and
- A follow-up article questions what professional practice learning elements. The three authors have experienced with this client group, and under these circumstances have. The outcome is to provide reflective clinical practice credits towards undergraduate courses for one of the students, and add to a set of guidance for class leaders using Zoom under development by BR at the time of writing.

The aim of this article is to explore the suitability and acceptance of Zoom to pwP participating in three Sheffield Branch online classes.

WHAT DOES THIS ARTICLE CONTRIBUTE TO THE EXISTING LITERATURE?

Exercise in Parkinson's is an essential means by which people might manage symptoms and remain mobile.

Our investigation into what made Zoom a suitable and acceptable platform by which to deliver exercise to people with Parkinson's (pwP) highlighted that:

- A pre-existing dynamic of class goers created a strong incentive to take up exercise through a digital platform many had previously felt incapable of trying, thus maintaining exercise through the COVID-19 lockdown.
- Inclusion of family members during the exercise component or after-exercise chats and a quiz have added a positive energy to the online classes in this time of isolation.
- Group participant responses emphasised differences in social elements and exercise expectations between class types.

All can be considered motivators for pwP to engage in and maintain exercise in the long term.

---

[1] Independent Physiotherapy Consultant.

[2] MSc Physiotherapy student, Department of Allied Health Professions, College of Health, Wellbeing and Life Sciences, Sheffield Hallam University UK.

[3] ZHAW (Zurich University of Applied Sciences) School of Health Professions, Switzerland.

Two clear biases of note are the requisite to investigate the issue for the Sheffield Branch of Parkinson's UK, and the writing as a consensus through the lens of three authors: two students with little prior exposure to pwP, and a clinician with prolonged engagement exercising with each group prior to the COVID-19 lockdown.

Method

Design

Mixed methodology research, utilising two main methods:

- A survey of participants of classes for pwP, via a questionnaire with analysis that explored their response to the use of Zoom for exercise.
- Observational research by the authors of the classes between April and July 2020. Comparison of field notes, then discussion from varied viewpoints allowed researcher reflexivity to shape ideas about the classes in an iterative manner over the course of the project.

Analysis

Descriptive statistics and thematic analysis were used to identify the main themes and examine group differences.

Procedure

Participants and classes

All three weekly Zoom classes were led by BR, funded by the local Branch of Parkinson's UK (the Foxhill general exercise class with 12 households in attendance), or run through the Hallamshire Physiotherapy Clinic, a private practice (PD Warrior session with 9 households in attendance; and a small group of three individuals who had not exercised as a group before the pandemic).

Participants received education about Zoom from BR prior to classes commencing. The sessions were an hour long comprising 40 minutes of exercise, and the remainder for set up and a catch up.

Procedure for the researchers to collect and share information

LEH and LS participated in allocated sessions, observing as many as they were able. Regular communication was established between the authors to take forward project aims.

Materials

The Zoom platform was chosen as in use by both the Sheffield Hallam University (SHU) and the Hallamshire Physiotherapy Clinic.

Participants used varied digital devices to access the class: TV, tablets, laptops, desktops and phones.

The survey process

- A pilot questionnaire of free-text responses was designed asking participants to describe their experiences of the delivery of exercise via Zoom. This was sent to two members of the Parkinson's UK (Sheffield Branch) Committee, who requested the addition of two questions relating to how the service might be provided in the future.
- The amended (8-response) questionnaire was emailed or posted, according to participant preference (*Appendix 1*).
- Returned questionnaires were explored following Nowell *et al*'s (2017) four-phase approach of thematic analysis. Each phase outcome was discussed at tutorials before moving to the next phase of analysis.
  - **Phase 1**: Responses and respondent details were transferred to a spreadsheet. eight Word documents were created to house responses to each question, underlining key phrases and anonymously coding the question number to the class they attended eg 1: F1 related to the first question, and the first respondent in the Foxhill class. The division of classes allowed pattern identification according to class differences where participants had known one another prior to the COVID-19 outbreak or not.
  - **Phase 2**: Phase 1 key phrases were labelled, and numbers of same type statement or idea counted, in part to apportion commonality of response.
  - **Phase 3**: Merging identified themes/labels common across all eight documents.
  - **Phase 4**: A revisit of this article's aims against which to ascribe the themes; agreeing specific quotes of interest as supporting evidence.

Results

All members of the previously run single-venue PD Warrior classes took up the Zoom offer; three of the previously run Foxhill class did not participate, as they either did not have Internet connection (2), or a device through which to access the Zoom class (1).

20 of the 24 questionnaires sent out were returned; an 83% response rate.

11/20 respondents (55%) favoured the single-venue group classes over online provision, 2/20 (10%) liked both too much to state a preference, and 2/20 preferred the online option (travel convenience (1), and exercise access more often than before (1)). As was obvious in their engagement with classes, however, 18/20 (90%) of the respondents acknowledged the suitability or their acceptance of Zoom in these circumstances.

The responses, supplemented by field note during the exercise session observations, fell into four broad themes:

- Reaction to Zoom as a digital platform, and related technical or technological factors
- Delivery of a class, or exercise through Zoom
- The importance of a social dynamic
- Exercise class delivery into the future

With regards class differences, social attributes were identified as important by respondents with pre-formed relationships from previously held single-venue classes, but unmentioned in those who had formed into a new exercise class. Instead, they ascribed more importance to the exercise content, and prior knowledge of the class leader. The PD Warrior class participants were more aware of the need for regularity and discipline of the exercises, compared with others, as per the programme philosophy.

Finding details

1. Zoom as a digital platform

The notion of suitability and acceptance of Zoom was apparent from the high uptake and adherence levels to the weekly classes. This was pleasing to the authors, as technology use was envisaged to be a potential barrier at the start of this study; all but two of the participants were of the older generation, and had expressed concerns in trying Zoom, despite Internet consumption noted as increasing in this generation (Office for National Statistics, 2018). The initial one-to-one support session was seen as helpful, with requests on questionnaire responses for more support to better understand Zoom. Some people reported that the technology became easier to use after set-up and a short period of familiarisation, although a few people depended on others to attend:

> *"I have family that set me up, every week. Without their help I wouldn't be able to join the class."* (2: F5)

The many positives about Zoom included convenience of the platform features:

> *"…mute, gallery options, chat."* (2:F1)

with one person stating:

> *"Also it is helpful that the name of the person speaking is displayed at the bottom of the screen so it is actually easier to learn names in Zoom than in class."* (4c:F6)

External influences making Zoom more acceptable, more often noted by the older participants, or those who had Parkinson's for longer, included:

> *"It also has a personal advantage to me as I don't drive and would therefore have to travel on public transport, (a three-hour round trip), which at the present time, with the Covid virus, I am reluctant to undertake."* (1:W7)

Voiced frustrations were around the practicalities of the technology:

> *"[Zoom technology is limited by] the speed and bandwidth of your local WiFi connectivity and its stability and consistency of performance during the day"… "I have experienced both image freezing and delay (at both ends leader / attendee) and sound distortion/loss which obviously make it difficult to follow what is going on."* (2:F8)

The tardiness of others' connecting:

> *"It is quite frustrating to lose a chunk of time because individual people have difficulties setting up or signing in each week."* (2:F3)

and possible aspects governing security, especially from those who work with technology:

> *"I understand some large corporate organisations do not permit installation or use of this software on office computers due to potential privacy and security issues with Zoom, especially if the equipment is linked to a PC or computer network."* (2: SG3)

Respondents, however, pointed out their ability to overcome these issues, with no lasting impact on acceptance and adherence to Zoom.

2. The delivery of a class or exercise through Zoom

Regardless of the general preference for the return to single-venue classes in the future, responses to current delivery qualified the Zoom class with words or phrases such as 'suitable', 'excellent', 'as good as', 'easier', or 'no difficulties' for online access.

Knowing the person leading the classes (more important in the newly formed group), and of prior friendships with other class participants (more in the Foxhill and PD Warrior groups) made engagement with online-delivered classes easier.

> *"The online class feels different to the posture class, which I attended prior to COVID-19. I took it up because Bhanu suggested it, and I knew she would be running it."* (1:F9)

> *"I joined the online class to maintain a degree of continuity with the exercises, the leader, the group."* (1:F6)

Exercise delivery comments spanned issues like class routine and regularity (noted more by the PD Warrior participants), time held, and context:

> *"The online sessions are clearly suitable. The objective … is that people with Parkinson's receive structured exercise led by a qualified physio; this is achieved."* (2:W3)

The PD Warrior class participants were more aware of the need for regularity and discipline of the exercises, compared with others, as per the programme philosophy.

The exercise was noted as being able to maintain wellness, fitness and management of the Parkinson's symptoms:

> *"The need to exercise and protect my fitness in dealing with Parkinson's is a[s] beneficial to me now as it has been for a long time. An online class is a great way to do this."* (1:W9)

although preferences of exercise style differed:

> *"I enjoy the class - to be honest, do not miss the introductory exercises. This is partly because I like 'pace'."* (1:F6)

> *"I think Zoom has its place in these difficult circumstances and I've really enjoyed class but do miss the relaxation sessions and personal observation and intervention."* (1:F3)

as did thoughts about seeing, and being seen by the class leader, as well as means of feedback:

> *"As the instructor is visible all the time, it's more like having your own personal trainer in the comfort of your own home. Therefore the instructor can watch what all the participants are doing and provide feedback."* (1:W7)

> *"I am not sure if Bhanu can see me all of the time as my image is small on my computer."* (1:W5)

> *"The difference is that you miss the expertise of Bhanu being there to adjust and help you with the exercise positions."* (1:W8)

3. The social dynamic of exercise delivery

The social dynamic emerged strongly, threaded throughout each of the questions asked by the questionnaire. Participants soon started using the pre- and post-exercise periods for purposeful 'catch-up' to check up on one another, at times joined by other family. Even those who were working from home were observed to remain the full hour for time to socialise, with some logging in early to chat in the Zoom 'Waiting room':

> *"All of this is the social side of the class and it is the social interaction that builds trust, friendships and allows people to share experiences not only about their condition but family, holidays etc."* (1:F8)

> *"… it is lovely to be able to chat to people in the flesh and being physically present seems to offer greater comradeship."* (1:W4)

> *"Socialising with other Parkinson's sufferers is supportive and informative."* (5: F3)

Those who formed a new group during lockdown, whilst not mentioning friendships, equally noted the importance of social contact:

> *"… it allows easy participation and benefit in exercising together with social interaction and confidence in the instructor."* (3a:SG2)

and one person noted the social aspect as their reason to join the Zoom class:

> *"Simply, as we went into lockdown and social isolation, Zoom provided the perfect opportunity to maintain a degree of normality and social connectivity. I would have hated to have come back to Foxhill for face-to- face sessions and not have any insight into how my fellow attendees had been faring in the interim."* (1: F8)

The mute feature requested initially was found to affect their enjoyment:

> *"Clearly I miss the group comments, fun and laughter we have during a real class."* (2: F3)

> *"The online classes are more impersonal compared to the face-to -ace sessions as one obviously misses out on the banter, humour and repartee that exists in the face-to-face sessions. Part of the enjoyment is listening to the moans and groans of your fellows."* (1:F8)

as did the use of 'Speaker view' to watch the class leader, creating an impression of losing the group setting:

> *"I would quite like to work as a group rather than an isolated individual."* (3a: F3)

Over time, the Foxhill and Small Group members agreed to remain unmuted throughout the exercise section of the class. The sound quality was surprisingly maintained (a reason the participants were initially muted), and the sound of others motivated participants to exercise harder.

