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Synapse

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INSIDE

Welcome

Synapse
SPRING 2024

Dear members,

Welcome to the spring 2024 edition of *Synapse*.

The aim of *Synapse* – the official journal of ACPIN – is to provide its readership (nationally and internationally), including wider multidisciplinary 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 23 and send your work for inclusion in the peer-review process. I look forward to receiving high-quality work for publication.

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‘Abnormal’ pressure hydrocephalus: an unusual case report

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Hydrocephalus is a build-up of cerebrospinal fluid (CSF) in the brain, with the excess fluid putting pressure on the brain which can damage it[1].

There are three main types of hydrocephalus:

- **congenital**: from birth
- **acquired**: developing after birth
- **normal pressure** (see *Figure 1*)

The sub-types of hydrocephalus have different symptoms with normal pressure hydrocephalus (NPH) tending to present as a triad of symptoms: cognitive decline, reduced mobility and incontinence[2]. Optimal management of the condition involves CSF diversion, normally via a shunt[3]. It can be a challenge to diagnose[4] but the main symptoms are well documented and can be reversible with correct diagnosis and management.

CASE SCENARIO

To ensure anonymity, the patient will be referred to as Mrs X throughout this case report.

Mrs X, a 58-year-old, was admitted to an acute hospital following a GP referral for hyponatremia (low sodium). She had a three-week history of declining mobility, regular falls, (tending to fall backwards), behavioural changes and aggression, memory difficulties, hiccups, vomiting and urinary incontinence.

She lived with her partner in a house and had been independent up until admission with all daily tasks, although needed some supervision in the last three weeks due to the memory issues and falls. Interestingly, she had stopped working about a year previously reporting difficulty with reading and concentration.

Mrs X’s main symptoms are summarised in *Table 1* alongside those typical of NPH.

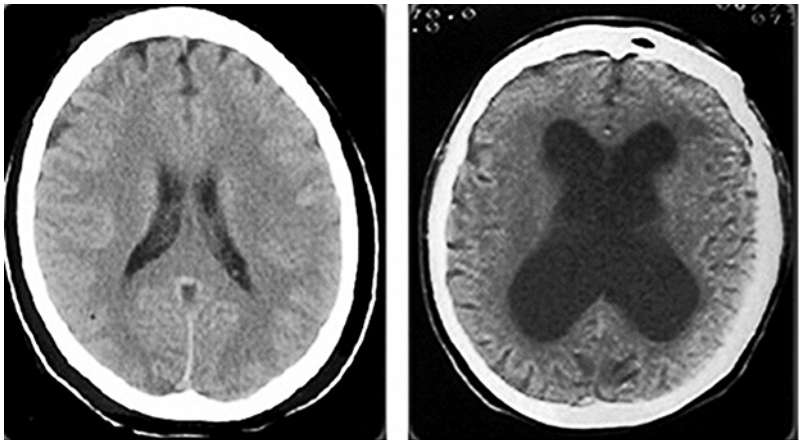

Figure 1 Scan of normal brain (left) vs NPH brain (right)[5]

Photograph: Codman

PATIENT JOURNEY

Medical review

Mrs X was reviewed in A&E by neurology. She had a CT scan and was diagnosed with cognitive decline on a background of micro-hemorrhages. She continued to vomit but no cause was identified, and she was prescribed anti-emetics. She had bilateral clonus and was ataxic, therefore an MRI of head and spine was ordered and a possible diagnosis of cervicothoracic myelopathy documented. A referral for physiotherapy was completed on the second day of admission. It was clear that the medical team were struggling to ascertain a clear diagnosis which therefore made possible treatment and prognostication more challenging.

Physiotherapy review

(on third day of admission)

- Alert but not orientated, unable to give full social history, could follow occasional one-stage commands thus formal neurological assessment limited. Slow processing and anxious.
- Movement noted in all four limbs, and sensation appeared intact.

Patient assessed in function:

- Needing assistance of two for lie to sit on edge of bed, retropulsive in sitting but able to try self-initiated sitting balance when assisted and prompted.
- Transferred via a Sara Stedy with two people assisting to a recliner chair when her relatives were present to aid safety.

Outcome measures: Modified Rivermead Mobility Index: 6/40; Berg Balance Score: 0/56

Occupational therapy review
(on fourth day of admission)

- Slow processing, poor insight into care needs and reduced following of instructions. Unable to complete formal cognitive screen.

Over the next ten days, Mrs X did not initiate eating or drinking, needed full care for daily needs, varied from independent sitting to assistance of one, and was able to maintain safety but in a recliner chair. Her transfers varied significantly, mainly due to cognition and engagement, from assistance of two people, to a hoist, with the nursing team. Rehabilitation was discussed but due to the severe cognitive deficits, and difficulty engaging in therapy Mrs X was experiencing, it was agreed by all the multidisciplinary team and Mrs X's partner that this was not the right path at this time.

Mrs X was regularly reviewed jointly by physiotherapy and occupational therapy. The neurology medical team decided investigations could be completed as an outpatient, and, if the therapy teams agreed, that the patient could go home (medically fit for discharge). This caused significant anxiety for Mrs X's partner due to such a large decline in her functioning prior to admission, and whilst an in-patient. Her partner required regular support and education which the physiotherapist and occupational therapist tried to provide, but with medical answers lacking, prognostication of recovery was difficult.

Throughout the admission, the physiotherapist and occupational therapist reported back their assessment findings daily in the multidisciplinary team (MDT) meeting. Efficient communication amongst the MDT is supported by Health Education England[6] MDT toolkit, recommending the patient should be at the centre of care, and that MDT members take a curious approach rather than always relying on the MDT 'norms' of practice. This is demonstrated within this case, where the physiotherapist, occupational therapist and patient's partner worked closely together. The neurology medical team reported back investigation findings, including that the MRI brain showed stable appearances of presumed idiopathic normal pressure hydrocephalus and old scattered micro-hemorrhages; and MRI spine demonstrated no significant findings. Five days later, with feedback of continued deterioration of functioning in physiotherapy and occupational therapy, the medical team performed a lumbar puncture – reporting a raised lactate and CSF protein, and repeated the MRI with contrast showing a possible obstruction of the third ventricle and progressing hydrocephalus. A neurosurgery referral was actioned to a local neurosurgery team, and Mrs X transferred for neurosurgery. The physiotherapist and occupational therapist felt relief that Mrs X was going for more specific treatment, as with such a decline in her functioning, it had been a very worrying clinical picture for the last two weeks.

MRS X'S SYMPTOMS	NPH SYMPTOMS
Memory and behavioural changes	Cognitive decline
Deteriorating mobility and falls	Mobility difficulties
Incontinence (urinary)	Incontinence (urinary)
Hiccups and vomitting	

Table 1 Mrs X's symptoms on admission versus NPH triad of symptoms[2]

Neurosurgery intervention
Mrs X underwent a septum pellucidotomy (removal of septum pellucidum – membrane that separates a portion of the two sides of the brain), and the reason for the obstructive hydrocephalus was noted, with the foramina of Munro almost completely stenosed. A right ventriculo peritoneal (VP) shunt was inserted. The patient was re-patriated back to our unit for further therapy assessment once medically stable.

Post-operative physiotherapy assessment
There was a large improvement in mobility when Mrs X returned from the local neurosurgical unit. She was able to get out of bed and sit independently and walk with minimal assistance of one person. She was following commands and engaging in conversation. She returned to independent eating and drinking, and daily tasks such as washing and dressing with minimal therapy input required.

The main physiotherapy input focused on balance training and regaining confidence with walking to regain full independence[7]. Mrs X and her partner were involved in discharge planning, and it was agreed after a successful stairs assessment was completed, that the patient would be discharged home with her partner's support. A referral to community therapy was made, and outpatient neurology medical follow-up. An exercise programme was prescribed to further retrain minor balance impairments noted on outcome measure review, and request for this to be progressed by the community physiotherapy team was documented in the referral. There is some evidence that patients with NPH benefit from home exercise programmes, with more gains being seen following VP shunt treatment in a very small sample[8].

Repeat outcome measures at reassessment: Modified Rivermead Mobility Index: 40/40; Berg Balance score 53/56

Reflections from this case
The challenges from not having a clear diagnosis that explained the functional decline meant that it was difficult to prognosticate

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recovery, decide on a treatment plan and educate Mrs X and her partner. She was described as medically fit for discharge early in the admission, but this created more questions for the patient's partner and the therapy team. The physiotherapist's and occupational therapist's diligence and persistence to advocate for the patient and her partner, and give feedback on the significance of the deterioration, likely helped gain further investigations sooner and quicker access to neurosurgical treatment. The cognitive decline was explained by other factors initially, like the low sodium, which is a risk in acute medical care, when co-morbidities are attributed to the current presentation despite other conditions or factors also being a differential diagnosis. The unusual presentation of a relatively rapid decline, and younger patient, made normal pressure hydrocephalus less likely, but the 'triad of symptoms' usually noted in clinical practice[3] were described from the patient's initial onset, with leaving work a year previous due to cognitive difficulties a possible starting point.

