Flinders University

Understanding Assessment and Clinical Reasoning in Neurological Physiotherapy: Bridging Practice and Education

By

Jill Patricia Garner
GradDipPhys. MClinRehab.

Thesis
Submitted to Flinders University
for the degree of

Doctor of Philosophy

College of Nursing and Health Sciences

12th March 2025

TABLE OF CONTENTS

ABSTRACT

Neurological conditions are a growing global concern, affecting over 3.4 billion people worldwide and representing the leading cause of disability and hospitalisation. These conditions present complex challenges across physical, cognitive, behavioural, and perceptual domains, significantly impacting quality of life and community participation. Management often requires a multidisciplinary team, with physiotherapists playing a pivotal role. In neurological physiotherapy, assessment serves as the cornerstone of effective treatment, informing clinical reasoning and guiding tailored management plans. However, a notable gap exists in the evidence base regarding specific methods and content of assessment and clinical reasoning in neurological physiotherapy practice, extending to how these critical skills are taught in pre-registration university programs.

This thesis aimed to understand assessment and clinical reasoning in neurological physiotherapy through five interconnected studies. A systematic review (Study 1) identified the five most frequently assessed domains in clinical practice: function, postural alignment and symmetry, gait, balance, and muscle strength. There was minimal evidence for factors impacting inclusion of assessment domains. This informed a national survey (Study 2) investigating physiotherapy assessment practices, barriers, and enablers in clinical settings. The survey revealed variability in assessment practices, with barriers and enablers related to therapist caseload, knowledge, and intrinsic patient factors.

Gaps identified in the survey led to a scoping review (Study 3) exploring clinical reasoning in practice and examining theoretical frameworks. Twenty-five conceptual clinical reasoning frameworks were identified, with the International Classification of Functioning reported most frequently. Key components of clinical reasoning included initial information gathering, objective examination, movement analysis, predicted patient performance, and evaluation/reassessment.

Building on these findings, a mixed-methods study (Study 4) explored the teaching of neurological assessment in pre-registration physiotherapy courses. Curriculum content was found to be taught using foundational modules, with themes of expectations, scaffolding, context, complexity, and clinical reasoning identified. Finally, a qualitative study (Study 5) explored physiotherapy students' perspectives on neurological assessment and clinical reasoning, revealing five major themes: process and components of assessment, treatment planning, patient-centred care, learning clinical reasoning, and assumptions and biases.

The thesis findings highlight a gap between clinical practice and education in neurological physiotherapy assessment and clinical reasoning. To bridge this gap, an evidence-based framework derived from identified frameworks and components could guide students and

clinicians, providing a more consistent approach to the clinical reasoning process. This aligns with the clinical reasoning components outlined by WCPT (2011) and the physiotherapy threshold requirements (Physiotherapy Board of Australia and New Zealand, 2023).

In conclusion, this comprehensive exploration of assessment and clinical reasoning in neurological physiotherapy underscores the need for greater alignment between clinical practice and educational approaches. By addressing this gap, we can better prepare future physiotherapists to meet the complex challenges of neurological assessment and treatment, ultimately improving patient care and outcomes.

Further research is needed to:

- Develop an evidence-based framework in neurological physiotherapy, which reflects the clinical reasoning components outlined by World Physiotherapy and the physiotherapy threshold requirements of Australia and New Zealand.
- Explore scaffolded teaching of clinical reasoning in neurology and assess the effectiveness of this intervention.

DECLARATION

I certify that this thesis:

1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university

2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and

3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed.....Jill Garner.....

Date.....19/03/2025.....

ACKNOWLEDGEMENTS

I would like to acknowledge all of those individuals who have supported me whilst studying for my PhD. To begin with I would like to sincerely thank my supervisors Associate Professor Maayken van den Berg, Associate Professor Belinda Lange and Emeritus Professor Sheila Lennon, who inspired me, were very patient, and who supported and guided me on this journey. It was a privilege to have supervisors with such knowledge and a variety of skills and experiences from which they drew, which made my experience richer. I would like to thank the physiotherapy department at Rehabilitation, Aged and Palliative Care, Southern Adelaide Local Health Network, Adelaide, South Australia who have supported me along this journey and the physiotherapists, educators and students who participated in the included studies. Lastly, I would like to thank my family Roger, Kezia, Bek and Oscar for their continued support and love throughout.

This research was supported by Australian Government Research Training Program Scholarship funding.

ABBREVIATIONS

AHPRA	Australian Health Practitioner Regulation Agency
APC	Australian Physiotherapy Council
APA	Australian Physiotherapy Association
ANOVA	Analysis of Variables
AVERT	a Very Early Rehab Trial
BIT	Behavioural Inattention Test
CHERRIES	Checklist for Reporting Results of Internet E-Surveys
COPM	Canadian Occupational Performance Measure
CPDANZ	Council of Physiotherapy Deans Australia and New Zealand
EBP	Evidence Based Practice
JHF	Jebsen Hand Function Test
POAM	Patterns of Activity Measure
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
ICF	International Classification of Functioning
RAMP	Restore, adapt, maintain and prevent
SBE	Simulation Based Education
SOAP	Subjective, objective, assessment, plan
WCPT	World Confederation of Physical Therapy
WPT	World Physiotherapy
WHO	World Health Organisation

PUBLICATIONS

Publications (thesis)

Garner, J., Berg, M. V. D., Lange, B., Vuu, S., & Lennon, S. (2023). Physiotherapy assessment in people with neurological conditions—evidence for the most frequently included domains: a mixed-methods systematic review. *Journal of Evaluation in Clinical Practice*, *29*(8), 1402-1424. https://doi.org/10.1111/jep.13909

Garner, J., Lange, B., Lennon, S., & van den Berg, M. (2024). Physiotherapy assessment of people with neurological conditions in Australia: A national survey. *Health Science Reports*, *7*(6), e2117. https://doi.org/10.1002/hsr2.2117

Publications (other)

Garner, J. & Lennon, S. (2018). Neurological assessment: The basis of clinical decision-making (Chapter 4). In S. Lennon, G. Ramdharry, & G. Verheyden (Eds.), *The Neurological Physiotherapy Pocketbook* (2nd ed., p. 55-82). Elsevier Science.