The decision by the class leader not to make use of the break-out rooms for individual conversations meant people noted the reduced freedom to socialise on a one-to-one basis, especially those new to the class:

> *"In the face-to-face environment, the new attendee can circulate to affect introductions and strike up one-to-one or one to many conversations without this limiting other conversations taking place. In the same way, jokes are shared, repartee and friendly banter is exchanged which one may not feel comfortable doing with everyone listening in the 'on line' environment."* (4c:F8*)*

> *"I think for the first time the face-to-face class would be a much better experience. It is actually quite difficult to join the conversation online. I find it a challenge."* (4c: W4)

A positive innovation, to retain an aspect of prior competitiveness, was that the Foxhill group introduced a quiz at the end of the exercise section:

> *"The opportunity to chat post session is still important and I think has been improved by the addition of a small degree of competition in terms of the quiz."* (3a:F8)

4. Class delivery into the future

The Parkinson's Branch Committee was keen to understand the use of digital platforms for the post-lockdown period; hence requested specific questions added to the questionnaire about the future for exercise classes supported by the Sheffield Branch.

There was an acknowledgement of the usefulness of Zoom under specific circumstances, including poor weather conditions to travel, workloads for those at work, and class cost:

> *"The online'class circumvents other issues that might prevent attendance [no transport to class, minor illness or temporary caring responsibilities or need to stay in the home for a delivery/engineer etc."* (4b:F8)

> *"In the winter months, would appeal to me."* (4b:F6)

and for a provision of both styles of delivery, with practical proposals put forward:

> *"How about a mixture: three weeks of virtual meetings followed by a face-to-face one?"* (4b:F6)

> *"An easy-to-use booking system would be required to alternate between the online and face-to-face classes."* (4b:SG2)

> *"Is it possible to do some relaxation classes too (sort of Pilates/ yoga)?"* (4c: F3)

Two issues were highlighted as potential drawbacks for new membership to an online class: firstly, the impersonality of Zoom communication between individuals, and secondly, although it was noted that the friendliness of people would soon put them at ease, an online class would still be less attractive proposition to new participants in the way a face-to-face class might.

Since our questionnaire was sent out, the boxing training and the Pilates classes have resumed via Zoom, plus a tango class has been set up as a trial via Zoom.

Discussion

Digital technology is increasingly used to deliver health and educational services. Groups most used to the use of digital technology in daily life suggest a preference in the use of multiple options over a single choice (Røe *et al* 2019) as reported by our respondents looking to how they might access exercise classes in the future.

The adoption of telemedicine and telehealth (services provided by doctors or by other health professionals respectively) creates challenges associated with systems and behaviours recognised by the slow uptake of such innovation within healthcare, and resistance among professionals to integrate digital technology into their practice (Safi *et al* 2018). This includes concerns voiced about the security of data transfer and maintenance of patient confidentiality (Laver *et al* 2020).

In primary and secondary care settings, face-to-face consultations have been interchanged with telehealth appointments for individual or family consultations eg in paediatric settings, and used between professionals (physician–physician) to refer or discuss cases (Williams *et al* 2017, Deldar *et al* 2016).

Pre-COVID-19, remotely accessed exercise interventions were gradually being tested using digital platforms. Research has been undertaken in groups partaking in cardiac and pulmonary rehabilitation, severe obesity management, in breast cancer survivors, and for Parkinson's, where the effectiveness of interventions has been shown to be at least as good as in control groups (Baillot *et al* 2017, Galiano-Castillo *et al* 2016, Garcia 2016, Rawstorn *et al* 2016, Stickland *et al* 2011, Stone 2016).

Many of our respondents experienced similar positives to those mentioned in other research, such as the avoidance of the need to travel, and cost or time savings (Eisenberg *et al* 2018), especially for those in rural communities (Orlando *et al* 2019, Wilkinson *et al* 2016). There were comparable difficulties reported in telehealth literature such as hearing or communication problems with the provider (Baillot *et al* 2017), especially in the larger classes (Calefato and Lanubile 2010), or where participants were using smaller devices ie a smart phone (Norris *et al* 2009), some raising concerns of the safety (security of data transfer) of the use of the technology (Laver *et al* 2020).

From the perspective of the class leader, real-time feedback proved difficult to give due to screen distortions, visibility of participants, and the class leader's need to concentrate on exercise delivery. There was an inability to use tactile feedback instead of, or as well as, verbal feedback to guide a body into a better position (Giguere 2019); some noted this as a missing element.

From the perspective of the class leader, real-time feedback proved difficult to give due to screen distortions, visibility of participants, and the class leader's need to concentrate on exercise delivery.

Co-production is essential for the success in evolving service delivery (Williams *et al* 2017). Participant feedback and engagement affected how the classes were run over the three months. There was consensus that the noise distortion, screen freezing (and the legalities of the music licences for online versus live class) necessitated a move from the use of music to motivate the vigour of participation in exercise (Lim *et al* 2014) to the use of a metronome beat. Although a strong cue for timing (important for pwP), the monotonous beat was not considered as much fun (Rose *et al* 2019).

Peer support for pwP is an affirmed essential with exercise delivery, permitting means of exchanging experiences, or identifying with others diagnosed with Parkinson's (Claesson *et al* 2019, Rossi *et al* 2018). Our respondents demonstrated willingness to cope with

Whilst there was a clear preference for single-venue exercise classes, the respondents and participants of the Zoom classes expressed a belief that in these circumstances (COVID-19 lockdown), online-delivered sessions were acceptable and suitable in meeting their physical, emotional and social needs.

the difficulties with Zoom to continue to be included within the exercise groups (Lowenthal 2010 page 4), and because of their trust in the class leader (Harvey and Griffin 2019).

Our questionnaire results, whilst adding to this literature, make comparisons with prior online-class delivery research difficult for three reasons:

- The researched programmes accessed via our literature searches were designed and delivered as a one-off online provision to new participants. We offered an opportunity for those already exercising to continue to do so, and mainly with class leaders and participants they had already formed relationships with. Whilst we recorded no clinical measures during the three month Zoom trial, the high levels of adherence, plus the reports of suitability and acceptance demonstrated that the participants found the classes an effective means of maintaining their exercise regime and managing Parkinson's symptoms.
- Subjects in trials were recruited as individual patients to investigate the effectiveness of one means of service delivery. Our classes were inclusive of the 'household', so the exercise participants might include another family member, offering insight into dyadic relationships, whilst introducing the family member to the exercises of benefit to the pwP. In one case, this included a three-year-old grandaughter being babysat at the same time as class. The mute feature of Zoom minimised class disruption, and, in subsequent conversations, the couple revealed that the grandchild would now hand grandma her resistance band every time she went to visit!
- We have been able to make (limited) group comparisons with information from members of a pre-existing single general exercise and posture class; from those who were part of any of two PD Warrior classes, so knew one another before, but were now mixed to exercise with people from another PD Warrior class (self-selected around the convenience of the time and day the class ran); and a small group of three people brought together as a newly formed exercise group.

Conclusion

Whilst there was a clear preference for single-venue exercise classes, the respondents and participants of the Zoom classes expressed a belief that in these circumstances (COVID-19 lockdown), online-delivered sessions were acceptable and suitable in meeting their physical, emotional and social needs.

Having become accustomed to its use, Zoom was seen as providing a means by which exercise classes could be continued even once restrictions were lifted. New exercise restrictions include a reduction in class numbers at single-venues, with exercise spaces having to respond to social distancing and sanitisation requirements, affecting the return of all prior participants.

Considering the findings of this study and existing evidence that suggests home-based exercise delivered via telehealth is and could be effective in mild to moderate Parkinson's populations (Flynn *et al* 2019, Garcia 2016, Stone, 2016), online exercise classes may provide a cost-effective, convenient alternative method of delivering exercise to pwP.

APPENDIX 1

Questions asked for survey:

1. **About your experience of participating in the online classes**:
   - Can you tell us your thoughts about the suitability of the online class for you? (For example, how different does participating in this class feel compared to the face-to-face exercise sessions you did before COVID-19; why did you take the offer up of this Zoom class?)
2. **About your experience with the technology**:
   - How are you finding Zoom? (For example, what are the good, the bad and the indifferent points to highlight; what device are you using; and issues with the technology on this device, or setting up the class?)
3. **To help us make the online class a better experience over the coming months can you tell us**:
   - What keeps you coming?
   - What are the changes that could be made to the online classes over the coming months?
4. **About online classes into the future, and how we engage new class members**
   - Is there anything that makes it difficult for you to attend?
   - It may be in the future you have a choice between both sorts of classes running i.e. a face-to-face class and an online class, and you can change which class you choose from week to week. Which class would you choose and why?
   - Thinking about the first time you went to the face-to-face class and met the class leader as well as other class members – would you find it harder or easier to interact with people online for the first time? Would this influence whether you joined the exercise class?
5. **Is there anything else you think we should be taking into consideration?**

REFERENCES

Baillot A, Boissy P, Tousignant M, Langlois M-F (2017) *Feasibility and effect of in-home physical exercise training delivered via telehealth before bariatric surgery* *Journal of Telemedicine and Telecare* 23 (5) pp529-535.

Calefato F, Lanubile F (2010) *Communication Media Selection for Remote Interaction of Ad Hoc Groups* *Advances in Computers* 78 pp271-313.

Chartered Society of Physiotherapy [CSP] (2012) *Quality Assurance Standards for physiotherapy service delivery*. London, CSP.

Claesson IM, Ståhle A, Johansson S (2019) *Being limited by Parkinson's disease and struggling to keep up exercising; is the group the glue?* *Disability and Rehabilitation* 42 (9) pp1270-1274.

Deldar K, Bahaadinbeigy K, Tara SM (2016) *Teleconsultation and Clinical Decision Making: a Systematic Review* *Acta informatica medica : Journal of the Society for Medical Informatics of Bosnia & Herzegovina: casopis Drustva za medicinsku informatiku BiH* 24 (4) pp286–292.

Eisenberg JL, Hou JG, Barbour PJ (2018) *Current perspectives on the role of telemedicine in the management of Parkinson's disease* *Smart Homecare Technology and TeleHealth* 5 pp1-12.

Galiano-Castillo N, Cantarero-Villanueva I, Fernández-Lao C, Ariza-García A, Díaz-Rodríguez L, Del-Moral-Ávila R, Arroyo-Morales M (2016) *Telehealth system: A randomized controlled trial evaluating the impact of an internet-based exercise intervention on quality of life, pain, muscle strength, and fatigue in breast cancer survivors*. *Cancer* 122 (20) pp 3166-3174.

Garcia E (2016) *The Effects of a Telehealth Exercise Program on Self-efficacy and Adherence in Individuals with Parkinson's disease* (Master's dissertation, California State University, Northridge).

Giguere M (2019) *Dance Trends: Touch as a Teaching Tool in Dance Class: When and How to Use Tactile Feedback* *Dance Education in Practice* 5 (4) pp30-32.

Harvey K, Griffin M (2019) *Exercise instructors for older adult fitness: A review of the literature* *Canadian Journal on Aging/La Revue canadienne du vieillissement* 39 (3) pp373-384.

Health and Care Professions Council [HCPC] (2013) *The standards of proficiency for physiotherapists* London, HCPC.

Laver KE, Adey-Wakeling Z, Crotty M, Lannin NA, George S, Sherrington C (2020) *Telerehabilitation services for stroke* *Cochrane Database of Systematic Reviews* Jan 31;1:CD010255.

Lim HBT, Karageorghis CI, Romer LM, Bishop DT (2014) *Psychophysiological effects of synchronous versus asynchronous music during cycling* *Medicine and Science in Sports and Exercise* 46 (2) pp407-413.