CONCLUSION

This unusual case demonstrates the severe level of physical and cognitive impairment normal pressure (and obstructive) hydrocephalus can cause, and is evidence of a more sudden onset rather than the gradual onset more typically described. The physiotherapist's regular communication to the medical team allowed further exploration of the causes of Mrs X's presentation, quicker access to in-patient investigations and quicker treatment, with a positive outcome in this case. The significance of the decline is a key learning point and how this was significantly reversible in this case, improving the patient's functional status, and both her and her partner's quality of life substantially. The triad of symptoms were present from the patient's history and so vigilance within each physiotherapist's assessment is required in this vulnerable group where subjective history is possibly more vague. Upskilling in assessment and management of hydrocephalus is warranted in acute neuroscience units. Surgical treatment options can have large improvements in a patient's function and quality of life, and in this case considerably improved the patient's outcome to allow them to return home, much more independent, with ongoing potential to progress.

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Development of a core outcome set: evaluating falls prevention interventions for people with multiple sclerosis, Parkinson's disease and stroke

Nicola O'Malley[1,2], Susan Coote[1,3,4], Fiona McCullough Staunton[5], Eileen O'Connor[5], Amanda M Clifford[1,2]

Fall events are common among people with multiple sclerosis (MS), Parkinson's disease (PD) and stroke and are associated with a range of negative physical, psychosocial and economic consequences.

Advancement in the field of falls prevention for people with these three neurological conditions has been hampered thus far due to heterogeneity in outcomes evaluating the effectiveness of interventions.

A core outcome set (COS) is a standardised set of outcomes that should be evaluated at a minimum in all studies pertaining to a specific research area. The development of a COS facilitates combination and comparison of data, reduces selective reporting of outcomes, and increases the relevance of outcomes to end users. Therefore, the aims of this study were to gain consensus from key stakeholder groups on a COS for evaluating the effectiveness of mixed-diagnosis falls prevention interventions for people with MS, PD and stroke, and to provide recommendations for the use of a single measurement instrument for each outcome in the COS.

METHOD

This was an international, multi-perspective Delphi consensus study with five key stages, designed in line with recommendations from the Core Outcome Measures in Effectiveness Trials (COMET) initiative. A public and patient involvement (PPI) panel, including individuals living with MS, PD and stroke, healthcare professionals, and representatives working with patient organisations, was established to guide the development of this COS. The PPI panel was involved in all aspects of this research study, from the design phase through to the dissemination and implementation phases. Stage one involved the systematic identification of potential outcomes through a review of the literature, a qualitative study with people with MS, PD and stroke (n=20) and consultation with the members of the PPI panel. Stage two was the development and piloting of the Delphi surveys. In stage three, outcomes were prioritised for inclusion in the COS by key stakeholders (patients, researchers, clinicians, service-planners/policymakers) using a three-round online Delphi survey. Stage four was centred around the identification of measurement instruments for outcomes in the COS. The fifth and final stage was an online consensus meeting to agree upon the final COS and respective measurement instruments. To be included in the final COS, at least 70% of participants and a minimum of one patient participant had to vote in favour of including the outcome or measurement instrument.

RESULTS

Forty-eight participants were recruited from eleven countries (patients: n=12, researchers: n=17, clinicians: n=12, service-planners/policymakers: n=7), with 87.5% of participants (n=42) completing all three rounds of the surveys. Sixty-two outcomes were included in the longlist of potential outcomes and were considered for inclusion in the final COS throughout the Delphi survey rounds. Fifteen participants from five countries (patients: n=3, researchers: n=7, clinicians: n=3, service-planners/policymakers: n=2) attended the online consensus meeting and agreed upon the final COS. Seven outcomes met the predefined criteria for inclusion in the final COS: fall incidence, injurious fall incidence, quality of life, falls self-efficacy, fear of falling, activity curtailment due to fear of falling and

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cost-effectiveness. A suggested measurement instrument was provided for every outcome except for cost-effectiveness, with attendees at the meeting stating that a health economist should be consulted to determine the most appropriate analysis for this outcome. Attendees also recommended that the assessment of any additional outcomes should be decided based on the theoretical underpinnings and anticipated mechanism of impact of the individual intervention.

CONCLUSION

A mixed-methods approach, including a review of existing literature, a qualitative study, and an international, multi-perspective Delphi consensus process, resulted in the development of a COS for evaluating the effectiveness of mixed-diagnosis falls prevention interventions for people with MS, PD and stroke. It is recommended that this COS and accompanying measurement instruments be used in all future trials in this field. The uptake of this COS will enable the comparison and combination of study findings, allowing for transparent and coordinated falls research, thereby facilitating progress in the research area. Furthermore, the successful implementation of this COS should translate into improved decision-making by service-planners/policymakers and clinicians with regard to the funding and delivery of evidence-based falls prevention interventions in clinical practice.

Effects of partnered dance in people with Parkinson's (PWP): a scoping review

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Parkinson's is a progressive neurodegenerative disorder, the main movement symptoms being caused by the loss of dopaminergic neurons in the substantia nigra (SN) disrupting basal ganglia (BG) functions (Surmeier 2018).

Dopamine deficiency causes motor dysfunction: primarily bradykinesia, resting tremors, and rigidity, and non-motor symptoms including sensory difficulties, cognitive impairment, and psychosocial changes (Kalia and Lang 2015). As the Parkinson's pathology progresses, activities of daily living (ADLs) are reported as becoming increasingly difficult, PWP are recorded as experiencing diminishing motivation to engage in social activities, increasing reliance on others (Shulman *et al* 2008), and reduced physical function (Zafar, Bozzorg and Hackney 2017). Moreover, Foster and Hershey (2011) suggested that restricted participation in ADLs results in reduced quality of life (QoL) (Duncan and Earhart 2011) and life satisfaction (Edwards *et al* 2006). Therefore, Parkinson's is also associated with a lower QoL and high socioeconomic cost (Gumber, Ramaswamy and Oranuch 2019). This relationship highlights the importance of pursuing interventions that improve symptoms and enhance participation in ADLs.

Current treatment for Parkinson's includes a combination of pharmacological and non-pharmacological options (National Institute for Health and Care Excellence 2017), for example, dopaminergic therapy and deep brain stimulation (Lindenbach and Bishop 2013), or antiparkinsonian medication and physical interventions (Keus *et al* 2014). With regards the pharmacological approach, dopaminergic therapy neither prevents progressive disability (Chaudhuri, Healy and Schapira 2006), nor does it adequately address the low participation factors reported by PWP including depression (Rascol *et al* 2003). Medication effectiveness also decreases as Parkinson's progresses and may lead to side effects such as severe on-off fluctuations and drug-induced dyskinesia (Lindenbach and Bishop 2013).

Exercise, however, has been proven to positively impact the Parkinson's motor symptoms, particularly gait, balance and ability to perform ADLs (Osborne *et al* 2022, Radder *et al* 2020). If performed at sufficient intensity and regularity, exercise may improve functional circuitry by increasing synaptic strength and influencing neurotransmission, therefore slowing the disease progression, demonstrating a neuroprotective role of exercise (Ellis and Rochester 2018). As personal preference to different types of exercise affects consistent participation, especially if a traditional exercise style is not enjoyed (Jancey *et al* 2007, Qutubuddin *et al* 2007), broadening the availability of styles to remain physically active, such as Tai Chi, dance, and yoga might increase adherence to exercise (Kabra *et al* 2018, Houston and McGill 2011).

Dance therapy has positive effects on motor impairment, endurance, balance, gait, and QoL (Sharp and Hewitt 2014). It encourages social interaction, promotes adherence, and fosters motivation to participate (Federici, Bellagamba and Rocchi 2005). One author currently runs dance classes locally for PWP but only single person routines are taught. The authors wanted to explore whether dancing with a partner would provide increased benefit in terms of outcomes.

In terms of the neuroanatomical effect, a positron emission tomography (PET) study suggested that the BG might be sensitive to the interactions among entrainment (co-ordination or synchronisation of rhythms), meter (counting), and spatial patterning (relating to the relationship of the dancer to objects or people in their environment), specifically seen in dance (Brown, Martinez and Parsons 2006), with potentially interesting implications for PWP where BG function is disrupted.