Garner, J. P., Lennon, S., & McLoughlin, J. V. (2023). Clinical Reasoning in Neurological Physiotherapy: Assessment and Treatment Principles. In S. Lennon, G Ramdharry, & G. Verheyden (Eds.), *Physical Management for Neurological Conditions E-Book: Physical Management for Neurological Conditions E-Book* (5th ed.,p. 33-52). Elsevier.

Vuu, S., Barr, C. J., Killington, M., **Garner, J.**, & Van Den Berg, M. E. (2022). Physical exercise for people with mild traumatic brain injury: A systematic review of randomized controlled trials. *NeuroRehabilitation*, *51*(2), 185-200.

Conference presentations

Garner, J., Lennon, S., van den Berg, M; & Lange, B. (2024). *Clinical reasoning scoping review* [Poster presentation]. Allied Health and Scientific Office Conference, Adelaide, Australia.

Garner, J., Lennon, S., van den Berg, M; & Lange, B. (2024). *What is taught to physiotherapy students about assessment of people with neurological conditions? A curricula survey from Australia* [Poster presentation]. World Conference in Neurological Rehabilitation, Vancouver, Canada.

Garner, J., Lange, B., Lennon, S., & van den Berg, M. (2024). *Measures used in neurological physiotherapy assessment in Australia: a national survey of clinical practice* [Poster presentation]. World Conference in Neurological Rehabilitation, Vancouver, Canada.

Garner, J., Lennon, S., van den Berg, M., & Lange, B. (2024). *What is taught to physiotherapy students about assessment of people with neurological conditions? A curricula survey from Australia* [Conference presentation]. Australian and New Zealand Association Health Professionals Educators Conference, Adelaide, Australia.

Garner, J., Lange, B; Lennon, S., & van den Berg, M. (2024). *Clinical reasoning in neurological physiotherapy-a scoping review* [Poster presentation]. Allied Health and Scientific Office Research Forum, Adelaide, Australia.

Garner, J., Lange, B; Lennon, S., & van den Berg, M. (2023). *Assessment and clinical reasoning in neurological physiotherapy* [Presentation to Master of Clinical Rehabilitation students, Flinders University]. Adelaide, Australia.

Garner, J., Lange, B; Lennon, S., & van den Berg, M. (2023). *Physiotherapy assessment and clinical reasoning of neurological conditions with a focus on stroke* [Presentation to South Australian neurorehabilitation and exercise physiotherapy community of practice]. Adelaide, Australia.

Garner, J., Berg, M. V. D., Lange, B., Vuu, S., & Lennon, S. (2022). *Physiotherapy assessment in people with neurological conditions—evidence for the most frequently included domains: a mixed-methods systematic review* [Poster presentation]. Southern Adelaide Local Health Network Research Week, Adelaide, Australia.

Garner, J., Lange, B., Lennon, S., & van den Berg, M. (2021). *Use of Measures in Physiotherapy assessment of people with neurological conditions in Australia: A national survey* [Oral presentation]. Southern Adelaide Local Health Network Research Week, Adelaide, Australia.

Garner, J., Berg, M. V. D., Lange, B., Vuu, S., & Lennon, S (2021). *Clinical reasoning in physiotherapy assessment for people with neurological disorders-limited evidence for essential domains-a mixed systematic review* [Conference presentation]. 2nd International Motor Control Conference, online.

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 BACKGROUND AND LITERATURE REVIEW

This introductory Chapter provides an overview of the literature in relation to physiotherapy assessment of people with neurological conditions. It begins by providing an overview of neurological conditions and introduces some of the key models and frameworks that can be utilised to guide physiotherapy assessment. The chapter then goes on to explore the role of physiotherapy in the management of people with neurological conditions, highlighting physiotherapy assessment and clinical reasoning and their implications, informing direction for treatment. This thesis explores assessment in the context of clinical practice and student learning, thus the synthesis of the literature in this chapter extends to healthcare education particularly in the context of neurological physiotherapy. The chapter concludes by outlining the aims of the thesis, the research questions it seeks to address, and its contributions to advancing knowledge in this area. An outline of the thesis is also presented.

Introduction

1.1 Overview of neurological conditions

Currently, approximately 3.4 billion people worldwide are affected by neurological conditions (Steinmetz et al., 2024). Globally, the burden of these conditions, including Alzheimer's and Parkinson's diseases, is increasing rapidly. Despite significant advances in the care and treatment of people with neurological conditions, these conditions remain the world's largest cause of disability and hospitalization (Khan et al., 2018).

There are at least 600 different neurological conditions (Australian Government, Department of Health and Aged Care, 2020). Common neurological conditions include cerebral palsy, dementia, motor neuron disease, traumatic brain injury, stroke, Parkinson's disease, and Multiple Sclerosis. They may be acute or become chronic. They may occur at a single point in time, such as stroke, traumatic brain injury, and spinal cord injury, or they can be degenerative, such as Parkinson's disease, or progressive such as Multiple Sclerosis and Amyotrophic Lateral Sclerosis. Individual variation exists in how people with neurological conditions present and progress, adding to the complexity of their management. The management of people with neurological conditions often involves a multidisciplinary team including neurologists, occupational therapists, speech pathologists, and physiotherapists.