Lowenthal PR (2010) *The Evolution and Influence of Social Presence Theory on Online Learning* *Online education and adult learning: New frontiers for teaching practices* Hershey, PA: IGI Global.

Norris AC, Stockdale RS, Sharma S (2009) *A strategic approach to m-health* *Health Informatics Journal* 15 (3) pp244-253.

Nowell L, Norris JM, White DE, Moules NJ (2017) *Thematic Analysis: Striving to Meet the Trustworthiness Criteria* *International Journal of Qualitative Methods* 16 pp1-13.

Office for National Statistics (2018) *Internet users, UK: 2018* Accessed 10.09.2020.

Orlando JF, Beard M, Kumar S (2019) *Systematic review of patient and caregivers' satisfaction with telehealth video-conferencing as a mode of service delivery in managing patients' health* *PLoS ONE* 14 (8) e0221848.

Ramaswamy B, Jones J, Carroll C (2018) *Exercise for people with Parkinson's: a practical approach* *Practical Neurology* 18 (5) pp399-406.

Rawstorn JC, Gant N, Direito A, Beckmann C, Maddison R (2016) *Telehealth exercise-based cardiac rehabilitation: a systematic review and meta-analysis* *Heart* 102 (15) pp1183-1192.

Røe Y, Rowe M, Ødegaard NB, Sylliaas H, Dahl-Michelsen T (2019) *Learning with technology in physiotherapy education: design, implementation and evaluation of a flipped classroom teaching approach* *BMC Medical Education* 19 article 291.

Rose D, Delevoye-Turrell Y, Ott, Annett LE, Lovatt PJ (2019) *Music and Metronomes Differentially Impact Motor Timing in People with and without Parkinson's Disease: Effects of Slow, Medium, and Fast Tempi on Entrainment and Synchronization Performances in Finger Tapping, Toe Tapping, and Stepping on the Spot Tasks* *Gait in Parkinson's Disease* Accessed 10.09.2020.

Rossi A, Torres-Panchame R, Gallo PM, Marcus AR, Statesa RA (2018) *What makes a group fitness program for people with Parkinson's disease endure? A mixed-methods study of multiple stakeholders* *Complementary Therapies in Medicine* 41 pp320-327.

Safi S, Thiessen T, Schmailzl KJ (2018) *Acceptance and Resistance of New Digital Technologies in Medicine: Qualitative Study* *JMIR Research Protocols* 7 (12) e11072.

Simpson J, Eccles F, Doyle C (2020) *The Impact of Coronavirus restrictions on people affected by Parkinson's*. The findings from a survey by Parkinson's UK. Lancaster University and Parkinson's UK. Accessed online on 18.11.2020.

Stickland MK, Jourdain T, Wong EY, Rodgers WM, Jendzjowsky NG, MacDonald GF (2011) *Using Telehealth technology to deliver pulmonary rehabilitation to patients with chronic obstructive pulmonary disease* *Canadian Respiratory Journal* 18 (4) pp216-220.

Stone R (2016) *The Effects of a Telehealth Exercise Program on Balance, and Mobility in People With Parkinson's Disease* (Master's dissertation, California State University, Northridge).

Wilkinson JR, Spindler M, Wood SM, Marcus SC, Weintraub D, Morley JF, Stineman MG, Duda JE (2016) *High patient satisfaction with telehealth in Parkinson disease: a randomized controlled study* *Neurology: Clinical Practice* 6 (3) pp241-251.

Williams OE, Elghenzai S, Subbe C, Wyatt JC, Williams J (2017) *The use of telemedicine to enhance secondary care: some lessons from the front line* *Future healthcare Journal* 4 (2) pp109-114.

World Health Organization (1998) *A health telematics policy in support of WHO's health-for-all strategy for global health development: report of the WHO group consultation on health telematics. 11-16 December, Geneva, 1997* Geneva: WHO.

Conflict of interest

Bhanu Ramaswamy is a committee member of the Sheffield Branch of Parkinson's UK, plus paid class leader for the Branch and for Hallamshire Physiotherapy Ltd.

Contribution factor

Each author contributed equally throughout the research process and with the writing of this article.

Ethical permission

No permission was required through the University Research and Ethics Committees.

Funding

No financial assistance was received; this has been a self-funded project.

Acknowledgements

Sheffield Branch of Parkinson's UK Committee, particularly Mrs Pamela Goff (Chair), Tony Hird and members who participated in the Project; Karen Hodgson, Director of Hallamshire Physiotherapy Ltd; Manuela Züger, Head of Neurology in Physiotherapy and Lecturer, ZHAW School of Health Professions, Zurich; Kathryn Cassidy, Lecturer Practitioner in Physiotherapy and Sports Injury Management at Sheffield Hallam University; Eleanor Schoch for proofreading the manuscript.

Reflection on the delivery of online classes for people with Parkinson's

from a professional practice development perspective

Dr Bhanu Ramaswamy OBE DProf FCSP[1]
Laila El Haddad[2]
Leanna Schoch[3]

This report explores the professional practice learning elements of the three authors, who ran and/or observed newly established online exercise classes hosted via the digital platform, Zoom, for people with Parkinson's (pwP) in and around Sheffield between April and July 2020.

Two of the authors (LEH in the United Kingdom and LS in Switzerland) were studying to be physiotherapists at the outbreak of the Coronavirus disease (COVID-19); restrictions in early 2020 halted their participation in clinical placements. BR, the third author and a clinician, offered the students a temporary solution of gaining clinical practice knowledge through participation in, and observation of, classes being offered to pwP with whom she had been working prior to the lockdown. The three exercise groups under consideration (named Foxhill, PDWarriors and Small Group) consisted of a total of 24 participants with Parkinson's (and, in three cases, family members often accompanied them as they exercised) with different relationships prior to lockdown, and diagnosis lengths and, for some, the period they had attended classes with BR ranged from over 20 years to three months.

The Foxhill group had been running for over 20 years with new members joining as old ones left. The PDWarrior group had pre-existed for three years as two single-venue groups now distributed into three online classes, mixing attendance according to the days people could join in; only the PDWarrior online class lead by BR was part of this report. The third group (Small Group) comprised three participants who had previously received one-to-one physiotherapy sessions with BR, so had not known each other beforehand. Each student observed at least one group.

The sessions were recorded with participants' consent permitting field notes and videos to be used for discussion at fortnightly tutorials. Ethical and professional practice issues were explored, alongside practical suggestions of delivery improvements. By the project end, LS assisted BR with the running of the Small Group class, twice taking the lead position, giving her insight as to actual delivery issues encountered by the class lead.

Aim of the report

To use the observation and an incidental research opportunity (a survey of participants' responses to the new online provision) during the project period to reflect on professional learning (knowledge and skills) and professional practice (behaviours and identity) (Grace and Trede 2013) that could inform the revision of existing guidance documentation setting out basic direction for professionals conducting online exercise classes for pwP.

Methods used to reflect and illustrate professional practice learning

The reflective element of this report adheres to the professional development standards 3 and 4 of the United Kingdom (UK) physiotherapy regulating body, the Health and Care Professions Council (HCPC 2017) in using Continuing Profesional Development (CPD) to enhance practice and service delivery and be of benefit to the service user.

A guidance document for professionals starting or running exercise classes online for pwP, co-authored with BR, was drafted in March 2020 for the Exercise Professionals Hub* (Exercise Hub). At the time of writing this report, the guidance document was under review, and hence provided the basis of the reflective report.

---

* The Exercise Professionals Hub (Exercise Hub) is a subgroup of the UK Parkinson's Excellence Network who aim to raise standards for professionals working with people with Parkinson's through the national charity, Parkinson's UK. The Exercise Hub comprises mainly physiotherapists, exercise professionals, and occupational therapists.

[1] Independent Physiotherapy Consultant.

[2] MSc Physiotherapy student, Department of Allied Health Professions, College of Health, Wellbeing and Life Sciences, Sheffield Hallam University UK.

[3] ZHAW (Zurich University of Applied Sciences) School of Health Professions, Switzerland.

The Exercise Hub guidance document identified six good practice areas for professionals to note:

1. Maintaining safety of participants (encompasses insurance, information necessary from pre-, during- and post-class)
2. How participants access the classes (encompasses digital platform, technology and pre-class support sessions)
3. How participants should prepare for the class (encompasses ideas for preparation and also class format)
4. Choice of background sound
5. Charging people
6. Support between classes (encompasses maintaining exercise and promoting other support mechanisms)

This report uses Gibbs Reflective Cycle (Paterson and Chapman 2013, Gibbs 1988) to demonstrate reflective practice (description, feelings, evaluation, analysis, conclusion and action) on one specific aspect in each good practice area. The Action from each reflection has been collated into a Recommendation section to be taken forward and inform the next iteration of the Exercise Hub document.

The six good practice areas have been illustrated as a set of figures (*Figures 1 – 6*) for this report with the exception of Good Practice Area 1. This is written in full to allow the reader insight into the depth of conversations that took place during tutorial sessions. A report of all six conversations written in the full format is available on request from the corresponding author.

Findings in each good practice area

1. Maintaining safety of participants

(*Figure 1*)

- **Description**: Maintaining safety during classes is a physiotherapist's duty of care to the participant. It requires a protocol to follow should the participant report or become injured/ill prior to or during the class, particularly if alone in the house. The current Exercise Hub guidance advises the exercise professional to have a record of participants' addresses, contact particulars, General Practitioner (GP) details and relevant medical history, plus a clear view of the participant to ensure optimal observation.

  BR has experience working with most of the online participants, with insight into their exercise capabilities so the paperwork assisted decisions made about individual adjustments to exercise eg, options in the seated or standing position.

  The authors identified the following issues as affecting safety:

- The (in)ability to keep the exercise participant in view of the camera, particularly for floor exercises, where space or a change of camera angle affected the view of the participant, compromising their safety.
- To understand where duty of care extended towards family members who chose to join in with the classes.
- To consider numbers participating online, affecting the ability for the class leader to observe everyone sufficiently.

DESCRIPTION	FEELINGS	EVALUATION	ANALYSIS	CONCLUSION
Avoiding or managing injury or illness (numbers, view of participant and family participation).	Concern over ability to monitor the situation, and intervene in a timely manner.	Existing relationship with participants enabled understanding of capabilities.	That stopping floor exercises would reduce risk where people consistently dropped from view or found transitioning between positions difficult.	Ensure paperwork of participants' medical issues and contacts for emergencies is up to date prior to class, and have a full view of participants during class.

ACTION: See Recommendation section

Figure 1 Summary of reflection on maintenance of participant safety

- **Feelings**: The concern was in upholding the ethical principles of beneficence and non-maleficence. In pre-existing single-venue exercise classes the leader had monitored participants closely, physically adjusting unsafe practice and gauging exertion levels. They could also offer direct care or ensure intervention from necessary services in the event of injury or illness during the course of the class, something less easily monitored or dealt with in online class delivery.
- **Evaluation**: In a participant survey conducted with this group investigating acceptance of online classes, several participants made the point that the pre-existing relationship with the class leader increased their confidence in the leader's capability to monitor for participant safety during class due to familiarity with their needs. This was the case, so BR monitored against complacency, and adequately observed participants ie if BR could not see them, could they see her properly?
- **Analysis**: Tutorial discussions advocated a change in practice to cease floor activity where participants could not alter camera angles to be seen adequately or were deemed unsafe transitioning between upright and floor positions.
- **Conclusion**: The class leader is not physically present in online classes but must still take action if an injury or illness occurs.

Relevant and regularly updated paperwork is necessary, as is the ability to observe the participants throughout the class, making necessary adjustments when appropriate.

- **Action**: See Recommendation section.