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Navigating movements, maintaining attention, and making decisions simultaneously provide the opportunity for multitasking (Earhart 2009). Music also acts as an auditory cue and boosts the reward system, releasing more dopamine via the ventral tegmental area to improve mood, motivation, and cognition (Rios Romenets *et al* 2015, Hackney and Earhart 2009). Keus *et al* (2014) suggest that partnered dance shows benefits for improving gait and reducing the risk of falls in PWP.

When considering different styles of dance, tango movements have been shown to enhance motor abilities by targeting Parkinson-related impairments, including initiation, spontaneous directional changes, and speed changes, thus alleviating difficulties with movement initiation, turning, and bradykinesia (Lötzke, Ostermann and Bussing 2015). In comparison, ballroom dance does not include backward and cross-stepping, allowing less able participants to be involved in the class (Kunkel *et al* 2017). Dancing with a partner promotes social and personal relationships while also improving physical limitations like axial impairments and dynamic balance (McNamara, Durso and Harris 2006). A study by De Dreu, Kwakkel and Van Wegan (2015) stated the benefits of different types of partnered dance and cueing; however, the respective changing effects caused by different types of dance are not mentioned.

There are several established dance organisations for PWP, including Dance for PD (New York), Dance for Parkinson's (London), and Queensland Ballet. Neither the research nor information from dance organisations make clear the critical aspects for understanding the effects of partnered dance on PWP. Moreover, studies focusing on the partner's importance and influence remain ambiguous as demonstrated in a single group pre-post design study by Koch *et al* (2016). Identifying themes across studies is critical for understanding the effects of partnered dance on PWP. A scoping review (ScR) is an approach for synthesising research evidence (Pham *et al* 2014) and aims to map and appraise current evidence and gaps to stimulate future change in practice, policies, and studies (Aromataris and Riitano 2014). This ScR encompasses different study designs, so a wide range of effects on PWP can be extracted, with mapping and engagement of the diverse research landscape (Arksey and O'Malley 2007).

AIMS

This ScR aims to summarise the effects of partnered dance on PWP physically, psychologically, and cognitively, and explores the effects exerted by cueing, partners, and leading professionals on PWP. In addition, current findings and gaps for future research will be summarised.

METHOD

This ScR uses a combination of the Arksey and O'Malley framework (2007), the Joanna Briggs Institute (JBI) approach (Peters *et al* 2020) and guidance from the Preferred Reporing Items for Systematic and Meta-Analyses Extension for Scoping reviews (PRISMA-ScR) (Tricco *et al* 2018) to establish an understanding of relevant terminology, concepts, and key items to report (Sarkis-Onofre 2021).

Eligibility Criteria

The Population, Concept, Context (PCC) framework (*Table 1*) is recommended by JBI to identify the main concepts in the review questions to develop a full search strategy.

ELEMENT	DESCRIPTION
Population	■ PWP
Concept	■ Interventions: Partnered dance ■ Outcomes ■ Effects: physically, psychologically and cognitively
Context	■ Primary health setting ■ Community ■ Dance room/dance class

Table 1 Details of the Population, Concept, Context (PCC) being investigated

The inclusion and exclusion criteria are shown in *Table 2* and reference the PCC elements, which were standardised for title and abstract screening and full-text screening.

INCLUSION	EXCLUSION
English Language	Non-English language
Parkinson's, stage 1-4, Hoehn and Yahr	Non Parkinson's
PWP with co-morbidities	
Partnered dance	Non-partnered dance
	Secondary studies
	Did not mention effects of partner

Table 2 Inclusion and exclusion criteria of terms searched for the review

To be included in the review, papers needed to focus on Parkinson's (with participants included who have Parkinson's), partnered dance, and the effects of the partner in partnered dance. Participant criteria were kept broad in line with a ScR, thus, all Hoehn and Yahr stages of Parkinson's (Hoehn and Yahr 1967) (a commonly used scale for describing symptoms of Parkinson's progression) were included, as were co-morbidities. Primary studies eg quantitative, qualitative, and mixed methods of studies were included. Secondary studies were excluded to avoid drawing secondary research data that had been included as primary papers. Only English language studies were included. No time

constraint or geographical filter was added as over-refining may filter out any related studies. Papers were excluded if they did not fit into the PCC framework, eg only focusing on non-partnered dance, without mentioning any effects of partnered dance.

Information sources

An initial limited search of PubMed and CINAHL was undertaken on 16th November 2022 to identify articles on the topic (JBI 2020). Titles, abstracts, and index terms were used to develop a comprehensive search strategy. The full search went on to include PubMed, CINAHL, COCHRANE Web of Science, EMBASE, and MEDLINE, Google Scholar, and Open Grey. Justification of the published database is listed in *Appendix 1*. Snowballing was performed, which is the process of screening the reference list of the included studies in case of missing preliminary studies (Kohli 2020), and can have an additional yield of relevant studies up to 42.7% (Horsley, Dingwall and Sampson 2011).

Search

The Boolean search strategy was applied (Aromataris and Rittano 2014). Truncations (*) and the 'OR' operation were used to maximise the sensitivity (Leach *et al* 2022). The 'AND' strategy was used to combine search terms to specify the search. Search terms were developed and executed by all the researchers and summarised in *Appendix 2*. A comprehensive search was carried out of the seven databases mentioned above with the search terms from inception to March 2023. A picture of the entire search strategy from MEDLINE is shown in *Appendix 3*. After completing the database search, Mendeley software was used to remove duplications.

Selection of sources of evidence

Group members were divided into two groups to screen the titles and abstracts of 355 articles using the inclusion and exclusion criteria as shown in *Table 2*. Journals that were not relevant were excluded. Where the relevance of a study was unclear, the full text was obtained and reserved for retrieval.

Then the list of 59 studies for full-text screening was divided and distributed between the two groups to check their eligibility. Disagreements were resolved through whole-group discussion. Studies that did not meet the inclusion criteria were excluded. Included and excluded studies, with justifications, were presented in a PRISMA-ScR flow diagram (*Figure 1 overleaf*).

Data charting process

All five researchers determined which variables to extract and developed the tables. All the members charted the data, discussed the results, and continuously updated the tables in an iterative process. Article characteristics eg origins, aims, sample size, intervention type, intervention comparator, and effects of partner were extracted to the Data extraction table (*Appendix 4*).

Data items

Data extracted included Parkinson's stage and medication, details of the intervention including setting, duration of the class, effects, cueing, type of partner, leading professionals, and outcome measures for the effects. Key themes and patterns that were identified were recorded in the Key Themes and Patterning charts (*Appendices 5* and *6*).

Finally, the Patterns, Advances, Gaps, Evidence for Practice and Research Recommendations (PAGER) framework was used (*Appendix 7*) to synthesise the results. Designed by Bradbury-Jones *et al* 2021, this tool provides an enhanced consistent approach to the analysing and reporting of review findings.

Critical appraisal

Critical appraisal of studies was not undertaken: unlike a systematic literature review (SLR), a ScR aims to scope the literature to summarise the current knowledge and gaps but not primarily focus on the quality of the studies.