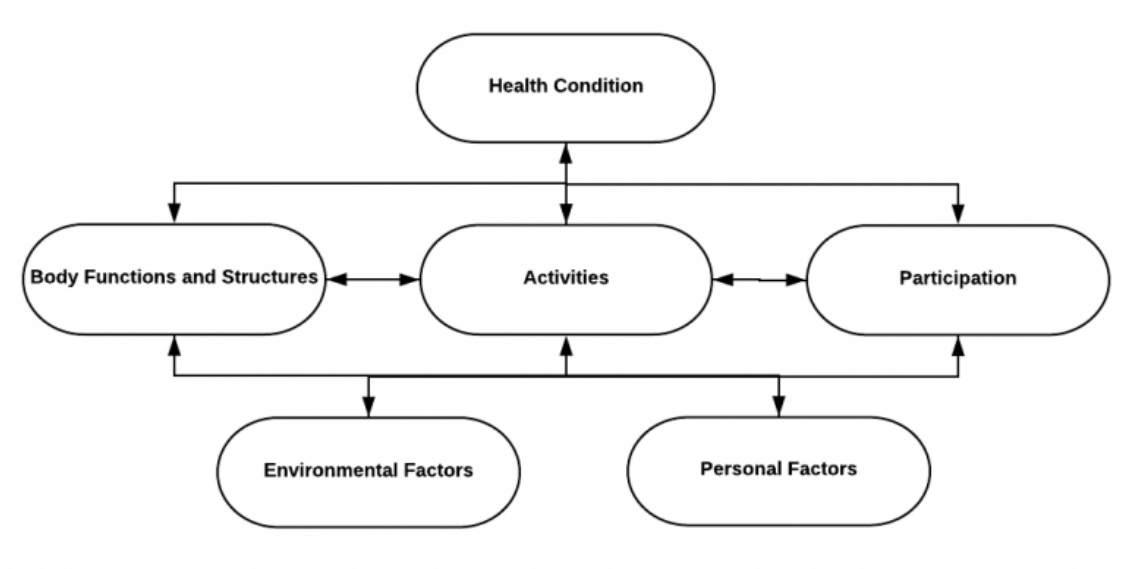
With an increasing number of people whose quality of life and function are affected by neurological conditions, there is a growing awareness that the services and resources offered to people with these conditions are scarce (Manikandan et al., 2023). People with neurological conditions often present with impairments, including weakness, sensory changes, and problems with function, and/or activities of daily living, that adversely impact their quality of life. Many of these individuals

require assessment by a physiotherapist in a hospital or community setting to develop an effective management plan to address their goals and concerns (Elsworth et al., 2011; Jones, 2011; WHO, 2012; Cieza et al., 2020; Bassile & Lennon, 2024).

1.2 The ICF framework in neurological rehabilitation

The World Health Organization's (2001) framework, the International Classification of Functioning, Disability and Health (ICF) (Figure 1), is a bio-psychosocial model of functioning and disability focused on the impact of the disease on the person (Jones, 2011; Rosenbaum & Stewart, 2004; Stucki et al., 2002). The model defines functioning and disability in the context of a health condition as multidimensional concepts at three levels. Firstly, at the level of body function and structures, such as muscle tone, coordination, memory, and proportions of structures. Secondly, at activity level, involving purposeful activities, and activities performed in daily living, such as stair climbing and work-related activities. The third level is that of participation in society, including self-care, work, and recreation. The framework also considers external and personal factors that influence these three dimensions. External factors include the physical, social, and attitudinal environments in which people live. Personal factors are an individual's 'particular background'. From here on for brevity, I will refer to 'body functions and structure limitations' as 'impairments'.

Figure 1-1 ICF framework developed by WHO (2001) (reproduced under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Intergovernmental Organization (CC BY-NC-SA 3.0 IGO) licence).



The use of the ICF framework can guide health professionals' assessments when formulating treatment goals and evaluating the health outcomes of the person they are assessing and treating (WHO, 2001). An accurate understanding of patients' problems can lead to effective advice and targeted therapy. A cohort study by Huber et al. (2011) demonstrated application of ICF framework in an acute hospital inpatient setting was feasible. The authors found that the ICF framework could be successfully used to assess patients' problems, define their goals, and use goal attainment

scaling to evaluate the effectiveness of therapy. The feasible use of the ICF framework also aligns with other work, including findings from a critical review of the clinical relevance of the ICF framework in physiotherapy by Allet et al. (2008) and a study classifying patient goals in people with stroke (Lohmann et al., 2011).

Higgs (2019) described a model for physiotherapists considering the WHO framework, which is biopsychosocial, collaborative, and hypothesis oriented. This model allows therapists to apply biopsychosocial therapy in their practice, thus providing high-quality patient-centred therapy. This collaborative model directs therapists to a 'holistic philosophy of health and disability.