2. How participants access the classes (*Figure 2*)

- **Description**: Online class participants had to learn new skills about digital platforms, devices and supportive technology required to access classes. The current guidance document suggests that people might benefit from a trial run through the technology to familiarise themselves with its use. BR therefore offered participants an initial one-to-one session on the use of Zoom prior to joining class.

DESCRIPTION	FEELINGS	EVALUATION	ANALYSIS	CONCLUSION
Use of digital platforms to access classes was new to all participants so an introduction to Zoom was offered to individuals.	1:1 training to set up and use Zoom reduced reluctance in the use of the technology and increased participant confidence to join in online classes.	Initial and subsequent 1:1 training was appreciated by participants, but may be impractical to arrange for some professionals.	Family helping with access for those still having difficulty could be a solution. Connectivity and sound/visual distortions may continue to be issues.	Ensure guidance is provided to help people set up their technology and access classes.

ACTION: See Recommendation section

Figure 2 Summary of reflection on how participants access the classes

DESCRIPTION	FEELINGS	EVALUATION	ANALYSIS	CONCLUSION
Participants were becoming deconditioned over time, necessitating the addition of equipment to build strength and alteration of class format.	Insufficient weights eg bottles of water, tins of beans, resulted in ineffective exercise. Conversely, those weaker due to lockdown restrictions risked injury if the resistance was incorrectly gauged (too heavy).	1. Difficulties in online testing made it hard to provide correct resistance equipment, plus screen monitoring negatively affected the ability to work people to a high enough intensity. 2. Appropriate equipment is needed if exercise online is to be continued in the long term.	1. Introduction of a basic leg strength and endurance test helped people monitor their physical state and judge how to push themselves. 2. Purchasing weights raised questions about whose responsibility it was to provide equipment.	Dialogue allowed agreement of exercise expectation and adaptation of mindsets of people from established classes to the exercise style and equipment requirements. Participants admitted to enjoying the occasional change in the exercise routine.

ACTION: See Recommendation section

Figure 3 Summary of reflection on the use of equipment for the classes

3. Preparation for the class (focus on equipment used) (*Figure 3*)

- **Description**: Online classes required that the participant take responsibility to ensure they had necessary space, water, a phone and possibly certain equipment for use during the session. Not all of the three classes started with people using equipment; however, over the course of three months the effects of deconditioning and worsening Parkinson's symptoms due to the restrictions to incidental activity were noticeable in many participants (Simpson *et al* 2020). The class format altered to include strengthening and balance exercise as well as posture, necessitating the addition of resistance equipment.

4. Choice of background sound (*Figure 4*)

- **Description**: The choice of background sound (including tempo) motivates people differently to exercise (Patania *et al* 2020) and BR had always used music (under licence) at classes. Music that complied with online licensing laws to keep people to time/push exercise intensity, and gradually increase participants' tolerance to a longer duration class (from 30 minutes to 45 minutes) was tried. Distortions experienced due to Internet services creating a time lag between participants' screen view and sound made it hard for them to follow the exercise to music, with participants agreeing that the use of a metronome offered a solution.

5. Charging people (*Figure 5*)

- **Description**: The original Exercise Hub guidance document states: "It is not for this group to suggest prices for running online classes. What is charged will depend upon your nature of employment, and whether you are already being paid to run the classes, or whether this is part of your existing business." Many physiotherapists, however, still work for a free-at-the-point-of-delivery health service, so charging raises ethical dilemmas. The Foxhill class provided by the Sheffield Branch of Parkinson's UK was free to participants, with the class lead paid for through Branch funds. Participants of the PD Warrior and the Small Group were charged variable prices set by the private practice to cover the costs of the class lead and the Zoom licence.

6. Support between classes (*Figure 6*)

- **Description**: Maintenance of exercise between the periods that online classes were delivered required wider support mechanisms such as non-live online opportunities from the main charity (Parkinson's UK), Local Authority provision or other private providers.

Recommendations

It is essential that professional practice considers a wider perspective than covered in this reflective report. Examples include an alteration in privacy and professional boundaries created through participants gaining access into the lives (and homes) of the professional and other participants when delivering/ accessing online classes from home; consideration of where our responsibilities and duty of care lie when family members join in with the exercise class; deliberation on how to maintain an all-important social aspect to the group forum.

From the six areas of guidance under inspection, the following recommendations will be taken forward to update the Exercise Hub documentation:

- Action 1: Maintaining safety of participants: Consider the conduction of an effective online assessment of the physical and cognitive ability of the participant, and their capability of setting up a safe environment from which to participate in online classes.
- Action 2: Participants' access to class: People should have guidance about their device, the technology used, and its secure use. This can be provided through one-to-one support or, where this is unavailable, by ensuring a link can be sent for the participant to read the guidance prior to joining a class.
- Action 3: Preparation for class: Participants using equipment should be responsible for ensuring it is in good condition. The class leader should use varied means of ensuring participants exercise effectively and safely according to their differing capabilities.
- Action 4: Choice of background sound: Considering the use of music, or in the first instance, a metronome, with differing cadence according to the type of exercise component worked on, and setting the number of repetitions according to the ability of people with slowed responses.
- Action 5: Charging people: No suggested change to the wording in the guidance document about class charges, but possibly suggest ways to open the conversation about covering class costs.
- Action 6: Support between classes: Recommend the updated guidance document pushes harder for the 'drip-drip' approach, feeding information gradually but constantly to class participants, including exercise sites, downloadable apps, the Parkinson's UK helpline and local group details so people can keep up sufficient activity.

As the social aspect is paramount for wellness, we would look to support the set up of buddy systems where a group 'at the end of class chat' is not viable, so participants can

DESCRIPTION	FEELINGS	EVALUATION	ANALYSIS	CONCLUSION
Background sound motivates people to exercise but is less easy to follow online. The metronome beat offered a solution.	Music choice and tempo seemed harder to deal with due to competing attention using an online platform. The steady, monotonous tone of the metronome helped.	Adjustments were made to the tempo and repetitions allowing the pwP more time to adapt to new exercise with the metronome.	Trials of 75 beats per minute (bpm) suited the warm-up and cardio section. More repetitions were added to allow a cognitive response to transition from one exercise into another. 60 - 70 bpm suited the balance and strength training.	Background sound must be adapted to the group ability, and class participants given time to adjust physically and cognitively to a new way of exercise.

ACTION: See Recommendation section

Figure 4 Summary of reflection on the choice of background sound

DESCRIPTION	FEELINGS	EVALUATION	ANALYSIS	CONCLUSION
Participants were charged differently depending on the provider and class costs.	Prices charged should allow class costs to be met, yet be affordable for participants.	Extension of the lockdown period beyond the anticipated three months necessitated a review of class costs.	Participants were more open to discussion about cost rises in class than BR had anticipated. Affordability was not a barrier to participation.	BR had to confront and overcome her personal mentality regarding judgements about class cost.

ACTION: See Recommendation section

Figure 5 Summary of reflection on charging people for classes

DESCRIPTION	FEELINGS	EVALUATION	ANALYSIS	CONCLUSION
Maintenance of exercise between classes was attempted by providing participants with supportive exercise material to access online .	BR was frustrated by the lack of participant follow-up of her numerous suggestions of ways to supplement these classes with different exercise, sent in varied format.	Lockdown had a profound effect on participants' physical and mental health affecting motivation and uptake of different activity.	The lack of social support affected engagement in non-live exercise with peers, however well promoted.	Promotion for ways to remain active continued as discussions at the after class 'chat' sessions; BR had to accept the difficulties people were under to engage in exercise.

ACTION: See Recommendation section

Figure 6 Summary of reflection on the use of materials to support exercise between classes continue to engage in their own social networks and maintain contact with other group members.

Conclusions

Although some people may be getting used to the use of online platforms by which to communicate with friends and family, it is a different experience to try to follow a live instruction during an online delivered exercise class, where both parties are not only moving but are some distance from the screen.

The findings from our observations and iterations have permitted the authors to make recommendations on how aspects of the current standards in an Exercise Hub guidance document for exercise professionals running online classes can be modified to carry out safer, more effective online exercise classes for pwP.

Joining the UK Parkinson's Exercise Network and Exercise Professionals Hub

- Join the Parkinson's UK Excellence Network at: https://www.parkinsons.org.uk/professionals/uk-parkinsons-excellence-network
- If interested in, or deliver exercise for people with Parkinson's, sign up for free membership of the Exercise Professionals Hub by emailing: excellence@parkinsons.org.uk

Conflict of interest
Bhanu Ramaswamy is a committee member of the Sheffield Branch of Parkinson's UK, plus paid class leader for the Branch and for Hallamshire Physiotherapy Ltd.

Contribution factor
Each author contributed equally throughout the research process and with the writing of this article.

Ethical permission
No permission was required through the University Research and Ethics Committees.

Funding
No financial assistance was received; this has been a self-funded project.

Acknowledgements
To participating members of the Sheffield Branch of Parkinson's UK and others involved in the project for sharing their opinions; Manuela Züger, Head of Neurology in Physiotherapy and Lecturer, ZHAW School of Health Professions, Zurich; Kathryn Cassidy, Lecturer Practitioner in Physiotherapy and Sports Injury Management at Sheffield Hallam University; Eleanor Schoch for proofreading the manuscript.

REFERENCES

Gibbs G (1988) *Learning by doing: A guide to teaching and learning methods* Further Education Unit, Oxford Polytechnic, Oxford.

Grace S, Trede F (2013) *Developing professionalism in physiotherapy and dietetics students in professional entry courses* *Studies in Higher Education* 38 (6) pp793-806.

Gumber A, Ramaswamy B, Thongchundee O (2019) *Effects of Parkinson's on employment, cost of care, and quality of life of people with condition and family caregivers in the UK: a systematic literature review* *Patient Related Outcome Measures* 10 pp321-333.

Health and Care Professions Council (HCPC) (2017) *Continuing Professional Development and your registration* Accessed on 19.08.2020.

Lord S, Godfrey A, Galna B, Mhiripiri D, Burn D, Rochester L (2013) *Ambulatory activity in incident Parkinson's: More than meets the eye?* *Journal of Neurology* 206 pp2964-2972.

Patania VM, Padulo J, Iuliano E, Ardigò LP, Čular D, Miletić A, De Giorgio A (2020) *The Psychophysiological Effects of Different Tempo Music on Endurance Versus High-Intensity Performances* *Frontiers in Psychology* 11.

Paterson C, Chapman J (2013) *Enhancing skills of critical reflection to evidence learning in professional practice* *Physical Therapy in Sport* 14 pp133-138.

Simpson J, Eccles F, Doyle C (2020) *The Impact of Coronavirus restrictions on people affected by Parkinson's. The findings from a survey by Parkinson's UK* Lancaster University and Parkinson's UK. Accessed online on 18.11.2020.

High intensity mobility training with multiple sclerosis:

using the CIMT approach for the lower limb

Karen Leslie BSc(Hons)[1]
Natalie Shingfield MSc[2]

This case study demonstrates how the principles of Constraint Induced Movement Therapy (CIMT) and the dose-dependent relationship with motor recovery can be applied to a patient with multiple sclerosis, and result in subjective and objective improvements without adverse effects.

CIMT and dose-dependent treatment

Large doses of therapy lead to clinically meaningful improvements (Lohse *et al* 2014) (Pollock *et al* 2014) particularly a high dose of task specific practice over a shorter period of time (Kwakkel *et al* 2004).