RESULTS

Selection of sources of evidence

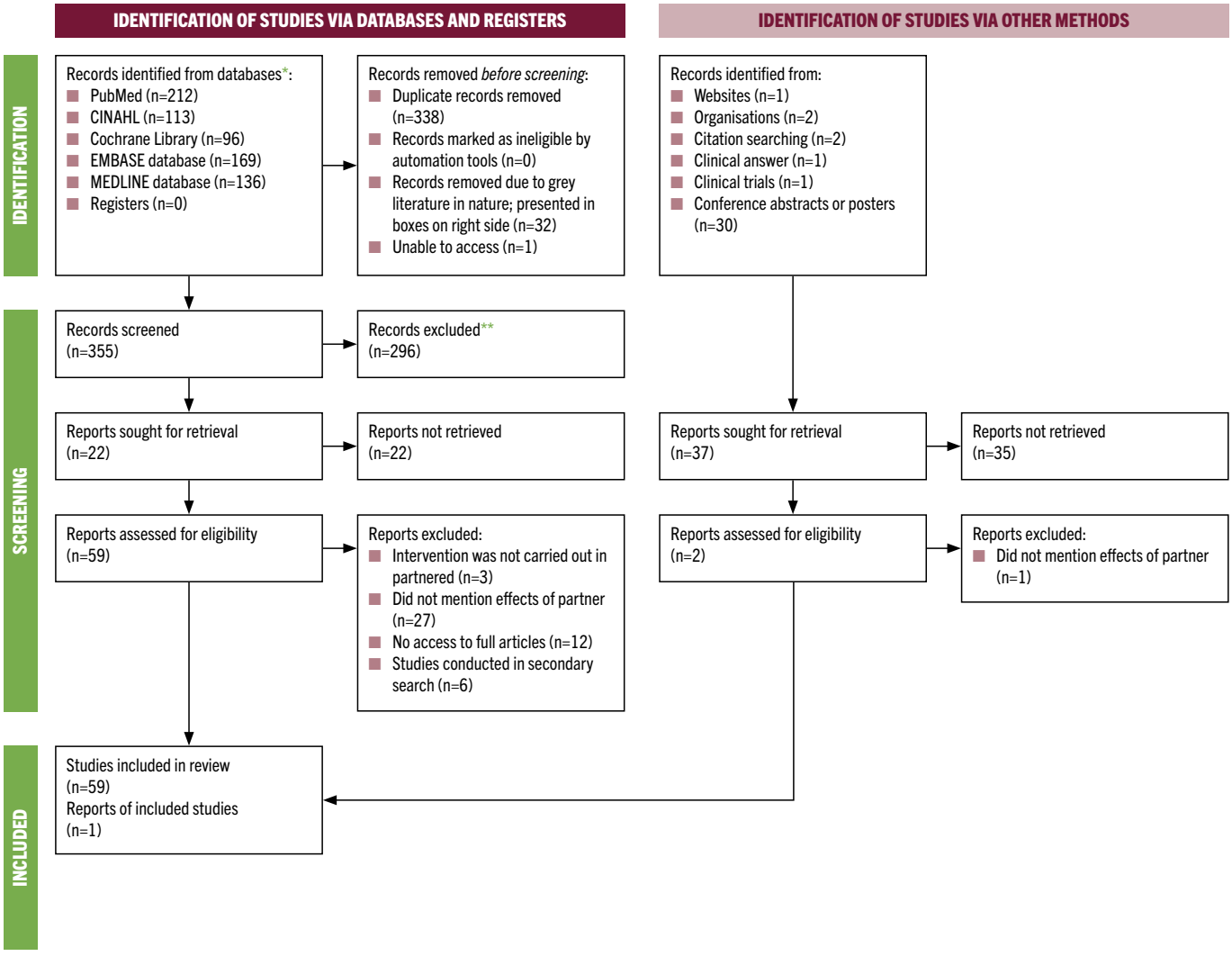
The PRISMA-ScR flow diagram (*Figure 1*) presents the article selection process. Seven hundred and sixty-three articles were identified as potentially relevant to the research question. Titles and abstracts of 355 papers were screened against inclusion and exclusion criteria in *Table 2*. Fifty-nine articles were eligible for full-text review. The main reasons for exclusion were not referring to the effects of partners and having no access to full articles due to time constraints to contact authors for full-text screening. Twelve articles were left for final synthesis.

Characteristics of sources of evidence

The articles' characteristics are described in *Appendix 4*, together with a description of the aim, origin, study design, sample size, intervention type, intervention comparator, and the effects of partners in partnered dance. The origins include the USA, UK, and Germany. The sample size varies from 11-102 participants.

The duration of the class, effects of partnered dance, cueing, type of partner, leading professionals, medications, and outcome measures are listed in the Key themes charting (*Appendix 5*). The Parkinson's stage of participants in the papers ranges from stage one to four. The setting includes living communities, a local dance centre, a dance school, etc.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources



* Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
** If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Figure 1: PRISMA-ScR flow diagram

Results of individual sources of evidence

Four main themes from partnered dance were identified:

1. The partners' effects
2. Types of partners
3. Cueing
4. Leading professionals

Effects of partner

Physical: Nine out of twelve studies (Beerenbrock *et al* 2020, Giménez-Llort and Castillo-Mariqueo 2020, Hackney *et al* 2020, Koch *et al* 2016, Duncan and Earhart 2012, Hackney and Earhart 2010, Marchant, Sylvester and Earhart 2010, Hackney and Earhart 2009, Hackney, Kantorovich and Earhart 2007) mentioned the positive physical impacts. Two studies (Giménez-Llort and Castillo-Mariqueo, 2020, Hackney *et al* 2020) mentioned the effect of facilitating movement. Partners provide spatial external cues and time-frames to facilitate movements, coordination, and execution. The partner's weight-shifting and direction of movement help initiate movement, increase or maintain stride length and cadence, and improve weight-shifting techniques, strengthening the PWP's unity of movements. Five studies (Giménez-Llort and Castillo-Mariqueo 2020, Marchant, Sylvester and Earhart 2010, Hackney and Earhart 2010, Hackney and Earhart 2009, Hackney, Kantorovich and Earhart 2007) stated improvements in balance and gait by external cues from

partner eg, physical contact at the hands allows PWP to challenge their movement boundaries and use their partner's limbs to counter-weight for self-balance. One study (Marchant, Sylvester and Earhart 2010) discusses the idea that the partner's help to develop weight-shifting provides an element of resistance that potentially enhances muscle strength.

Psychological: Six studies (Beerenbrock *et al* 2020, Giménez-Llort and Castillo-Mariqueo 2020, Kunkel *et al* 2018, Zafar, Bozzorg and Hackney 2017, Koch *et al* 2016, Kunkel *et al* 2017) mentioned psychological impacts. Dance partnerships impact the degree of the PWP's enjoyment and well-being. PWP found it more reassuring and pleasurable when dancing with a partner. The delightful atmosphere enhanced participation in the dance class and extended their social life. In the study by Koch *et al* (2016), they used the outcome measure 'Therapeutic factors of art therapies in PD' and found that unison with the partner increased happiness after the intervention. Dancing with a partner radiates a sense of harmony among the family, as reported in a semi-standardised interview from the study by Beerenbrock *et al* (2020). Negative psychological effects arose when opinions clashed and were unresolved, and the stress of perhaps 'letting down partners'.

Types of partner

All the studies mentioned the types of partners, identifying six types: general volunteers, spouses, relatives, friends, caregivers and other participants in the intervention.

Cueing

Nine studies (Giménez-Llort and Castillo-Mariqueo 2020, Hackney *et al* 2020, Koch *et al* 2016, Kunkel *et al* 2017, Duncan and Earhart 2012, Marchant, Sylvester and Earhart 2010, Hackney and Earhart 2010, Hackney and Earhart 2009, Hackney, Kantorovich and Earhart 2007) mentioned the cueing strategy. This includes auditory cueing eg music, verbal cueing, rhythmic and metronome, visual, tactile, cognitive, and cueing from partners which combines a mixture of the above types.

Leading professionals

Except for the studies by Giménez-Llort and Castillo-Mariqueo (2020) and Duncan and Earhart (2012), all included studies indicated different leading professionals: dance instructors, exercise trainers, therapists, and assistants.

Synthesis of results

Information of the effects, cueing, type of partner, leading professionals, medication and outcome measures for partnered dance were synthesised and patterned in the Patterning chart (*Appendix 6*).

DISCUSSION

This ScR identified twelve studies exploring the effects of partnered dance on PWP. Four key themes including the physical and psychological effects, the accompanying cues, the types of dance partners, and leading professionals will be discussed.

Many PWP experience freezing which impairs their ADLs (Tambasco *et al* 2016), and the inability to accomplish daily tasks leads to unsafe conditions and poor QoL (Edemekong *et al* 2022). Partners exert positive physical effects such as weight-shifting techniques and cueing direction of movement, to help initiate movement which may alleviate freezing. The partner supports the PWP to develop weight-shifting techniques through turning. Different movements have various levels of weight transfer; for example, a step involves full weight-bearing, and a rock or check, only partial (Crewe 2020). It is proven that multimodal biofeedback such as visual and vibrotactile together, delivered by the partner, facilitates movement initiation more effectively than just one model (Lee *et al* 2015). However, one RCT (Hackney *et al* 2007) found that both the partnered tango group and the exercise group showed trends toward reduction in freezing, with no difference between the two groups. Moreover, weight-shifting encourages greater use of the affected limb, enhancing muscle strength (Reyna 2013). To overcome the offered resistance, the PWP utilises isometric muscle control instead of 'flopping' onto the partner (Binda, Culham and Brouwer 2010), possibly strengthening their muscles for daily use. Ideally, the improvement in initiating movements and muscle strength may prove to the PWP that they have the strength and promote participation.