1.3 Role of physiotherapy in the management of neurological conditions

The role of a physiotherapist working with people with neurological conditions begins with assessment. Therapists use the information gathered from this assessment to form a movement-based diagnosis (Deutsch et al., 2022). This is carried out using their clinical reasoning skills and from this point, together with the patient they develop and work on a management plan (Bassile & Lennon, 2024). The plan is based on goals that are important to the patient. The interaction between the patient and physiotherapist requires an 'active partnership' (Bassile & Lennon, 2024). This partnership between the physiotherapist and the patient's family often includes a myriad of healthcare professionals who are actively involved in the care of the patient. The collaborative goal-setting process leads the partnership to develop a treatment plan. This plan is highly individualised and depends on many factors, including the condition itself, disease trajectory, associated prognosis, patient situation, deficits or activity limitations, and their ability to participate in therapy. The treatment plan developed is based on the best available evidence (Bassile & Lennon, 2024), considering patient preference and therapist knowledge and experience (Sackett et al., 1996). In addition, standardised outcome measures are used to establish baselines for many aspects of the patients/persons' life such as quality of life, disease state, and functional performance (McDonnell et al., 2018). Once the baseline measures have been completed treatment commences. Assessment and treatment can often become intertwined, as the physiotherapist uses observational movement analysis skills to observe changes in performance during the treatment sessions (Scrivener & Shepherd, 2022). Standardised measures are repeated at key points along the course of the treatment trajectory to detect changes and for re-evaluation. Re-evaluation can be utilized to modify treatment and or discharge planning. Considering the ICF framework, thirteen guiding principles, as suggested by Bassile and Lennon (2024, p.12) can be used to guide physiotherapists when interacting with their patients. These principles include participation during therapy, teamwork, focus on person-centred care to encourage patients to gain knowledge about their condition and treatments, to increase the ability to manage their condition long-term, behaviour change principles, and mindset. Prediction is discussed as one of the thirteen

guiding principles. Physiotherapists are often asked to make predictions about recovery, speed of recovery, and length of stay in organisations such as hospitals, based on their knowledge of conditions and factors impacting recovery. Neuroplasticity is a key concept that must be considered when treating patients with neurological conditions, as it significantly impacts recovery (Voss et al., 2017). Understanding motor control principles, the interaction between different systems, and movement re-education to optimise movement functioning are important influencing factors for physiotherapists working in this area (Bassile & Lennon, 2024 p.10-13).

Promoting skill acquisition is a key principle for therapy related to the patient's goals and functional performance (Bassile & Lennon, 2024 p.13). This is achieved through task practice, with careful consideration of the amount of practice and with feedback given on patient performance. Other important principles utilised to guide neurological physiotherapy practice include promoting health, prevention, self-management, behaviour change, and mindset to assist the patient in managing their condition.

The role of the physiotherapist in the management of people with neurological conditions may vary depending on the clinical setting, needs of the organisation, and phase or stage of the condition. An example is the AVERT trial (Bernhardt et al., 2015) the findings of which demonstrated that early mobilisation is important for post-stroke recovery, however, it should be approached with caution in the early stages post-stroke. On the other hand, when treating people in the deteriorating phase of Guillain Barre Syndrome, strenuous exercise may be contraindicated (Leonhard et al., 2021).

1.4 Neurological physiotherapy assessment

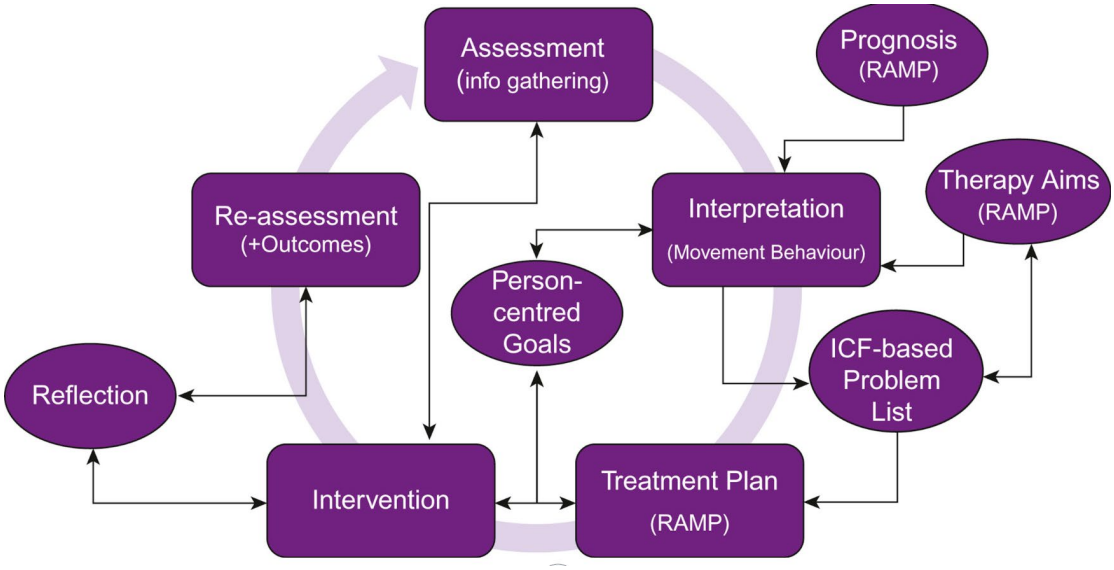
Assessment by a physiotherapist has been defined as a process of analysis, synthesis, and evaluation (World Physiotherapy, 2011). During the analysis, presenting problems are explored, and contributing factors are considered. Synthesis brings together knowledge, experience, and ideas to develop a comprehensive understanding of the situation, with weighting of each factor that has been identified to develop a hypothesis and treatment plan (Jones et al., 2019; Garner et al., 2024 p.33-34). This process is known as clinical reasoning (Dimitriadis et al., 2016; Gjelsvik, 2016; Garner & Lennon 2018). Assessment and the process of clinical reasoning are described in the physiotherapy practice thresholds of the Physiotherapy Board of Australia and the Physiotherapy Board of New Zealand (2023). Registered physiotherapists are required to be able to 'plan and implement an efficient, effective, culturally safe and responsive and client-centred physiotherapy assessment' (practice threshold 1.1). Acquiring clinical reasoning skills is a key requirement for physiotherapy undergraduate education (practice threshold 1.2). Clinical reasoning is complex, situation-specific, and refined through experience (Delaney & Golding, 2014).