Constraint induced movement therapy (CIMT) is an established intervention using these dose-dependent principles for upper limb rehabilitation in hemiplegia (Taub *et al* 2002). A CIMT programme takes place over two to three weeks, with treatment lasting up to six hours a day. The key components of a CIMT programme are intensive repetitive practice of functional movements, alongside a 'transfer package' to utilise the movements in daily life (Taub *et al* 2002)

The 'transfer package' is key to transfer the gains made in a clinical setting into real-world activities of daily living, and has been shown to increase gains up to 2.4 times compared to similar clinical input without it (Taub *et al* 2013). A transfer package generally includes:

- Behavioural contract
- Home practice given between clinic sessions
- Post-treatment home practice

The application of CIMT has now been extended to the lower limb with intensive programmes on post-stroke patients showing improvements in ambulatory function, gait velocity and muscle strength (Stock *et al* 2009), and weight asymmetry and falls reduction (Vearrier *et al* 2005) with improvements sustained at three and six month follow-ups (Marklund *et al* 2006).

Lower limb CIMT uses similar protocols to the upper limb programme, with three hours a day of therapist contact for ten consecutive weekdays. Treatment is focused almost entirely on the affected limb, aiming to reduce the 'learned misuse' of the weaker side. CIMT for the upper limb involves a constraint mitt on the unaffected side to enforce consistent use of the weaker side; however, while several options have been explored for lower limb, including a shoe wedge to facilitate weight shift to the weaker side, it has been concluded that a lower limb constraint is unnecessary and may have a detrimental influence on gait (dos Anjos *et al* 2020).

Clinical sessions involve repetitive motor training following shaping principles, where specific movements are broken down and made progressively more complex with modelling, coaching and feedback from the therapist (dos Anjos *et al* 2020).

The 'transfer package' still applies to lower limb CIMT, ensuring that the affected side becomes involved in everyday mobility tasks such as sit to stand, walking and stair climbing.

This case study details a CIMT lower limb programme for a patient with multiple sclerosis (MS).

Intensive training for multiple sclerosis

Exercise has been shown to be beneficial for people with MS, improving central nervous system integrity and having a positive effect on the modulation of the blood-brain barrier (Negaresh *et al* 2019).

> *The 'transfer package' is key to transfer the gains made in a clinical setting into real-world activities of daily living, and has been shown to increase gains up to 2.4 times compared to similar clinical input without it.*

---

[1] Senior neurological physiotherapist, physio.co.uk (part of Tx Group)
[2] Senior neurological physiotherapist, physio.co.uk (part of Tx Group)

The primary concern of using an intensive approach was the risk of triggering fatigue; however, a small study had already carried out a three-week programme of lower limb CIMT on people with MS, with therapy sessions lasting 3.5 hours a day. The improvements gained were maintained at a six-month follow-up and 50% of patients had maintained at a four-year follow-up. (Mark *et al* 2013) No adverse events were recorded and there was no impact on fatigue ratings.

More recently, a study looked at four weeks intensive treadmill training on people with MS with moderate to severe disability and again found significant improvements gained with no detrimental effects (Jonsdottir *et al* 2018).

After reviewing the evidence with the patient, she provided informed consent to take part in the intensive lower limb programme.

The patient

Joan is in her 50s and was diagnosed with primary progressive multiple sclerosis in 1998, affecting her left side. She is independently mobile with a stick and had been using an Odstock FES device for outdoor mobility for six months, having previously used an AFO that she did not find comfortable. Joan reported her MS symptoms had been stable for many years.

Joan's main difficulties were left leg weakness with foot-drop due to weakness of her ankle dorsiflexors. Joan presented with full passive range of movement at her left hip and knee, with some reduction in range to her left ankle. Muscle activity in her ankle was at grade 0-1, and she achieved grade 3 in her hip and knee. She was able to lift her leg up towards her chest partially, had difficulty flexing her knee in prone due to weakness in her hamstrings, and could bridge with mild asymmetry of the pelvis. Joan had reduced sensation in her left leg to light touch and some reduced proprioception in the ankle.

Joan was able to stand unsupported but struggled with positions requiring more demands on her postural control such as standing with feet together, turning to look behind and step stand positions. As is common in hemiplegic presentations (Bohannon and Larkin 1985) Joan bore more weight through her unaffected side in a general standing position.

Joan could walk independently with and without her FES device. She had difficulty with the swing-through phase of walking due to reduced left hip flexion, requiring circumduction of the left leg and compensatory trunk lean to achieve swing through. With the FES on, walking speed increased though the heel strike remained limited. This effortful gait pattern has led to a reduction in the distance that Joan can walk, and her postural instability reduced her confidence significantly when walking outdoors.

Joan attended her local MS centre and had weekly neurological physiotherapy input which she found helpful; however, Joan wanted to explore whether a more intensive treatment programme would help to improve her mobility and reduce her risk of falls.

Intervention/method

The goals of the programme were to improve Joan's mobility by:

- Increasing distance
- Increasing speed
- Improving strength
- Improving balance

From the initial assessment and first day measurements, the therapy team discussed what the focus of the programme should be in order to meet Joan's goals. Given the severity of her foot-drop it was unrealistic to expect change in this area within a two-week programme, therefore the clinical focus of therapy sessions was:

- Left hip flexion
- Left hamstring activity
- Hip stability
- Increased weight bearing on left side
- Static and dynamic balance training
- Reduced circumduction of left leg during swing phase
- Reduced compensatory movements of rest of body
- Increased stamina and exercise tolerance

The programme involved three hours a day in clinic for ten consecutive weekdays. Clinic sessions focused on core areas of strength, balance and gait. Each exercise or activity was designed to target at least one area of the clinical priorities listed above, with the emphasis on intensive repetition of a movement almost solely for the left leg. The shaping principles were applied, with each activity made progressively more complex, alongside provision of coaching and praise to provide further motivation.

Joan worked in a variety of postural sets and we included equipment such as gym balls, Thera-Bands and slide sheets to aid or challenge as part of the shaping process. Very little hands-on facilitation was utilised, the focus being more on achievable activity that could be intensively repeated.

Regular breaks were used, or activity focuses changed, to allow muscle groups to rest. Joan also completed daily treadmill training for up to ten minutes at a time.

For gait re-education we addressed mobility with and without FES as Joan would mobilise indoors without it, for example to access her bathroom at night.

As part of the transfer package, Joan was given on average five tasks to do each day outside of clinic time, which she managed to mostly complete despite the intensity of the therapy sessions. The tasks involved practice of specific movement components of gait, for example isolated stepping and weight transference.

Outcome measures

We wanted to select a variety of outcome measures to capture both subjective and objective data. Subjectively we were keen to explore Joan's fatigue levels and how she felt her MS impacted on her walking, so we selected the Modified Fatigue Impact Scale, which has shown to have reliability in people with MS (Mathiowetz 2003) and the MS Walking scale (Hobart *et al* 2003).

Objectively we wanted to look at walking speed, stamina and balance. We were conscious that some of the outcome measures may have been affected by the variability of her FES, which is why we made sure to include measures that did not use FES.

We therefore selected the ten-metre walk test (with and without FES), timed up and go (with and without FES), 6-minute walk test (with FES) and BERG balance, which have all been shown to be reliable in ambulatory MS subjects (Paltamaa *et al* 2005).

Results

The outcome measures demonstrated that during the two-week programme Joan improved her walking speed and balance, with no detrimental effect on her reported fatigue.

Every outcome measure showed improvement (see *Table 1*). Objectively her ten-metre walk test became quicker, more significantly without the FES, as did her timed up and go test. In the six-minute walk test she was able to cover over 30 metres more after two weeks, and her BERG balance showed improved higher level balance in feet-together and step-stance positions.

Clinically the following was observed:

- Increased hip flexion of the left leg, allowing for a less effortful step-through with left leg
- Increased weight bearing on left side in static stand and stance phase
- Improved balance and confidence in transferring weight to left side
- Improved hamstring activation

It is important to acknowledge that this observational analysis is not objectively measured and therefore subject to bias.

Joan's FES settings were adjusted to increase the ramp time, to allow her to utilise the increased movement at her knee. This adjustment in FES may account for the improvements in outcome measures when FES was involved; however the improvements shown without FES signify that the intervention had a significant role.

Subjectively, Joan's fatigue levels were reduced by the end of the programme, and her impression of her walking ability was improved (*Table 2*).

Joan was given an exercise plan to continue with following completion of the programme, with key exercises to build on the strength gains already made. The 'transfer package' incorporated the gait re-training into her walking pattern, with Joan now more aware of how she could use her left leg.

On follow-up four months later, the subjective outcome measures were repeated and show a continuation of the improvement in fatigue, and improvement in walking. Joan reported she was able to walk further with less recovery time outdoors and was now enjoying walks in the countryside using walking poles. She also found it easier to walk without FES within the house.

> *We were conscious that some of the outcome measures may have been affected by the variability of her FES, which is why we made sure to include measures that did not use FES.*

OBJECTIVE OUTCOME MEASURES

Objective measure	Day 1	Day 5	Day 10
10-metre walk test			
without FES	29 seconds		21 seconds
with FES	7 seconds		15 seconds
Timed up and go			
without FES	26.53 seconds	25.17 seconds	19.07 seconds
with FES	18.91 seconds	19.89 seconds	15.44 seconds
6-minute walk test	170 metres	191 metres	202 metres
with FES	no rest	no rest	no rest
Berg Balance (max 56)	47	49	51

Table 1

SUBJECTIVE OUTCOME MEASURES

Subjective measure	2 March 2020	13 March 2020	14 July 2020
Modified Fatigue Impact Scale			
(0 – 84) (lowest best)	30	7	7
Physical subscale			
(0 – 36) (lowest best)	16	5	4
Cognitive subscale			
(0 – 40) (lowest best)	11	2	2
Psychosocial subscale			
(0 – 8) (lowest best)	3	0	1
MS Walking Scale			
(0 – 60) (lowest best)	51	35	28

Table 2

The follow-up session was carried out virtually due to Covid restrictions, so objective measures have not been repeated, but on observation she was seen to have improved hamstring activation further, increased hip flexion, and several of the exercises were progressed showing ongoing improvements.

Implications for practice

This case study demonstrates the dose-dependent relationship between therapy input and functional improvements, and the potential to create significant change over a short period of time.

While most research on intensive therapy has focused on stroke patients, there have been studies to show similar improvements with brain injury (Peters *et al* 2014) and incomplete spinal cord injury (Fritz *et al* 2011). Just as CIMT for the upper limb has now been applied to a wide range of neurological conditions that produce hemiplegia, it would be logical to assume that lower limb training can be equally applied to any condition that results in a weaker leg.

It is important to acknowledge that providing 30 hours of one-to-one therapy over two weeks is an unrealistic expectation of NHS services. However, given the short time frame over which this intervention occurs, there could be cause to rethink how outpatient and community services are delivered, with a focus on short but intensive input as opposed to regular reviews that are spaced out over a longer period of time. Group sessions, or individual goal-driven challenges to accrue training hours, could all be options worth exploring with the right patient population.

This case study also demonstrates the capability of someone with multiple sclerosis to tolerate intensive exercise without adverse effects on fatigue, and given the established benefits of exercise for MS in general this should inform the advice given to people with MS on the quantity and nature of the exercise they should be aiming for.

Summary

This case study demonstrates that high intensity mobility training can improve all aspects of mobility in a hemiplegic presentation, and shows that intensive training is both beneficial and tolerated by someone with multiple sclerosis, with improvements maintained in the long term.

The nature of MS is individual and complex, so it is not possible to conclude that this approach is suitable for every person with MS. The basis of CIMT approaches is to readdress a learned non-use or misuse of a weaker side, and so relies on a hemiplegic presentation. There is not enough evidence to conclude that this approach would be suitable for a more global presentation.