Balance problems are related to fall risks, preventing PWP from being active due to fear of falling (Abendroth, Lutz and Young 2012, Wielinski *et al* 2005). Partnered dancing intervention consistently improves balance performance (Shanahan *et al* 2015, Sharp and Hewitt 2014, Earhart 2010) and multiple types of sensory information have been indicated in two RCTs as critical elements of balance control for PWP (Lefaivre and Almeida 2015, Conradsson *et al* 2012). The results support the use of cueing from partners for improving balance, which correlates with the studies found in this review and the mechanisms will be explained under the theme 'cueing'. Physical touch also allows the PWP to challenge their balance boundaries safely as they are confident that their partners will assist them by controlling dynamic balance and external disturbances, as well as providing readjustment of movement if needed. The stops, starts, and turns with the partner can also be seen as a

form of functional balance training (de Dreu *et al* 2012). Improvement in balance enhances motor learning, ADL performance, QoL, and well-being (Tan *et al* 2012, Ellis *et al* 2011).

Interestingly, partners were found to have positive and negative psychological impacts. Depression is prevalent in 8.1% of PWP (Changas *et al* 2013) and depressive symptoms correlate with decreased dopamine transporter in the anterior putamen (Weintraub *et al* 2005). Rhythmic tango steps have been shown to selectively activate the putamen by the PET scanner (Brown, Martinez and Parsons 2006). It could be postulated that tango improves depressive symptoms through activation of the putamen. Mood has been demonstrated to impact health, and the expression of emotion has certain health benefits (Goodill 2005). It was found that dance partnership impacts the degree of enjoyment for PWP. They feel more reassured, and with the release of dopamine, the 'happy hormone', mood is improved and symptoms of anxiety and depression are alleviated (Douka *et al* 2019). As non-motor symptoms and motor symptoms are alleviated with dopamine release, participation in social activities increases, reinforcing the feeling of well-being. However, one interviewee who was the dance partner and spouse of the PWP from Kunkel *et al* study (2018) stated that he felt stressed about leading due to the lack of confidence and difficulties and was afraid to let down his partner. Negative impact also happens when PWP and their partners have clashed opinions. Therefore, the choice of partner will be discussed.

Among the twelve studies, none of them discussed the cognitive effects of dancing with a partner, yet 80% of PWP have one or more cognitive domains impaired after five years from diagnosis. Neuroimaging in PWP showed early affectation of monoamine and cortical systems beyond the nigrostriatal dopaminergic pathway that cause cognitive impairments with executive dysfunction, trouble concentrating, and memory issues (Speelman *et al* 2011). Available literature (Pereira *et al* 2019, Dhami, Moreno and DeSouza 2015, Bläsing *et al* 2012) suggests that partnered dance contributes to a PWP's cognition improvement, including spatial memory, perception, and emotions; however, the benefits observed were not measured in a way that could directly attribute them to the presence of a partner. In other words, the benefits could be derived from other factors such as the steps or music. Research that attempts to explore this would allow a more holistic view of how partnered dance specifically affects cognitive function.

Cueing is defined as 'an external temporal or spatial stimulant to facilitate movement initiation and continuation' (Lim 2009). The caudate and putamen (collectively known as the striatum), are the input nuclei for the BG. The output nuclei SN and globus pallidus (GP) inhibit the thalamus. External cues activate the cerebral cortex to send information to the striatum via the cortico-striatal pathway (Haber 2016). The glutamate neurons in this pathway excite neurons in the striatum, releasing gamma-aminobutyric acid (GABA) in the GP internal and substantia nigra pars reticulata (SNpr). The GABA inhibits activity in the GP and SNpr and stops inhibiting the thalamus that is involved in movements (Galvan *et al* 2010), thus opening the gate for movement to occur (Muthukrishnan *et al* 2019). The different types of cueing observed in the included studies were auditory, visual, tactile, cognitive, or combined cues from the partner. With the aid of external cues, a PWP can achieve movements of nearly normal speed and amplitude through focused attention to critical aspects of movement (Baker, Rochester and Nieuwboer 2007). Auditory cues improve the temporal parameters, including cadence and gait speed, which can bypass the internal rhythm deficit associated with Parkinson's (Lee, Lee and Song 2015).

Music is the most mentioned type of cueing and by affording a variety of mind-body responses from self-regulation to sensorimotor coupling, it is effective for mobility, and psychological and social well-being (Bieńkiewicz and Craig 2016). Nombela *et al* (2013) suggest that music also facilitates the activation of motor networks that bypass the Parkinson's-affected networks via cerebellum-thalamic-cortical circuitry. One study participant stated the music allowed her to forget her imbalance and lifted her mood and she found initiation of movement to be easier (Hackney, Kantorovich and Earhart 2007). In contrast, some participants in the control group of the same study found it distracting which is corroborated by several Parkinson's studies that found music offered additional cognitive demands (Rose *et al* 2019). Previous studies have cited the importance of considering cultural aspects: PWP may find the class more enjoyable if they know the songs and become emotionally involved with specific memories of their culture (Jensen and Bonde 2018, Hannon, Soley and Ullal 2012).

Visual cues, such as stepping over and tapping a partner's foot, can relieve freezing of gait (Jiang and Norman 2006) and enable the visual-cerebellar motor circuit that influences the spatial aspects of gait (Morris *et al* 1994). Tactile cues are presented in 'contact improvisation' where the point of contact facilitates interaction through a shared site of stabilisation or movement (Marchant, Sylvester and Earhart 2010). Contact improvisation techniques include 'rolling and pulling' and also utilising the negative space around the

partner which may provide cognitive cues for creating movement (Marchant, Sylvester and Earhart 2010). In the stroke population, a small sample size (n=22) study (Waller and Whitall, 2005) looking at bilateral arm training with rhythmic auditory cues (BATRAC) saw benefits in upper-extremity function and strength for people with left hemisphere lesions. Interestingly, and in opposition to these findings, a study by (Richards *et al* 2007) found no effects, explained by the participants having a higher motor function, and being less sensitive to the treatment: this explanation is also supported by another study (Lum *et al* 2006), highlighting the importance of considering the individual's severity level of condition when providing treatment. Controversially, cueing exerts negative effects on people with Huntington's (PWH). One study found using musical and metronome cueing to be distracting for PWH while walking (Schaefer 2014), contraindicating results for PWP where cueing assisted and improved PWP's gait. This can be explained by a higher prevalence of attentional deficit and difficulties with sensorimotor synchronisation in PWH as compared to PWP (Aldaaz *et al* 2019). This result implies some executive function and cognitive capacity is necessary for auditory cues to support gait (Schaefer 2014), highlighting the importance to consider an individual's cognitive level when using cues.

In the included studies a wide range of partners were recruited as shown in the Patterning chart (*Appendix 5*). However, only one interview study (Beerenbrock *et al* 2020) explored the impact of different partners on PWP. They suggest that when choosing volunteers, the experience should be considered: they should enjoy dancing, be sensible, and have good social skills, which is corroborated by a recommendations paper by Hackney and Earhart (2010). Beerenbrock *et al* (2020) suggest the PWP's experience of the dance class may be influenced by their relationship and compatibility with their partner: partners who were able to develop a good rapport gained greater enjoyment and a sense of achievement. Dancing with a spouse provides morale and emotional support to PWP, improving adherence and positive reinforcement. Participants who partnered with friends or relatives reported feeling motivated and experiencing more enjoyment as it was someone they knew. Participants who partnered with volunteers had ambiguous feelings; for example, if the PWP and the volunteer partner had a clash of personality or opinions, experience was less positive. One of the volunteers stated the dilemma of wanting to help without being seen to take over, which highlights the importance of the volunteer encouraging PWP to take the lead, after safety considerations.

EVIDENCE GAP AND RECOMMENDATIONS FOR FUTURE STUDIES

PAGER (*Appendix 7*) was applied to analyse and report the inherent gaps, and how the review findings can resonate with and inform the future direction for both practice and research (Bradbury-Jones *et al* 2021).

This ScR has identified the physical and psychological effects of partnered dance on PWP in most of the included studies; however, none explored the cognitive effects. Researchers should investigate the effects of partnered dance on PWP's cognitive function to consider whether partnered dance can be another adjunct treatment targeting cognitive symptoms in this population. Despite the use of outcome measures throughout the studies, the direct physical and psychological effects of partnering on PWP were mainly self-reported by the participants or interpreted by the authors. However, one study (Koch *et al* 2016) used the therapeutic factors of art therapies in PD outcome measures which directly measure the happiness with the company of the partner, and consist of eight items that reflect central hypothesised active factors in art therapies related to the aesthetic experience particularly geared toward PWP. This highlights the need for designing unified outcome measures to ensure the validity of the findings and that they are specifically due to the presence of a partner rather than other factors. Evidence with regards to how the PWP's experience is affected by different types of partners is limited with the need for further exploration to validate the recommendations about the choice of the partner type.