Neurology focuses on the functions and disorders of the nervous system, as well as neurological conditions that cause deficits and functional problems. These issues can be assessed and treated by physiotherapists, with an emphasis on gaining or regaining function (Walker, 2013). As part of the assessment, the physiotherapist undertakes an observational movement analysis that requires knowledge of skill acquisition and human movement to form a management plan together with the patient (Walker, 2013). Needs identified as part of this assessment are often complex and deficits may be physical, cognitive, behavioural, and/or perceptually based. All these areas need to be considered to effectively treat patients (Garner & Lennon, 2018).

1.5 Clinical reasoning in neurological physiotherapy assessment and treatment principles

World Physiotherapy (2011) defines physiotherapy assessment as encompassing clinical reasoning, current evidence, and the perspectives of both the patient and caregiver. Clinical reasoning is a broad concept essential for managing and evaluating a patient's medical problems. Clinical reasoning refers to the "diagnosis of the patient problem, making a therapeutic decision and estimating the prognosis for the patient" (Yazdani & Hoseini Abardeh, 2019, p. 703). Clinical decision making refers to a part of the clinical reasoning process where an action is taken or decision made in collaboration with the patient (Holder et al., 2028; Higgs, 2019, p. 34). Clinical reasoning and decision-making help facilitate collaboration between a physiotherapist and their patient to develop and evaluate an appropriate plan of care for each patient. Figure 1-2 details the key components of clinical reasoning.

Figure 1-2 Key components of clinical reasoning in neurological physiotherapy* (Garner et al., 2024, p. 35)



** RAMP is an abbreviation of Restore, Adapt, Maintain, Prevent.* This figure was published in Physical Management for Neurological Conditions, 5th edition, S. Lennon, G. Ramdharry, & G. Verheyden (Eds.), Clinical Reasoning in Neurological Physiotherapy: Assessment and Treatment Principles. p. 35, Copyright Elsevier (2024).

Assessment is the foundation for clinical reasoning, and proficiency in clinical reasoning requires physiotherapists to possess the skills necessary for effective assessment and management, taking all contributing factors into account. The ability to competently clinically reason is essential for making appropriate judgments in response to the unique clinical situation of each individual patient. This clinical reasoning process integrates knowledge from various sources, including scientific evidence, procedural 'know-how', 'personal philosophy of practice', and values and ethical considerations. The terms clinical reasoning and decision-making are often used interchangeably but can be defined separately (Brentnall et al., 2022).

There is limited literature to support what happens in clinical practice related to physiotherapy assessment and clinical reasoning in neurological physiotherapy. Nutbeam and Muscat (2021) have highlighted a disconnect between real-world healthcare needs encountered in clinical practice on the one hand, and educational curricula on the other hand. The content and processes of physiotherapy assessment of people with neurological conditions taught to physiotherapy students in the classroom may not align with what is observed and practiced in various healthcare settings (Sole et al., 2019), because what is currently happening in clinical practice is unclear. What happens in clinical practice also needs to be reflected in what is taught to students, so students can use this knowledge to transition into practice on placement and once qualified.

1.6 Teaching in healthcare education

The educator's role in higher education is to provide an environment and resources in which each student can learn. Experiential learning derived from the work of Dewey (Williams, 2017) is commonly used in healthcare education, as it focuses on developing competencies and practising skills in a specific context (Yardley et al. 2012).

Educator practices in higher education are influenced by a variety of factors. These factors include intuition, personal views on educational practices, ideas and beliefs about teaching, modelling based on others' teaching, insights gained from educational programs, experience, and engagement with teaching literature (Beatty et al., 2020; Hunt & Chalmers, 2021). Reflection can be used to develop a personalised teaching philosophy, which is often modified over time as educators explore new educational practices and theoretical philosophies (Beatty et al., 2020). Educator practices and theoretical philosophies underpin the learning environment for students. This learning environment requires a clear purpose; with support to understand previous learning to allow for reflection and analysis of issues and experiences (Sikandar, 2015).

Students learning to become healthcare professionals need to develop an understanding of healthcare. It involves interaction and collaboration between staff and patients, critical and philosophical considerations, professionalism, and profession-specific skills (Walker, 2013; Soares et al., 2019; Teherani et al., 2017).

Health education is not just about the dissemination of health-related information but also needs to foster the motivation, skills and confidence (self-efficacy) necessary to take action to improve health (Nutbeam & Muscat, 2021). There can be a 'mismatch' between real-world healthcare needs in clinical practice and educational curricula (Nutbeam & Muscat, 2021).

1.7 Teaching neurology to physiotherapy students

There are frameworks that provide guidance when developing physiotherapy education. The Physiotherapist Education Framework (World Physiotherapy, 2021) aims to ensure the continuing development of physiotherapists in accordance with the definition of physiotherapist practice within individual countries. This framework highlights the connection between the curriculum, teaching, learning, culture, staff, and quality assurance, leading to continued education and learning once qualified, and confirms the importance of linking skills learnt at university to clinical practice including assessment and managing patients.

The core area of neurology is concerned with functions and disorders of the nervous system, including the brain, spinal cord, and nerves. The core areas have essential physiotherapy components that are concerned with assessment, movement, exercise prescription, and treatment. All of which are essential to effectively manage patients. Students are taught to assess movement

dysfunction by analysing the component tasks and applying their knowledge of skill acquisition and human movement to plan the treatment strategy (Walker, 2013). This process is grounded in a theoretical understanding of neuroanatomy, particularly the sensorimotor system, as well as principles of motor control, neuroplasticity and neurophysiology.