There has also not been enough research to explore the 'ideal dosage' for this type of therapy. Despite the strong evidence base, CIMT is still not widely used in practice, and those that do utilise the approach can often modify dosage, or leave out the transfer package (Christie *et al* 2019). Further research is required to establish protocols that are realistic but remain as effective.

REFERENCES

Bohannon R, Larkin P (1985) *Lower Extremity Weight Bearing Under Various Standing Conditions in Independently Ambulatory Patients with Hemiparesis Physical Therapy and Rehabilitation* 65 (9) pp1323-1325.

Christie LJ, McCluskey A, Lovarini M (2019) *Constraint-induced movement therapy for upper limb recovery in adult neurorehabilitation: An international survey of current knowledge and experience Australian Occupational Therapy Journal* 66 (3) pp401-412.

dos Anjos S, Morris D, Taub E (2020) *Constraint-Induced Movement Therapy for Lower Extremity Function: Describing the LE-CIMT Protocol*, *Physical Therapy and Rehabilitation* 100 (4) pp698–707.

Fritz SL, Merlo-Rains AM, Rivers ED (2011) *An intensive intervention for improving gait, balance, and mobility in individuals with chronic incomplete spinal cord injury: a pilot study of activity tolerance and benefits Archives of Physical Medicine and Rehabilitation* 92 (11) pp1776-1784.

Hobart JC, Riazi A, Lamping DL, Fitzpatrick R, Thompson AJ (2003) *Measuring the impact of MS on walking ability. The 12-Item MS Walking Scale (MSWS-12) Neurology* 60 (1) pp31-36.

Jonsdottir J, Gervasoni E, Bowman T (2018) *Intensive Multimodal Training to Improve Gait Resistance, Mobility, Balance and Cognitive Function in Persons With Multiple Sclerosis: A Pilot Randomized Controlled Trial Frontiers of Neurology* 9 p800.

Kwakkel G, Van Peppen R, Wagenaar RC (2004) *Effects of augmented exercise therapy time after stroke: A meta-analysis Stroke* 35 (11) pp2529-2536.

Lohse KR, Lang CE, Boyd LA (2014) *Is more better? Using metadata to explore dose-response relationships in stroke rehabilitation Stroke* 45 (7) pp2053-2058.

Mark VW, Taub E, Uswatte G (2013) *Constraint-induced movement therapy for the lower extremities in multiple sclerosis: case series with 4-year follow-up Archives of Physical Medicine and Rehabilitation* 94 (4) pp753-760.

Marklund I, Klässbo M (2006) *Effects of lower limb intensive mass practice in poststroke patients: single-subject experimental design with long-term follow-up Clinical Rehabilitation* 20 (7) pp568-576.

Mathiowetz V (2003) *Test–Retest Reliability and Convergent Validity of the Fatigue Impact Scale for Persons With Multiple Sclerosis American Journal of Occupational Therapy* 57 (4) pp389–395.

Negaresh R, Motl RW, Zimmer P, Mokhtarzade M, Baker JS (2019) *Effects of exercise training on multiple sclerosis biomarkers of central nervous system and disease status: a systematic review of intervention studies European Journal of Neurology* 26 (5) pp711-721.

Paltamaa J, West H, Sarasoja T, Wikström J, Mälkiä E (2005) *Reliability of physical functioning measures in ambulatory subjects with MS Physiotherapy Research International* 10 (2) pp93-109.

Peters DM, Jain S, Liuzzo DM (2014) *Individuals with chronic traumatic brain injury improve walking speed and mobility with intensive mobility training*. *Archives of Physical Medicine and Rehabilitation* 95 (8) pp1454-1460.

Pollock A, Farmer SE, Brady MC *et al* (2014) *Interventions for improving upper limb function after stroke*. *Cochrane Database Systematic Review* (11):CD010820.

Stock R, Mork PJ (2009) *The effect of an intensive exercise programme on leg function in chronic stroke patients: a pilot study with one-year follow-up* *Clinical Rehabilitation* 23 (9) pp790-799.

Taub E, Uswatte G, Elbert T (2002) *New treatments in neurorehabilitation founded on basic research* *Nature Reviews Neuroscience* 3 pp228-236.

Taub E, Uswatte G, Mark V, Morris D, Barman J, Bowman M, Bryson C, Delgado A, Bishop-McKay S (2013) *Method for Enhancing Real-World Use of a More-Affected Arm in Chronic Stroke: The Transfer Package of CI Therapy* *Stroke* 44 (5) pp1383-1388.

Vearrier L, Langan J, Shumway-Cook A, Woollacott M (2005) *An intensive massed practice approach to retraining balance post-stroke* *Gait & posture* 22 (2) pp154-163.

An upper extremity class held in a neurological rehabilitation unit – a service evaluation

Qian Yang MSc[1]
Grahame Pope MPhi[2]l

Upper extremity (UE) motor impairments, such as muscle weakness, dystonia and abnormal movement coordination, are common consequences following neurological disorders.

> *… CCT can increase active practice time without increasing staff requirements, by focusing on both lower and upper limb functional training.*

Moderate-quality evidence suggested some interventions may be effective for improving UE function after stroke (Pollock *et al* 2013); however, the majority of these interventions are resource-intensive (requiring at least a one-to-one staff-to-patient ratio). In addition, the intensity of motor tasks is considered an important determinant of functional recovery (Kwakkel *et al* 2004), especially the duration of active practice and the number of repetitions of movement practised (Lang *et al* 2015). Stroke Foundation (2010) suggested that no less than one hour per day be spent in active practice. However, previous studies reported that the physical activity is very low in either the whole hospitalisation (West and Bernhardt 2012) or physiotherapy sessions (Kaur *et al* 2012).

Circuit Class Therapy (CCT) is a resource-efficient method, which delivers tailored exercise programmes (eg task-specific therapies) to a group of participants (more than two) with a staff-to-participant ratio not over 1:3 (English *et al* 2007). CCT was shown to be effective for improving UE impairments in post-stroke patients (Blennerhassett and Dite 2004, Pang *et al* 2006). Additionally, English *et al* (2014) and De Weerdt *et al* (2001) indicated that CCT can increase active practice time without increasing staff requirements, by focusing on both lower and upper limb functional training. However, to date, no published studies have evaluated a CCT programme which solely includes UE activities training. Furthermore, the UE activity contents in the class were not reported in detail in previous studies (Bernhardt *et al* 2004, Elson *et al* 2009).

In clinical practice, a rehabilitation unit of a hospital in the UK had been running a UE circuit class for neurological inpatients for over six months. However, there were no clearly defined standards in place concerning the duration, contents, and staff-to-patient ratios about CCT. Additionally, no service evaluation of the CCT had been conducted in the rehabilitation unit before. Therefore, there was a lack of specific information regarding how this class was delivered or what the outcomes were. Thus, the aims of the current study were to evaluate the UE programme and to determine:

- for all sessions, the average percentage of time (and amount of time) spent by patients engaged in physical activity and inactivity
- time spent in different subcategories of physical activity and inactivity
- the staff-to-patient ratios

Method

Study design

This was a service evaluation with embodied observation of the CCT provided to neurological inpatients of the rehabilitation unit. The study had been registered with the Hospital National Health Service (NHS) Clinical Quality, Risk and Safety Team prior to commencing the study. The oral consent for both patients and staff was gained before the study.

Observed classes

The UE CCT was provided routinely (once a week) to neurological inpatients. It consisted of four stations, with training items or devices placed on each station in order to improve the sensation, strength, fine movements and the ability of functional activities of patients. The activities practised in the class were tailored to the needs of patients. There were neither instructions of staying at a station for a particular length of time nor instructions of practising specific activities given to patients.

A (treatment) session was defined as a patient participating in a class. For example, if

---

[1] Physiotherapist, Department of Rehabilitation Medicine, Zhongshan Hospital, Fudan University, Shanghai, China.

[2] Associate Professor, Head of Division, Physiotherapy & Rehabilitation Sciences, University of Nottingham, United Kingdom.

four patients participated in a class, there were four sessions in total. During the data collection period, treatment sessions were included if they met the following inclusion criteria:

- patients participating in the treatment sessions had UE problems after a neurological disease
- staff providing the service were therapists, therapy assistants or students
- the treatment session mainly addressed UE problems.

Exclusion criteria for sessions were:

- the patient was unable to finish a class session
- the treatment session focused on addressing other problems (eg lower limb problems, cognitive problems) rather than UE problems. Neither therapy staff nor patients were blinded to the purpose of the study.

Observation protocol

Four entire classes were observed by two observers, who recorded the contents of the class, the time spent in each subcategory of activity and inactivity, and the number of staff and patients in the class using a behaviour mapping form (*Appendix 1*). One observer was a qualified senior physiotherapist, and the other one was a MSc physiotherapy student with four years' experience in rehabilitation. An interval of one minute was used for counting the time of activities. If patients changed the activity within one minute, then each activity duration was recorded as 30 seconds. An introduction procedure was carried out to make sure the patients and staff were comfortable with the presence of observers; for example, we observed a few classes prior to the data collection period. To confirm the consistency across the observers, any discrepancy in the process of observation was discussed after each class.

The behavioural mapping form was developed based on the studies of Ada *et al* (1999) and De Weerdt *et al* (2001), with classifications identified in order to cover the range of potential activities. All categories of practice were divided into activity and inactivity. Activity was defined here as targeted task-specific physical activities (Kaur *et al* 2012), which was subdivided into tasks (whole tasks and task components) and functional activities. Tasks included targeted active exercises (eg strengthening tasks, dexterity tasks and Wii Fit game), active movements and conversing with staff for task rehabilitation (Con_1). Functional activities included ADL (activities of daily living)-type activities, IADL-type activities and relative conversation (Con_2). Inactivity was defined as unrelated activities, such as passive exercises, resting and conversing with no purpose of rehabilitation (Con_3). Activity and inactivity consisted of subcategories according to the activity classifications of the therapy group. Specific activities of these subcategories can be found in the form (*Appendix 1*).

Data analysis and statistical analysis

Quantitative data from observations was managed in SPSS Statistics 22 (IBM Corporation, New York, USA). Descriptive statistics were used to characterise amounts of activity and inactivity, time spent in specific activity categories and the structure of the class. No specific tests were carried out.

Results

Demographic characteristics and basic information

During the data collection period, seven neurological inpatients attended the class, and their characteristics are shown in *Table 1*. Each patient attended one to three classes (*Table 1*), and there were 15 sessions observed in total.

PATIENTS' DEMOGRAPHIC CHARACTERISTICS

Patient number	Age (years)	Gender	Diagnostics	Dominant hand	Affected side(s)	Length of stay (d)	Classes attended (n)
1	48	M	Traumatic brain injury	R	L	81	3
2	58	F	Encephalitis	R	R	156	1
3	55	M	Acquired brain injury	R	L	112	2
4	56	M	Cerebral Infarction – decompressive craniectomy	R	L	37	3
5	57	M	Intra-cerebral haemorrhage	R	R	202	3
6	25	F	Hypoxic brain injury	R	R	199	2
7	48	F	Ruptured right middle cerebral artery (MCA)	L	L	188	1

Abbreviations: M = male, F = female, R = right, L = left.

Table 1

The amount of physical activity and inactivity

The proportion of time patients spent on activity or inactivity was shown in *Table 2*. The mean time spent on physical activity (55.7%±25.9%) was a little higher than that of inactivity (44.3% ±25.9%), with a large part (51.6%±24.6%) on tasks, and a small proportion (4.1%±9.5%) on functional activities. The variance of the physical activity and inactivity was large, which can be appreciated by the SDs given in *Table 2*.