Lastly, although the types of leading professionals recruited in the included studies were mentioned, none provide any evidence on how leading professionals impact on PWP in partnered dance. Studies are required to address the significant gap in the field as a precursor for researchers to explore whether different types of leading professions exert different effects on PWP.

STRENGTHS AND LIMITATIONS

Recommended guidelines and standard methods were followed to conduct this ScR with a comprehensive literature search including grey literature. However, the following limitations should be considered when interpreting the review results. Firstly, to broaden the number of studies included, the stages of PWP in the Hoehn and Yahr scale, co-morbidity, and medications did not limit whether studies were included. This could affect sensitivity to interventions leading to variating results. Secondly, due to the scoping nature of this review, critical appraisal was

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not conducted to rate the quality of evidence, therefore implications for practice cannot be graded. Lastly, due to time constraints, authors for studies that we have no access to could not be contacted.

CONCLUSION

This ScR summarises a collection of studies exploring different elements of partnered dance. It is important to consider symptom severity and cognitive levels when providing partnered dance treatment. With this in mind, two key benefits of partnered dance for PWP that are highlighted in this SR were found:

1. **Physical**: Mainly through initiation of movement and improving balance and gait.
2. **Psychological**: By providing reassurance, promoting socialisation and enhancing participation and improving QoL.

A variety of cueing methods and the pathophysiology of cueing were discussed. Benefits of cueing are improved gait and initiation of movement, although some people may find cueing to be a distraction. This research also found that PWP's experience of dance classes may be influenced by their relationship and compatibility with their dance partners, so thoughtful recruitment of types of partners is needed. The paucity of articles discussing the effects of different leading professionals highlights the need for further investigations, e.g. systematic review for clinical implications when setting up partnered dance groups. Overall, this ScR provides a precursor for further investigations on different elements of partnered dance targeting different Parkinsonism symptoms.

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APPENDICES

DATABASE	JUSTIFICATION	LIMITATION
PUBMED (cite: National Library of medicine, PubMed user guide.) https://pubmed.ncbi.nlm.nih.gov/help/#how-do-i-search-pubmed	■ Free resource ■ More than 34 million citations and abstracts of biomedical literature ■ Available to public online since 1996 ■ Maintained by the national center for biotechnology information (NCBI), at the US National Library of Medicine (NLM)	
CINAHL	■ Covers more than 4500 journals from fields of nursing and allied health ■ Coverage dating as far back as 1937 ■ Offering complete coverage of English language nursing journals and publications from the National League for Nursing and the American Nurses' Association, CINAHL covers nursing, biomedicine, health sciences librarianship, alternative/ complementary medicine, consumer health and 17 allied health disciplines (UWE 2022)	Majority of the journals covered are in English language

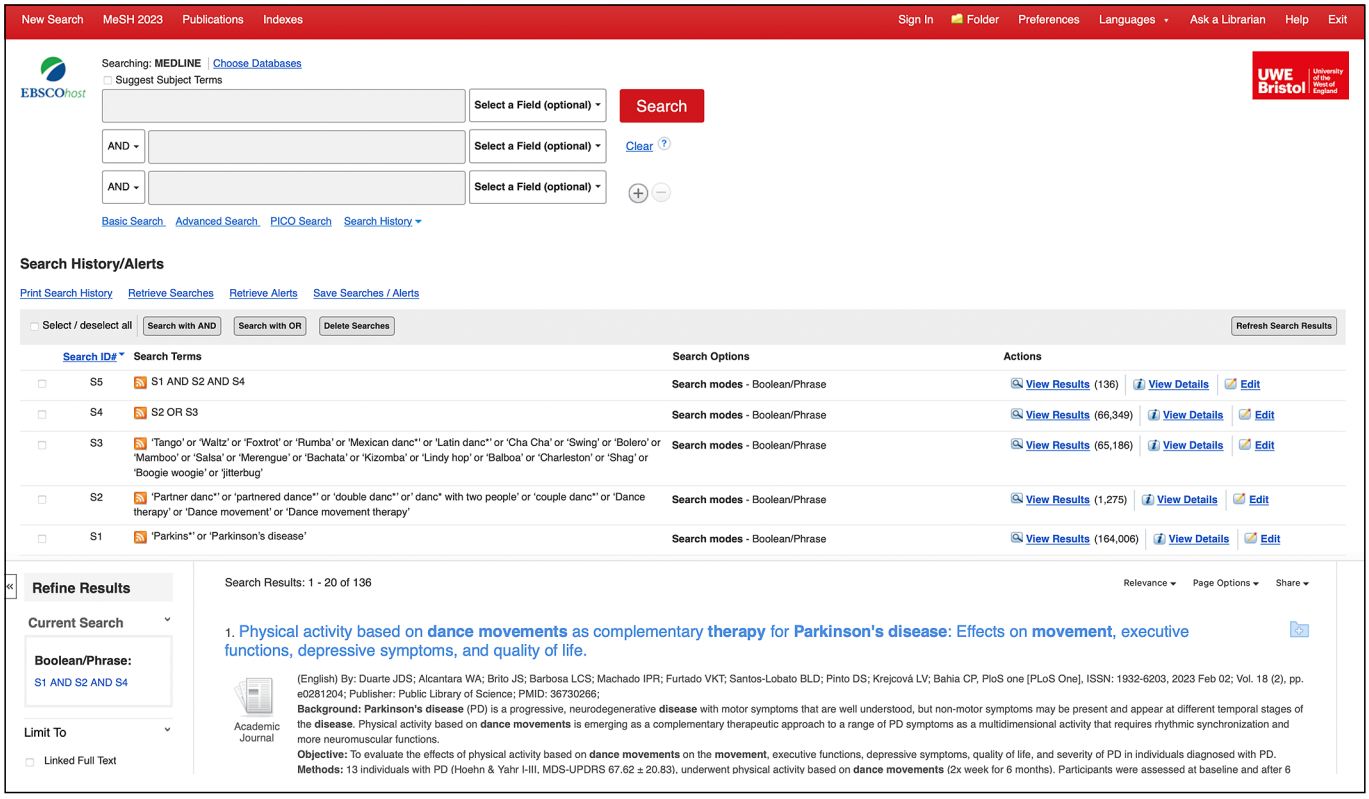
AMED
(Allied and complementary medicine)
	■ Bibliographic database produced by the Health Care Information Service of the British Library
	■ Covers three main subject areas:
	  ■ Complementary medicine
	  ■ Palliative care
	  ■ Professions allied to medicine (physiotherapy, occupational therapy, rehabilitation, and speech and language therapy)
	(UWE 2022)	

COCHRANE LIBRARY	■ Considered to be the best only source of reliable evidence on the effects of health care ■ Includes the Cochrane Database of Systematic Reviews (CDSR) which is the leading resource for systematic reviews in health care (UWE 2022)	
EMBASE	■ Includes 24 million indexed records in the field of biomedicine ■ Covers more than 7,500 current, mostly peer reviewed, journals, of which 2000 are not included in Medline ■ Specialist areas include psychiatry and pharmacology ■ Includes conference abstracts from more than 7,000 biomedical, drug and medical device conferences dating back to 2009 (UWE 2022)	
MEDLINE	■ Contains journal citations and abstracts for biomedical literature from around the world ■ US National Library of Medicine (NLM) premier bibliographic database that contains more than 26 million references to journal articles in life science with a concentration on biomedicine (UWE 2022) ■ Currently, citations from approximately 5,200 worldwide journals in 40 languages; 60 languages for older journals (UWE 2022)	

Appendix 1 Justifications and limitations of databases

SEARCH NUMBER	SEARCH TERMS
Search 1	'Parkins*' or 'Parkinson's disease'
Search 2	'Partner danc*' or 'partnered dance*' or 'double danc*' or 'danc* with two people' or 'couple danc*' or 'Dance therapy' or 'Dance movement' or 'Dance movement therapy'
Search 3	'Tango' or 'Waltz' or 'Foxtrot' or 'Rumba' or 'Mexican danc*' or 'Latin danc*' or 'Cha Cha' or 'Swing' or 'Bolero' or 'Mamboo' or 'Salsa' or 'Merengue' or 'Bachata' or 'Kizomba' or 'Lindy hop' or 'Balboa' or 'Charleston' or 'Shag' or 'Boogie woogie' or 'jitterbug'
Search 4	Search 2 OR search 3
Search 5	Search 1 AND search 2 AND search 4