A major aim of teaching students about neurological conditions is to prepare them for assessing and treating patients in clinical practice after they are qualified. To support students in assessing people with neurological conditions, they are encouraged to adopt a problem-solving approach, underpinned by evidence-based practice. Additionally, students are guided to apply skills acquired from all aspects of their degree to enhance their understanding and practice (Walker, 2013). Other aspects of the course that support neurology teaching include interprofessional and interdisciplinary practice. These aspects emphasize patient-centred care, teamwork, and communication (O'Keefe et al., 2017). This is important in managing people with neurological conditions, as effective support and treatment often requires team collaboration. The team considers activity limitation and participation restriction (Escorpizo et al., 2013) as part of the management plan to deliver effective therapy and achieve the patients' goals (Stroke Foundation, 2024). Physiotherapists in particular focus on movement-related issues (Walker 2013).

Literature supporting the teaching of neurological content has primarily focused on medical students (Giles, 2010). Shaefer et al. (2018) highlighted the benefits of problem-based learning in neurology education, suggesting that this approach may be less 'intimidating' for students and fosters collaboration in a shared learning environment, which is crucial for developing clinical reasoning.

Ajjawi and Higgs (2008) have emphasized the importance of clinical reasoning in allied heath practice. They highlighted the complexity of clinical reasoning, noting that it requires both knowledge and experience to evaluate available options, as well as communication skills to gather relevant information. When working with people with neurological conditions, additional challenges such as communication and cognitive impairments may hinder a student's ability to obtain information and collaboratively set goals with the patient.

1.8 Teaching assessment and clinical reasoning to physiotherapy students

Physiotherapy students are taught to assess various domains, including pain, posture, range of movement, reflexes, respiratory, spasticity/tone, strength/weakness, sensation, balance, clinical reasoning, coordination, endurance, and falls. Additionally, they learn to assess aspects that can also be evaluated by other health professionals, such as communication and mood, functional mobility and "things we want to know but not measure' (Tyson et al., 2008). These domains, among others, guide students to "plan and implement an efficient, effective, culturally responsive,

and patient-centred physiotherapy assessment" (Australian Physiotherapy Council, 2016). Observation is a key component of physiotherapy assessment (Wallace et al., 2024).

Clinical reasoning is an essential skill for physiotherapy clinical practice; however, only a few studies have explored student experiences and learning of these skills. Cruz et al. (2012b) explored final-year physiotherapy students' understanding of clinical reasoning in the context of musculoskeletal physiotherapy and identified four themes: clinical reasoning is a tool for diagnosis and management planning, it is clinician-centred, clinicians have ownership over the process with input from the patient, and it is knowledge and context-specific. These themes may differ in neurological practice, where diagnoses are often already established by a physician. In neurological practice, the patient-centred approach tends to be more collaborative, with the patient placed at the centre of their care. Many neurological conditions assessed by physiotherapists are long-term and degenerative in nature, often making a self-management approach highly effective (Lennon et al., 2024).

There is little published evidence on entry-level physiotherapy programs, their curricula, and the content and delivery of neurological assessment. Walker's (2013) doctoral thesis detailed the neurological program at one university in the United Kingdom, providing a foundation for further research into physiotherapy students' thoughts, feelings, and experiences of learning neurological physiotherapy, highlighting the need for further research in this area.

1.9 Thesis aims and questions

Drawing on over 30 years of personal clinical experience in assessing people with neurological conditions, and observing other clinicians, it appears there is a lack of uniformity in assessment practices within the same and across different clinical settings. Assessments may be modified based on organizational demands, such as the need to communicate information to other healthcare professionals, update nurses on transfer status, or meet discharge planning and outcome measures requirements. From a preliminary literature search to identify relevant literature related to physiotherapy assessment of people with neurological conditions, nine studies were found to be relevant, identified from 1970 to 2020 (Alexander, 1970; Kleynen et al.,2017; Lahelle et al., 2020; Lennon, 2003; Proud et al., 2013; Sibley et al., 2013; Tyson & Desouza, 2003; Tyson et al., 2008; Walmsley et al., 2018; Winward et al., 1999). From this search, findings indicated here was limited information related to the timing of assessment in only one study (Winward, 199). Not all studies explored clinical practice. Historically, Alexander (1970) aimed to influence clinical practice by constructing a chart, which to my knowledge has not been utilised in clinical practice. Tyson et al. (2008) explored what could be measured not necessarily what is assessed. Further studies are required to develop a consensus framework that explains the rationale for neurological physiotherapy from an international perspective. There are evidence-based gaps related to the

current clinical practice for physiotherapy assessment of neurological conditions, timing of assessment, and factors that influence assessment choices (Tyson et al., 2008).

This thesis aimed to understand the physiotherapy assessment of people with neurological conditions in clinical practice, and the nexus between this and what is taught and learnt by physiotherapy students at university.

These aims will be addressed by answering the following questions:

1. What are the essential domains explored by physiotherapists during the clinical assessment of adults with neurological conditions (Chapter 3 & 4)?
2. What are the factors that influence the physiotherapy assessment of adults with neurological conditions in clinical practice (Chapter 3 & 4)?
3. What measures are used as part of the assessment of people with neurological conditions (Chapter 4)?
4. What ideas do clinicians hold regarding the assessment of people with neurological conditions during clinical placement (Chapter 4 and Chapter 6)?
5. Which clinical reasoning frameworks are used in neurological physiotherapy? What is the existing evidence underlying the clinical reasoning process and its components in neurological physiotherapy (Chapter 5)?
6. How is physiotherapy assessment of people with neurological conditions taught to students, and what is included in the curriculum in physiotherapy modules that teach the assessment of people with neurological conditions at universities in Australia (Chapter 6)?
7. What are the views and experiences of physiotherapy students regarding assessment processes and clinical reasoning abilities (Chapter 7)?