TIME SPENT ON PHYSICAL ACTIVITY AND INACTIVITY

Category	Mean (minutes)	per cent	SD, per cent
Session time (minutes)	35.9		
Activity	19.2	55.7	25.9
Tasks	17.7	51.6	24.6
Functional	1.5	4.1	9.5
Inactivity	16.7	44.3	25.9

Table 2

On closer examination for all sessions (*Figure 1*), a mean of 19.2 minutes was spent on physical activity, especially on dexterity tasks (6.0 minutes), Wii Fit game (4.1 minutes), and sensory activities (3.2 minutes). Physical inactivity contributed to 16.7 minutes, such as passive activities (4.9 minutes), other non-specific activities (3.5 minutes) and arrival and preparing activities (2.6 minutes). Time spent on functional activities and the other subcategories was minimal.

The staff-to-patient ratio

The staff-to-patient ratio was over 0.8 in each class (*Table 3*). From real-time observation, therapy staff provided individual therapy to patients for most of the time in class sessions. In each class, a patient was treated by one (or two) staff.

THE NUMBER OF THERAPY STAFF AND PATIENTS IN EACH CLASS

Class	Number of therapy staff	Number of patients
1	4	5
2	3	2
3	5	5
4	4	3

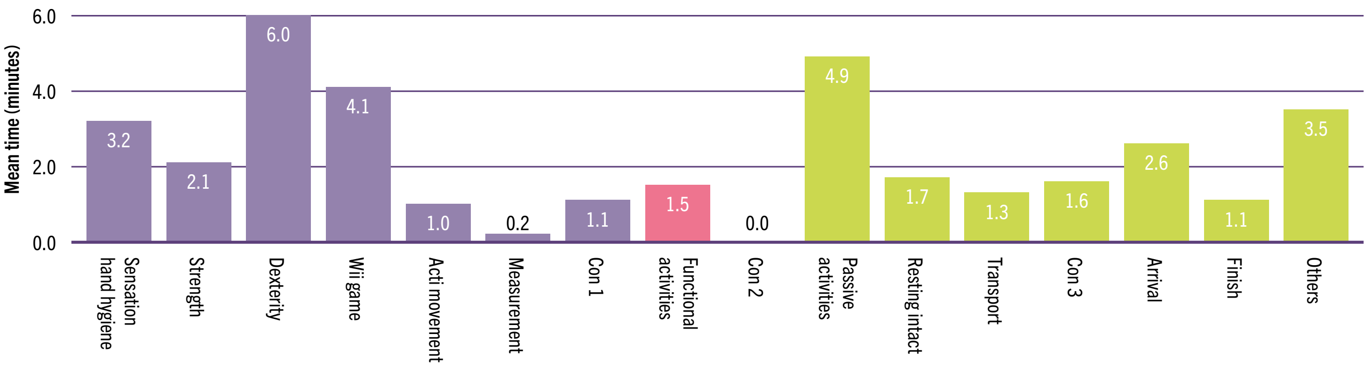
Table 3

Discussion

This study aimed to evaluate the amount of physical activity and inactivity of patients in a UE programme. The proportion of the session time spent on physical activity was only about 55%. Some subcategories of activities contributed to more time than others, such as dexterity tasks, Wii Fit game, passive and non-specific activities. The results also showed that the staff-to-patient ratio was over 0.8 in all sessions.

The proportion of inactivity time (44.3%±25.9%) in this study was higher than the result of a previous study (30%) focusing on both lower and upper limb practice (Elson *et al* 2009), which may be due to the strict inclusion criteria of Elson *et al* (2009) (participants being able to walk at least 14 metres with/without assistance). Neurological patients in the current study may be more dependent due to more severe impairments, which may explain the smaller percentage of activity time. However, comparable studies that focus solely on the amount of active time of UE practice have not been done.

MEAN TIME SPENT ON SUBCATEGORIES OF ACTIVITY AND INACTIVITY



Categories are:

🟪 **Sensory activities** (hand hygiene), strengthening tasks, dexterity tasks, Wii Fit game, active movement, measurement activity, conversing for tasks;

🟥 **Functional activities** (ADL/IADL-related activities), conversing for functional activities;

🟩 **Passive activities**, resting and/or intact arm activities, transport, conversing with no purpose of rehabilitation, arrival and preparing activities, finishing and leaving, other non-specific activities

Figure 1

For the time spent on activity, patients were active for about 19.2 minutes (*Figure 1*) in a class, including the time spent on task practice and functional activities. Stroke Foundation (2010) suggested that one hour per day be spent on physical activity. However, activity-related arm training was found to take up only 4-17 minutes in acute or subacute rehabilitation sessions after stroke (Hayward and Brauer 2015). It is unknown how much active time is optimal for improving UE function in a therapy session, because most studies only reported the time scheduled for therapy. A previous study investigated the efficacy of a high-quality, high-dose and high-intensity therapy on arm function and found clinically significant differences in measures of impairment and activity (Ward *et al* 2019). Patients in this study were able to complete the programme of six hours practice every day for three weeks (90 hours in total). Considering the similar group of patients included, the study of Ward *et al* (2019) may indicate that the active time of the current study was lower than expected. The large time spent on inactivity (mean 16.7 minutes), may be due to factors related to patients (eg complex arm impairments, lacking motivation, cognitive impairments) or staff (eg readiness, lacking related skills or knowledge). This study included patients with a wide range of length of staying (*Table 1*). There were suggestions that chronic stroke patients might not tolerate large amounts of training (Lang *et al* 2016), which may explain the large amount of inactive time.

On closer examination, most time was spent on task practice, such as dexterity activities and Wii Fit games, while the optimal type of tasks in task-specific training are still unknown (French *et al* 2016). However, repeated practice of challenging tasks would result in functional recovery (French *et al* 2016). The amount of time spent on functional activities by patients was little; however, they can be encouraged to conduct daily activities more independently and get involved in community life through practising related activities. Moreover, studies have shown that the therapy intensity is associated with functionary recovery (Kwakkel *et al* 2004). Thus, higher-dose and higher-intensity repetitive practice (tasks and functional activities) may be beneficial for the arm recovery of neurological patients.

In all sessions, the staff-to-patient ratio was over the recommended 1:3 (English *et al* 2017). The high ratio was likely owing to the wide range of upper limb impairments and mixed conditions of patients (*Table 1*), and a high staff-to-patient ratio would guarantee tailored therapy for each patient. However, one of the benefits of CCT is that it is more economical than individual therapy. The high ratio may suggest that the patients included may be not appropriate for the class, such as patient factors of severity, age and others. For example, the study by Schneider *et al* (2019) observed the intensity levels of participants with mixed neurological conditions within an upper limb class, which also showed a high staff-to-patient ratio.

Recommendations for future service delivery

Proposed changes to the existing service could contribute to high-quality therapy delivery and optimising the recovery of participants in the class. Firstly, strategies of improving the current physical activity may focus on patients or staff. A certain amount of education or related practice may be provided to patients to inform them about the importance of practice intensity. Such interventions, eg tailored counselling (Morris *et al* 2014) and self-management programmes (Jones *et al* 2015), have been suggested by previous reviews to improve activity levels. However, the strict inclusion criteria of patients in these studies may limit the generalisability of results, as these studies only included participants of community-dwelling patients. Secondly, therapy staff might pay attention to the selection of activities, such as providing high-dose and high-intensity, repetative, challenging tasks. Thirdly, the class can be provided with a therapy-to-patient ratio no more than 1:3 through including appropriate participants. For example, previous studies on CCT mainly included stroke patients with mild to moderate severity (English *et al* 2017).

The amount of time spent on functional activities by patients was little; however, they can be encouraged to conduct daily activities more independently and get involved in community life through practising related activities.

Conclusion

The current service evaluation demonstrated that the physical activity of neurological patients was lower than expected. The selection of categories of practice might not be optimal. And the therapy-to-patient ratio was over the suggested 1:3 by previous studies. The results suggested that more active UE practice in CCT be better involved in arm recovery after neurological diseases. The selected categories of tasks and functional activities and the staff-to-patient ratio need to be reconsidered. Future studies may focus on the optimal amount of physical activity for patients in CCT.

REFERENCES

Ada L, Mackey F, Heard R, Adams R (1999) Stroke rehabilitation: does the therapy area provide a physical challenge? *Australian Journal of Physiotherapy* 45 pp33-40.

Bernhardt J, Dewey H, Thrift A, Donnan G (2004) Inactive and alone: physical activity within the first 14 days of acute stroke unit care *Stroke* 35 pp1005-1009.

Blennerhassett J, Dite W (2004) Additional task-related practice improves mobility and upper limb function early after stroke: a randomised controlled trial *Australian Journal of Physiotherapy* 50 pp219-224.

➤➤

APPENDIX 1

Category	Types of activities		Code	Assis
Tasks (bilateral and unilateral)	Sensation	Hand hygiene (hand washing, hand drying, hand cream using)	Sen 1	
		Sensory kits for texture discrimination	Sen 2	
		Sensory discrimination of location, fingers, etc	Sen 3	
	Strength	Cones (reaching)	Str 1	
		Velcro weight	Str 2	
		Boules	Str 3	
		Thera-Band	Str 4	
		Dumbbell	Str 5	
		Digit-Flex (for grip and grasp)	Str 6	
	Dexterity (including tasks and some games playing)	Clothes pegs practice	D1	
		Threading buttons/beads	D2	
		Metal kits (nuts and bolts, screw driver using)	D3	
		Paperclip	D4	
		Turning over cards/book pages	D5	
		Inserting chess into holes	D6	
		Using pencil sharpener	D7	
		Using spray	D8	
		Using stapler	D9	
		Small Lego bricks (plastic ones)	G1	
		Drawing line game	G2	
		Tumbling wooden tower	G3	
		Dominoes	G4	
		Connect Four	G5	
		Shut the box game	G6	
		Playing with a ball	G7	
		Playing cards	G8	
	Wii game	Playing Wii game	G9	
	Measuring	Measure upper limb function with measurement tools	M1	
	Active movement	Active movement (wrist extension, forearm supination, finger flexion, etc)	I1	
		Self-stretch/muscle relaxation (arm and/or hand)	I2	
	Conversing for purpose of exercises	Talking with therapists for practising functional activities	C1	ND
	Functional activities: ADL and IADL	Cutting food	F1	
		Opening packets	F2	
		Squeezing toothpaste and spreading	F3	
		Opening and/or closing a lid of a jar/can	F4	
		Pouring liquid	F5	
		Folding pillowcase/cloth	F6	
		Cleaning with duster/cloth	F7	
		Using scissors	F8	
		Writing	F9	
		Brushing teeth	F10	
	Conversing for purpose of functional tasks	Talking with therapists for practising functional activities	C2	ND

APPENDIX 1 (continued)

Category	Types of activities		Code	Assis
Inactivity (Periods of inactivity of greater than 30 seconds are recorded)	Passive activity	Passive movement/stretch, except sensation	N3	ND
		Passive muscle relaxation	N4	CA
		Passive functional activities (eg assisted dressing)	N5	CA
	Resting or intact arm activities	Resting or doing nothing	N1	ND
		Intact arm activities	N2	ND
	Transport	Transport to other areas of the therapy room; repositioning	T1	ND
		Going outside (such as going to one's room, toilet, to another therapy room)	T2	ND
	Conversing without purpose of rehabilitation	Conversing with others (therapists, relatives/visitors, other patients, nurses/others), any other non-specified person	C3	ND
	Arrival and preparing	Welcome, socialisation and preparing (positioning, getting equipment, putting on aids)	W1	ND
	Finish and leaving	Finishing and transporting outside of the room	L1	ND
	Other non-specific activities	eg drinking, eating	01	ND

REFERENCES (continued)

De Weerdt W, Nuyens G, Feys H, Vangronsveld P, Van de Winckel A, Nieuwboer A, Osaer J, Kieken SC (2001) *Group physiotherapy improves time use by patients with stroke in rehabilitation* *Australian Journal of Physiotherapy* 47 pp53-61.