Appendix 2 Search terms



Appendix 3 Figure of the entire search strategy from MEDLINE

Author (year)	Origin	Aims/ purpose	Study Design	Sample size	Intervention type	Intervention comparator	Effects of partnered dance
Hackney, M.E., Kantorovich, S. and Earhart, G.M. (2007)	USA	1) To determine whether the functional mobility benefits noted in elders following a tango dancing program might also extend to older individuals with Parkinson's 2) To provide baseline information about the effectiveness of a traditional strength/ flexibility exercise regimen based upon the Fit 'N Fun program 3) The long-term goals of this study are to establish how partnered expressive movement done to a rhythmic pulse, such as tango, influences functional mobility and to develop optimized therapeutic movement interventions to address balance and gait difficulties associated with PD and normal aging.	RCT	n=38	Argentine Tango	Traditional exercise	Provide helpful sensory information and stabilizing support that leads to improved balance and gait.
Zafar, M., Bozzorg, A. and Hackney, M.E. (2017)	N.A.	To determine (1) the impact of aging alone versus aging combined with disease on participation and (2) participation levels before and after a 12-week AT dance intervention in both older individuals with PD versus older individuals without PD.	Non randomised trial	n= 88	Adapted tango	Adapted Tango on older adults	Enhanced participation in social life
Kunkel, D. et al. (2017)	U.K.	To explore the feasibility of 1) using a Dance Centre to deliver a mixed dance program for people with Parkinson's, 2) exploring participant experience, 3) examining the appropriateness of our primary and secondary outcome measures, which will be incorporated into the planning of a larger phase III trial to address the efficacy question.	RCT	n=51	3 types of ballroom dance and 3 types of American Latin dance	Control-group participants were encouraged to continue with usual care, which typically comprised medication, attending medical clinics and routine visits from Parkinson's nurses.	Reassuring
Marchant, D., Sylvester, J.L. and Earhart, G.M. (2010)	USA	To explore the feasibility, therapeutic potential and possible benefits of contact improvisation as an exercise intervention for individuals with PD	Pilot study	n=11	Contact improvisation(CI) dance	Tango dance	Developing weight shifting techniques. Learnt to use limbs nas counterweight ballast- a means of self-balance. Weight shifting provided resisitance both to the partner receiving and transfering weight, which has the potential to enhance muscle strength as a resistive exercise.
Hackney, M.E. and Earhart, G.M. (2010)	USA	To determine if individuals with PD would benefit more with respect to functional mobility if they participated in partnered or non-partnered tango lessons	RCT	n=39	Tango Dance	Non-partnered Tango Dance	Partners maintain physical connection, potentilally aiding balance. More severely affected participants might be able to challenge their movement boundaries safely with the assistance of a partner.
Hackney, M.E. and Earhart, G.M. (2009)	USA	To compare the effects of two distinct 20-hour partnered dance programs to an untreated age-, sex- and stage of disease-matched cohort (Control)	RCT	n= 58	Tango and Waltz/Foxtrot dance	N.A.	Partnering provide important external cues. Partner may enhance balance by virtue of the physical contact at the hands. Cues such as the partner's weight shifting and indicated direction of movement can help initiate movement, and increase or maintain stride length and cadence.
Kunkel, D. et al. (2018)	U.K.	To explore the views and experiences of people with Parkinson's and their dance partners through in-depth, qualitative interviews to identify factors that may influence the benefits and enjoyment whilst participating in partnered ballroom and Latin American dance classes.	RCT	n=14	3 ballroom and 3 Latin American dance	N.A.	People with Parkinson's experience of dance classes were influenced by the relationship and compatibility with their dance partner. Dance partnerships impact on degree of enjoyment, outcome and continued participation in dance classes. Spouse partner provide "moral support" and shared enjoyment that this afforded Pwp. Pwp may have negavtive psychological effects if they have clash opinons and cannot resolve with their partners. They may also have views that afraid to let down their partners.
Giménez-Llort, L. and Castillo-Mariqueo, L. (2020)	US	To propose PasoDoble as an intervention for people with Parkinson's and for their caregivers	Proposal	N.A.	PasoDoble (a type of ballroom dance)	Self-reliant older adults	1) Dance partners may exert additive effects on achievement of rhythmicity since they both provide spatial external cues and timeframes that may facilitate movement initiation and execution in a PD-brain. 2) It is an effective and attractive form of entertaining for patients with PD due to the level of physical interactions and amusement between partners and the social group. 3) The dance partner can facilitate the coordination of the steps, increase balance and postural stability. 4) In turn, signals such as a change in weight and direction of movement given by the dance partner can help initiate the movement and increase or maintain the length and cadence of the steps. 5) The dance partner can help the mastery of balance and displacement by contributing to the
Beerenbrock, Y. et al. (2020)	Germany	To assess the perceived effects of Tango Argentino (TA) on body experience in individuals with PD.	Interviews	n=12	Tango Argentine	No direct comparator.	1) Strengthening of unity in the movements during TA 2) Positive repercussions on one's own well-being 3) Sense of harmony radiated further into everyday life
Duncan, R.P. and Earhart, G.M. (2012)	U.S.	To determine the long term effects of a 12-month community based tango program for individuals with PD on disease severity and physical function, with all evaluations conducted off medication.	RCT	n=62	Argentine tango	N.A.	Progressive motor skills learning in the precence of external cues providede by the music and the partner.
Hackney, M.E. et al. (2020)	USA	Aim 1 will evaluate whether exercise reduces OFF-time in PD patients who regularly suffer OFF-time. Aim 2 will examine the effects of a combined motor/cognitive intervention on cognition, specifically spatial cognition. In Aim 3, with physiological biomarkers, we aim to show that exercise slows neurodegeneration in humans with PD. people with Parkinson's	RCT	n=102	Partnered dance aerobic exercise	Walking aerobic exercise	1) Partner can provide external cues to facilitate movement 2) Develop cognitive engagment from attention to partner and coordinating body movement with partner
Koch, S.C. et al. (2016)	Germany	1) To assess the feasibility of measuring changes in psychological outcomes, specifically well-being, body self-efficacy, outcome expectations, and experienced beauty after a single Argentine Tango intervention in a workshop format. 2) To employ tango for PD patients to explore its impact on health-related psychological outcomes in the course of assessing the feasibility of a workshop format, and to explore the aesthetic experience as a therapeutic factor, an aspect previously unaddressed. 3) To show the feasibility of measuring health-related psychological changes following a single tango intervention, to ensure patient acceptance and that the workshop format is appropriate for patients with severe neurodegenerative health problems such as PD.	Single-group pre–post design	n=34	Argentine Tango	N.A>	1) Attuning to partner allows Pwp to repeatedly initiate movement without any problem 2) Music and partner affect and move the person in particular yet unpredictable and emergent ways that resonate within the lived body. The person's bodily resonance (kinesthetic) and the dance (kinetic) change and influence one another on a moment-to-moment basis 3) Pwp have pleasure of the company of their partner 4) The unison with partner plays an additional role in that readjustment.