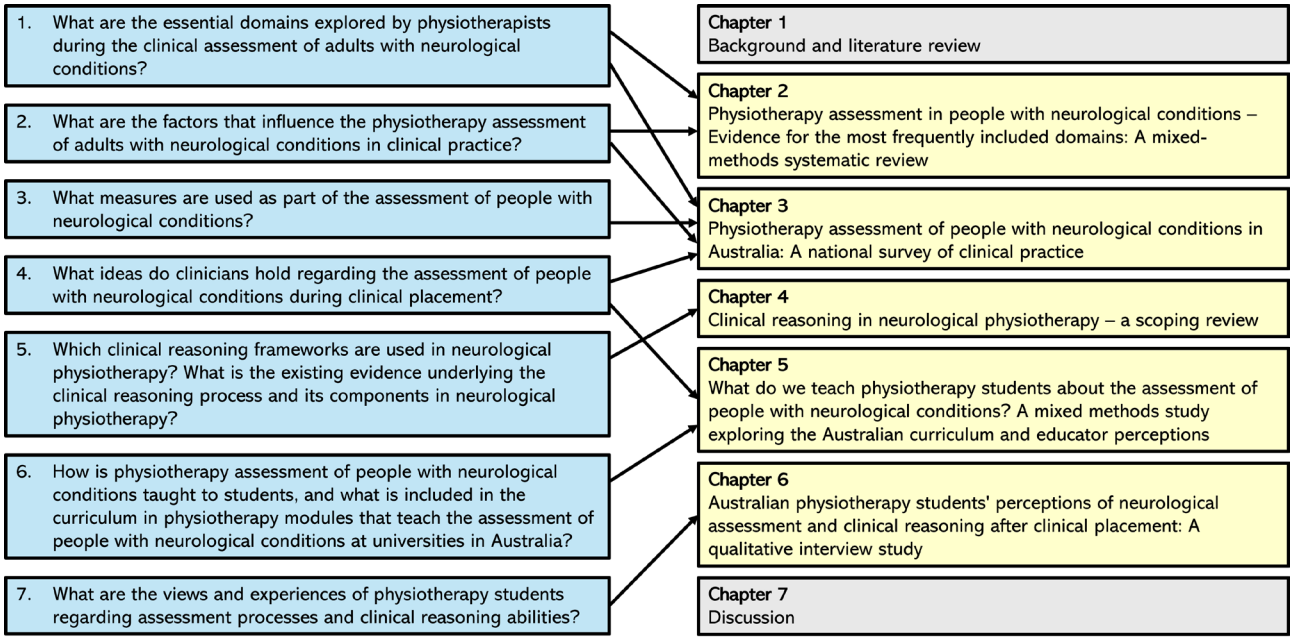
1.10 Original contribution to the thesis

This thesis contains original work by the candidate and all content that has been published is reference throughout.

1.11 Outline of this thesis

Figure 1-3 displays the chapters included in this thesis. The thesis begins by exploring assessment and clinical reasoning in practice and goes on to describe how assessment of people with neurological conditions is taught to physiotherapy students at university and clinical placement.

Figure 1-3 Thesis chapters (data from thesis questions and chapter titles, 2024)



Chapter 3 utilizes a mixed-methods systematic review methodology to identify domains that physiotherapists routinely assess in people with neurological conditions in clinical settings and explored factors influencing assessment domains including country, clinical setting, therapist experience and neurological condition.

Chapter 4 presents a national online survey, aimed to explore current physiotherapy clinical practice in the assessment of people with neurological conditions, including barriers, enablers, and influencing factors. Clinical practice activities in the context of supervising physiotherapy student placements were also explored. Chapter 5, a scoping review, aimed to explore and synthesize available literature pertaining to clinical reasoning in neurological physiotherapy. It sought to describe conceptual frameworks relevant to clinical reasoning and to characterize the components of the clinical reasoning process in (1) conceptual frameworks developed to guide clinical reasoning in neurological physiotherapy and (2) in the clinical practice of neurological physiotherapy. It also intended to assess commonalities and differences between theory and practice, and map study findings to standards of clinical practice.

In Chapter 6, a mixed method study, involving web-based audit and semi-structured interviews with educators, aimed to examine what is taught to physiotherapy students regarding the assessment of people with neurological conditions and how this is achieved. Curriculum content from a sample of Australian physiotherapy courses was explored, comparing learning objectives, methods of teaching, formative and summative assessment methods, and resources used to teach the assessment of people with neurological conditions at universities.

Finally, in Chapter 7, a qualitative study using semi-structured interview methodology, aimed to investigate Australian physiotherapy students' perceptions, beliefs, and experiences of

neurological assessment and clinical reasoning within the context of coursework and clinical placement. The study explored how prepared students feel before starting clinical placement in relation to assessment processes, and their views and experiences after clinical placement, from a theoretical and practical perspective.

The thesis concludes with Chapter 8, a general discussion that reiterates the research aims and summarises the work completed. It integrates the findings of the individual thesis chapters and discusses them in the context of the existing literature. The chapter also presents implications for clinical practice and suggests areas for future research.