Elson T, English C, Hillier S (2009) *How much physical activity do people recovering from stroke do during physiotherapy sessions?* *International Journal of Therapy and Rehabilitation* 16 pp78-84.

English C, Hillier S, Kaur G, Hundertmark L (2014) *People with stroke spend more time in active task practice, but similar time in walking practice, when physiotherapy rehabilitation is provided in circuit classes compared to individual therapy sessions: an observational study* *Journal of Physiotherapy* 60 pp50-54.

English C, Hillier SL, Lynch EA (2017) *Circuit class therapy for improving mobility after stroke* *Cochrane Database of Systematic Reviews* 6 CD007513.

English CK, Hillier SL, Stiller KR, Warden-Flood A (2007) *Circuit class therapy versus individual physiotherapy sessions during inpatient stroke rehabilitation: a controlled trial* *Archives of Physical Medicine and Rehabilitation* 88 pp955-963.

Foundation NS (2010) *Clinical guidelines for stroke management 2010* National Stroke Foundation.

French B, Thomas LH, Coupe J, McMahon NE, Connell L, Harrison J, Sutton CJ, Tishkovskaya S, Watkins CL (2016) *Repetitive task training for improving functional ability after stroke* *Cochrane Database of Systematic Reviews*.

Hayward KS, Brauer SG (2015) *Dose of arm activity training during acute and subacute rehabilitation post stroke: a systematic review of the literature* *Clinical Rehabilitation* 29 pp1234-1243.

Jones TM, Dean CM, Hush JM, Dear BF, Titov N (2015) *A systematic review of the efficacy of self-management programs for increasing physical activity in community-dwelling adults with acquired brain injury (ABI)* *Systematic Reviews* 4 article 51.

Kaur G, English C, Hillier S (2012) *How physically active are people with stroke in physiotherapy sessions aimed at improving motor function? A systematic review* *Stroke Research and Treatment* article ID 820673.

Kwakkel G, Van Peppen R, Wagenaar RC, Wood Dauphinee S, Richards C, Ashburn A, Miller K, Lincoln N, Partridge C, Wellwood I (2004) *Effects of augmented exercise therapy time after stroke: a meta-analysis* *Stroke* 35 pp2529-2539.

Lang CE, Lohse KR, Birkenmeier RL (2015) *Dose and timing in neurorehabilitation: prescribing motor therapy after stroke* *Current Opinion in Neurology* 28 (6) pp549-555.

Lang CE, Strube MJ, Bland MD, Waddell KJ, Cherry-Allen KM, Nudo RJ, Dromerick AW, Birkenmeier RL (2016) *Dose response of task-specific upper limb training in people at least 6 months poststroke: A phase II, single-blind, randomized, controlled trial* *Annals of Neurology* 80 pp342-54.

Morris JH, MacGillivray S, McFarlane S (2014) *Interventions to promote long-term participation in physical activity after stroke: a systematic review of the literature* *Archives of Physical Medicine and Rehabilitation* 95 (5) pp956-967.

Pang MY, Harris JE, Eng JJ (2006) *A community-based upper-extremity group exercise program improves motor function and performance of functional activities in chronic stroke: a randomized controlled trial* *Archives of Physical Medicine and Rehabilitation* 87 (1) pp1-9.

Pollock A, Farmer SE, Brady MC, Langhorne P, Mead GE, Mehrholz J, Van Wijck F, (2013) *Interventions for improving upper limb function after stroke* *Cochrane Database of Systematic Reviews*.

Schneider EJ, Lannin NA, Ada L (2019) *A professional development program increased the intensity of practice undertaken in an inpatient, upper limb rehabilitation class: A pre-post study* *Australian Occupational Therapy Journal* 66 (3) pp362-368.

Ward NS, Brander F, Kelly K (2019) *Intensive upper limb neurorehabilitation in chronic stroke: outcomes from the Queen Square programme* *Journal of Neurology, Neurosurgery & Psychiatry* 90 (5) pp498-506.

West T, Bernhardt J (2012) *Physical activity in hospitalised stroke patients* *Stroke Research and Treatment* Article ID 813765.

Instructions for authors on submission to *Synapse*

STRUCTURE

Your paper should be compiled in the following order:

- title page
- abstract
- keywords
- main text introduction, materials and methods, results, discussion
- acknowledgments
- declaration of interest statement
- references
- appendices (as appropriate)
- table(s) with caption(s) (on individual pages)
- figures
- figure captions (as a list)

Please do not include author's name on the blind-manuscript.

Please include another file with title of paper, authors' names, corresponding authors, disclosure statement – conflict of interest as a separate file.

AUTHOR DETAILS

Please ensure everyone meeting the International Committee of Medical Journal Editors (ICMJE) *requirements for authorship* is included as an author of your paper. All authors of a manuscript should include their full name and affiliation on the cover page of the manuscript. Where available, please also include ORCiDs and social media handles (Facebook, Twitter or LinkedIn). One author will need to be identified as the corresponding author, with their email address normally displayed in the article PDF. Authors' affiliations are the affiliations where the research was conducted. If any of the named co-authors moves affiliation during the peer-review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after your paper is accepted.

All authors submitting to medicine, biomedicine, and health sciences, allied and public health journals should conform to the *Uniform Requirements for Manuscripts Submitted to Biomedical Journals*, prepared by the International Committee of Medical Journal Editors (ICMJE).

PEER REVIEW AND ETHICS

Synapse is committed to peer-review integrity and upholding the highest standards of review. Once your paper has been assessed for suitability by the editor, it will then be double blind peer reviewed by independent, anonymous expert referees.

Complying with ethics of experimentation

Please ensure that all research reported in submitted papers has been conducted in an ethical and responsible manner, and is in full compliance with all relevant codes of experimentation and legislation. All papers which report in vivo experiments or clinical trials on humans or animals must include a written statement in the methods section. This should explain that all work was conducted with the formal approval of the local human subject or animal care committees (institutional and national), and that clinical trials have been registered as legislation requires. Authors who do not have formal ethics review committees should include a statement that their study follows the principles of the *Declaration of Helsinki*.

Consent

All authors are required to follow the *ICMJE requirements* on privacy and informed consent from patients and study participants. Please confirm that any patient, service user, or participant (or that person's parent or legal guardian) in any research, experiment, or clinical trial described in your paper has given written consent to the inclusion of material pertaining to themselves, that they acknowledge that they cannot be identified via the paper; and that you have fully anonymised them. Where someone is deceased, please ensure you have written consent from the family or estate.

Using third-party material in your paper

You must obtain the necessary permission to reuse third-party material in your article. The use of short extracts of text and some other types of material is usually permitted, on a limited basis, for the purposes of criticism and review without securing formal permission. If you wish to include any material in your paper for which you do not hold copyright, and which is not covered by this informal agreement, you will need to obtain written permission from the copyright owner prior to submission.

WORD LIMITS

Please include a word count for your paper. Word limit guidance is provided below:

- **Qualitative studies/ Systematic literature reviews** – 5,000 words
- **Quantitative studies** – 3,000-4,000 words
- **Case reports** – 2,000-3,000 words
- **Service/ Quality improvement programmes** – 3,000-4,000 words.

STYLE GUIDELINES

Please use UK spelling style consistently throughout your manuscript.

Please use double quotation marks, except where "a quotation is 'within' a quotation". Please note that long quotations should be indented without quotation marks.

All articles should be well organised and written in simple, clear, correct English. The positions of tables and charts or photographs should be appropriately titled and numbered consecutively in the text.

Formatting your manuscript

- Papers may be submitted in Microsoft Word formats.
- **Figures** should be saved separately from the text and should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour, at the correct size). Figures should be supplied in one of our preferred file formats: EPS, PS, JPEG, TIFF, or Microsoft Word
- **Tables** should present new information rather than duplicating what is in the text. Readers should be able to interpret the table without reference to the text. Please supply editable files.
- **Units** Please use *SI units* (non-italicised).
- All **abbreviations** must be explained.
- **References** should be listed alphabetically, in the Harvard style eg: Pearson MJT *et al* (2009) *Validity and inter-rater reliability of the Lindop Parkinson's Disease Mobility Assessment: a preliminary study Physiotherapy* 95 (2) pp126-133.
- **Spacing** The main document should be double-spaced, with one-inch margins on all sides, and all pages should be numbered consecutively.
- **Font** The text should appear in 12-point Arial font. Normally, only two categories of heading should be used. Major ones should be typed in capital letters in the middle of the page and underlined; sub-headings should be typed in lowercase and also underlined. Headings should not be numbered.

SUBMITTING YOUR PAPER

To submit your work, email your manuscript and all supporting files to:

Synapse@acpin.net and cc in *membership-support@acpin.net*

What you need to submit

1. Covering letter to the editor

In which you have to declare that the work submitted to *Synapse* has not been published elsewhere and is not submitted to another journal simultaneously.

2. Blind manuscript should include:

- Title page title of manuscript
- A structured abstract of 250 words. You may structure your abstract with the following headings: (a) Background or introduction, (b) Objective or purpose, (c) Methods, (d) Results, and (e) Conclusion.
- Between three and five keywords.
- Main body with following headings: main text introduction, materials and methods, results, discussion; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figures; figure captions (as a list).

3. Title page with author's details

- Title
- List of authors followed by affiliation

Corresponding author: name, position, work address, email, phone details

Please include professional and academic qualifications for all authors and their current positions. For original research papers, include a brief note about each author that indicates their contribution, and a summary of any funds supporting their work.

- Funding details. Please supply all details required by your funding and grant-awarding bodies.
- Disclosure statement. This is to acknowledge any financial interest or benefit that has arisen from the direct applications of your research.

SHARING YOUR PUBLISHED WORK

On acceptance, we recommend that you keep a copy of your accepted manuscript. If your manuscript is rejected, then you are free to submit to any other journal.

Using your eprints to share your article

We want you to share your article, highlight the importance of your research, and ensure it has impact. Every *Synapse* author who publishes in a subscription journal gets **ten free eprints** to share with colleagues as soon as their article is published on *Synapse Online*.

This **includes all named authors**. So, if you collaborated on a paper with three other researchers, this means you get ten free eprints each.

For further information please contact the *Synapse* editor:

- Dr Praveen Kumar: *synapse@acpin.net*

acpin

Synapse

Official journal of the **Association of Chartered Physiotherapists in Neurology**

www.acpin.net

MARCH 2021

Editor
Dr Praveen Kumar
synapse@acpin.net

Editorial advisory committee
Members of the ACPIN Board and national committees as required.

Design
kwgraphicdesign
44 (0) 1395 260398
kw@kwgraphicdesign.co.uk

Key aspects to *Synapse's* publication and dissemination strategy are :

1. To provide a platform for publication of high quality research studies.
2. To provide peer-review feedback for novice researchers.
3. To have special/supplementary editions on specific topics/areas/student related projects.
4. To have a clearly defined editorial board.
5. To have a review board that includes both national and international reviewers. (This includes academics, researchers, clinicians, ACPIN members, non-ACPIN members/experts in the field of neurology/neurological rehabilitation, physical medicine and rehabilitation).

Image credits

page 3: 9nong/Shutterstock.com

acpin

Connecting knowledge and practice

Synapse

MARCH 2021

OFFICIAL JOURNAL OF THE ASSOCIATION OF
CHARTERED PHYSIOTHERAPISTS IN NEUROLOGY

WWW.ACPIN.NET