Appendix 4 Data extraction table

Author	PD stage (Hoehn and Yahr Score)	Setting	Duration of class	Negative effects			Neutral			Positive effects			Cueing	Type of partner	Leading Professions	Medication	Outcome measures for partnered dance
				Physical	Psychologic	Cognitive	Physical	Psychologic	Cognitive	Physical	Psychologic	Cognitive					
Hackney, M.E., Kantorovich, S. and Earhart, G.M. (2007)	1-3.	N.A.	1 hour session, twice a week, 20 lessons within 13 weeks							✓			Music	Healthy Elderly from control group	A professional dance instructor/certified personal trainer.	On	N.A.
Zafar, M., Bozzorg, A. and Hackney, M.E. (2017)	1-3.	Senior independent living communities	90 mins session, 20 lessons within 12 weeks								✓		N.A.	Pwp: individuals without PD (caregivers, friends and relatives, graduate and undergraduate students). Older adults: younger volunteers and other participants in the class.	Tango Instructors	On	N.A.
Kunkel, D. et al. (2017)	1-3.	Local Dance Center	1 hour session, twice a week for 10 weeks.								✓		Verbal	Individuals nominated a potential dance partner, e.g. spouse, friend and family member. For those who did not have a partner, authors recruited healthy volunteers of similar age from the Dance Centre and local gym.	Professional dance teachers	N.A.	N.A.
Marchant, D., Sylvester, J.L. and Earhart, G.M. (2010)	2.4 ± 0.4	N.A.	1.5 hours session, 10 lessons over 2 weeks							✓			Rhythmic recurring, one-off , visual, tactile, auditory and cognitive	Healthy volunteers previously trained in contact improvisation	A professional improvisational dance instructor	On	N.A.
Hackney, M.E. and Earhart, G.M. (2010)	1-4.	N.A	1 hour session, twice a week within 10 weeks							✓			Music and auditory.	individuals without PD (caregivers, loved ones and young adults volunteers recruited from physical therapy, pre-physical therapy and pre-medical programs).	An experienced professional ballroom dance instructor and an American Council on Exercise–certified personal trainer	On	N.A.
Hackney, M.E. and Earhart, G.M. (2009)	1-3.	N.A.	1 hour session, twice a week, within 13 weeks.							✓			Auditory cues from music, visual cues from partner	Healthy young volunteers recruited from physical therapy, pre-physical therapy and pre-medical programs.	An experienced professional ballroom dance instructor and an American Council on Exercise certified personal trainer	On	N.A.
Kunkel, D. et al. (2018)	1-3.	Local Dance Center	1 hour session, twice a week for 10 weeks		✓						✓		N.A.	Spouses, friends or relatives, and volunteer partners	Professional dance teachers	On	N.A.
Giménez-Llort, L. and Castillo-Mariqueo, L. (2020)	1-3.	Socially established free-living environments (community setting such as elders social centers, home)	1 hour session, twice a week for 12 weeks							✓	✓		Visual, rhythmic auditory, metronome and music	Caregivers (Spouse most of the time or family)	N.A.	On	N.A.
Beerenbrock, Y. et al. (2020)	NA	The Tango Delepalata dance school in	1hour session for 10 weeks							✓	✓		N.A.	N.A.	Tango Argentine instructor	N.A.	N.A.
Duncan, R.P. and Earhart, G.M. (2012)	1-4.	Community based Argentine Tango	1 hour session, twice a week for 12 months							✓			Music	N.A.	N.A.	Off	N.A.
Hackney, M.E. et al.(2020)	1-3.	N.A.	1.5 hour session, twice a week for 20 weeks 90-min weekly in maintenance period.							✓			Music and partner	Individual without PD, e.g. trained caregivers, friend, or university student.	Experienced instructor and trained assistant	On	N.A.
Koch, S.C. et al. (2016)	N.A.	SRH University Heidelberg and Ludwigshafen PD support group setting	1.5 hour session							✓	✓		Music, partner and group	Spouses, relatives/friends, or students of master program, or other patients	Dance movement therapists and tango teacher	N.A.	Scale for Therapeutic Factors of Arts Therapies in PD

Appendix 5 Key themes charting

Author (Year)	Negative effects			Neutral			Positive effects			Cueing					Type of partner						Leading Professions				Medication		Outcome measures for partnered dance
	Physical	Psychological	Cognitive	Physical	Psychological	Cognitive	Physical	Psychological	Cognitive	Auditory	Visual	Partner	Tactile	Cognitive	Volunteers	Spouse	Relatives	Friends	Caregivers	Other participants	Dance instructor	Exercise personal trainer	Therapists	Assistance	On	Off	
Hackney, M.E., Kantorovich, S. and Earhart, G.M. (2007)							✓			✓										✓	✓				✓		
Zafar, M., Bozzorg, A. and Hackney, M.E. (2017)								✓							✓		✓	✓	✓		✓				✓		
Kunkel, D. et al. (2017)								✓		✓					✓	✓	✓	✓			✓						
Marchant, D., Sylvester, J.L. and Earhart, G.M. (2010)							✓			✓	✓		✓	✓	✓						✓				✓		
Hackney, M.E. and Earhart, G.M. (2010)							✓			✓					✓	✓			✓		✓	✓			✓		
Hackney, M.E. and Earhart, G.M. (2009)							✓			✓	✓				✓						✓	✓			✓		
Kunkel, D. et al. (2018)		✓						✓							✓	✓	✓	✓			✓				✓		
Giménez-Llort, L. and Castillo-Mariqueo, L. (2020)							✓	✓		✓	✓								✓						✓		
Beerenbrock, Y. et al. (2020)							✓	✓													✓						
Duncan, R.P. and Earhart, G.M. (2012)							✓			✓																✓	
Hackney, M.E. et al.(2020)							✓			✓		✓			✓			✓	✓		✓			✓	✓		
Koch, S.C. et al. (2016)							✓	✓		✓		✓			✓	✓	✓	✓		✓	✓		✓				✓

Appendix 6 Patterning chart

PATTERN	ADVANCES	GAPS	EVIDENCE FOR PRACTICE	RESEARCH RECOMMENDATION
The partners' effect on PWP	There is evidence of positive effects from the partner to PWP physically and psychologically.	■ There is a need for exploring unified outcome measures for measuring the effects of partners on PWP physically and psychologically. ■ There is limited evidence on the negative effects from the partner to PWP physically and psychologically. ■ There is lack of evidence on the effects from the partner to PWP cognitively.	■ When targeting to treat PWP's physical symptoms, one may consider applying partnered dance. ■ Leading professionals should notice any psychological changes of PWP that may arise from their partners.	■ To develop a unified outcome measure to ensure the validity of the findings. ■ To carry out more research exploring any negative effects from the partner to PWP psychologically in partnered dance. ■ To carry out more research investigating any cognitive effects derived from partners.
Types of partner	There is evidence that PWP's experience of the dance class appeared to be influenced by their relationship with their dance partners and their compatibility with them.	■ There is a need for ongoing empirical work exploring how different types of partners affect PWP. ■ There is inadequate research about any different physical effects derived from different partners on PWP.	■ It is important that professionals or research conductors consider the recruitment or selection of the types of partners when conducting partnered dance classes for PWP and to consider any training needs to be given to PWP's partners.	■ To continue exploring the relationship between different types of partners and the effects on PWP to validate recommendations on the choice of the type of partners. ■ To carry out more research exploring any possible/ different physical effects derived from various types of partners.
Cueing	There is evidence of a positive relationship between different types of cueing and the effects on PWP.	■ There is a lack of studies unifying the use of types of cueing targeting various symptoms for PWP. ■ There is a paucity of research on the direct effect of cueing on PWP in partnered dance.	■ It is important that professionals or research conductors consider what and how different types of cueing can be applied to assist and benefit PWP.	■ Research is needed to specifically investigate how different types of cueing can affect PWP differently, particularly in partnered dance.
Leading professionals		■ There is a paucity of evidence of how different leading professionals may affect PWP's participation to class physically, psychologically and cognitively.	■ Evidence to emerge from future research.	■ Studies are required to address the significant gap in the field regarding leading professionals' impact on PWP.

Appendix 7 Patterns, Advances, Gaps, Evidence for Practice and Research Recommendations (PAGER) framework

How is the post-acute national stroke registry perceived by stakeholders in England and how is data currently used?

L Russell[1], S Lewis[1], N Chouliara[1], M James[2], R Fisher[3]

National registries or audit programmes are recognised methods of assessing quality of healthcare delivery[1]. The Sentinel Stroke National Audit Programme (SSNAP) collects a clinical dataset for stroke patients in England, Wales and Northern Ireland (85,000 patients annually)[2].

Evidence suggests that SSNAP has been successful in driving improvements in hospital-based stroke care[3]. However, there are challenges to audit implementation in community (post-acute) services which may impact its use for service improvement, such as variations in resources and service models[4]. This raises questions as to how to best capture multidisciplinary activity and how this relates to patient outcomes[5].

AIMS

This study explores how the audit is perceived by community stakeholders, what influences their participation and how audit-data is currently used.

METHODS

An online survey distributed through social media and established clinical networks. Individuals were invited to participate if they worked in, managed or commissioned community stroke rehabilitation. A combination of free text, yes/no options and five-point Likert scales were used to gather both qualitative and quantitative data.

RESULTS

A national sample from a broad group of stakeholders was achieved (n=206). Participants described using data to support a range of service improvement activities such as securing funding for additional staff/equipment and service reorganisation. However, concerns were raised regarding the audits ability to accurately reflect the post-acute stroke population, detect changes made by this cohort or capture the variety of services delivered. Participants identified a number of barriers that prevented audits leading to service improvement. These included insufficient skills to interpret audit reports, a lack of administrative support for data collection and competing demands on clinical time. A lack of organisational support, both in terms of leadership and funding, was also reported as limiting the ability of teams to act on audit findings.

CONCLUSIONS

Stakeholders are engaged with the post-acute audit and report using data to support a variety of service improvements. However, participants acknowledge the limitations of the data submitted and report frustration with the barriers identified to using this data to improve services. Despite the perceived limitations of SSNAP data, it is being utilised by stakeholders to inform service improvements. Further investigation of the barriers identified are required in order to realise the potential of a national clinical audit as a tool for quality improvement in the post-acute stroke setting.

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