CHAPTER 2 RESEARCH FRAMEWORK

2.1 Ontology and Epistemology

2.1.1 Pragmatist Perspective

This thesis incorporates a pragmatist perspective to address the practical and applied nature of the research questions. Pragmatism emphasises the importance of actionable outcomes, and the part research plays in solving real-world problems (Creswell & Plano Clark, 2017; Biesta, 2021). A pragmatist perspective allows the research within this thesis to focus on practical outcomes, exploring what works in real-world settings, which aligns well with the exploration of both theory and practice in neurological assessment. This is particularly relevant in the context of neurological physiotherapy, where the ultimate goal is to improve patient care, education, and clinical outcomes.

Within a pragmatic framework constructivist approaches offer ways for understanding how knowledge about neurological assessment is created and interpreted. The relationship between pragmatism and constructivism is complementary within this thesis.

2.1.2 Constructivist perspective

The research in this thesis is grounded in a constructivist epistemology, which acknowledges that knowledge is constructed through individual and collective experiences and is context-dependent (Crotty, 1998; Lincoln & Guba, 1985). Constructivists assert that learners construct knowledge. Students apply new knowledge learned actively through interaction with educators and the clinical environment (Alanazi, 2016). In neurological physiotherapy, clinical practice involves complex interactions between people with the condition, physiotherapists, and education, so the constructivist perspective is particularly relevant. Knowledge about neurological assessment and clinical reasoning emerges through a combination of experiential learning, reflection on practice, and the nexus with theory and practice. The constructivist perspective also acknowledges that multiple perspectives, including those of clinicians, educators, students and clients, contribute to the co-construction of knowledge related to assessment and clinical reasoning of an individual with a neurological condition. This epistemological stance informed the design of the studies within this thesis, particularly in prioritising diverse data sources and using a variety of methods to capture a holistic understanding of neurological physiotherapy.

2.1.3 Ontological position

The research adopts a relativist ontological position, which views reality as multifaceted and shaped by individual and collective experiences (Guba & Lincoln, 1994). In the context of neurological physiotherapy, reality is understood as a dynamic interplay of factors such as the needs of the patient, clinician knowledge, expertise and experience, and the needs of healthcare

services and education. This perspective acknowledges that there is no single, objective reality but that his depends on individual contexts and interactions.

Relativist ontology aligns with the complexity inherent in neurological conditions, where each patient's presentation and rehabilitation journey is unique to them. It also supports the view that educational approaches and clinical reasoning processes are contextually situated and influenced by institutional, cultural, and experiential factors. This justifies the use of methodologies that capture a variety of perspectives and experiences (clinicians, educators, students), reflecting the complexity of the area being studied.

2.2 Methodological rationale

To address the research objectives, a mixed methods approach was employed, combining quantitative and qualitative methodologies. This approach aligns with the pragmatist, constructivist epistemology and relativist ontology perspective by allowing for the exploration of both measurable patterns as well as experiences of educator and student experiences. The choice of methodologies was informed by the need to capture the complexity and context-dependence of neurological physiotherapy assessment and clinical reasoning. This approach also facilitated triangulation, enhancing the validity and reliability of the research findings by drawing on multiple data sources and perspectives. By combining systematic reviews, surveys, scoping reviews, curricula audits, and interviews, the research was able to explore the breadth and depth of knowledge in neurological physiotherapy, contributing to a more holistic understanding of the field. Below, the rationale for each methodological component is outlined in Table 2-1.

2.3 Conclusion

This chapter has outlined the methodological approach and specific methods employed in this thesis. A mixed-methods design was adopted to thoroughly investigate the complexities and diverse realities in neurological physiotherapy. This chapter detailed both quantitative and qualitative methodologies, which align with a pragmatist and constructivist epistemology, as well as a relativist ontological perspective.

By aligning the methodological design with these philosophical foundations, the research contributes to bridging the gap between clinical practice and education, ultimately improving quality and effectiveness of patient care.

Table 2-1 Rationale for methodologies utilised in this thesis (data from thesis text, 2024)

Study No	Chapter/study title	Methodology	Methods	Quality guide	Rationale
1	Physiotherapy assessment in people with neurological conditions – evidence for the most frequently included domains: a mixed- methods systematic review	Mixed methods	Systematic review	Joanna Briggs Institute (JBI) Convergent Integrated Approach to mixed-methods systematic reviews was used and the findings were reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2015).	A systematic review was chosen for its ability to synthesize existing evidence systematically and transparently (Levac, Colquhoun, & O'Brien, 2010). This method aligns with the constructivist epistemology by acknowledging that knowledge is cumulative and contextually situated.
2	Physiotherapy assessment of people with neurological conditions in Australia: a national survey of clinical practice	Mixed methods	National web-based survey	Referred to the checklist for reporting results of internet e-surveys (cherries) (Eysenbach, 2004) to guide the reporting of this survey	This mixed methods approach allowed for the collection of data from a broad sample of physiotherapists, providing insights into patterns of assessment and variability in clinical practice within Australia. The survey design reflects the relativist ontology by recognizing that assessment practices are influenced by diverse contextual factors, including therapist experience, clinical settings, and patient characteristics.
3	Clinical reasoning in neurological physiotherapy – a scoping review		Scoping review	Referred to reporting items for systematic review and meta-analysis extension for scoping review guidelines (Tricco et al., 2018).	A scoping review was chosen for its flexibility in mapping key concepts and identifying gaps in the literature (Arksey & O'malley, 2005; Peters et al., 2022). This method aligns with the constructivist perspective by facilitating an exploration of how clinical reasoning component and theoretical frameworks are developed to guide practice. It also supports relativist ontology by highlighting the contextual factors influencing the use of both clinical reasoning components and frameworks.
4	What do we teach physiotherapy students about the assessment of people with neurological conditions? A mixed methods study exploring the Australian curriculum and educator perceptions	Mixed methods	Curricula audit and semi-structured interviews	Referred to COREQ checklist for reporting of qualitative interviews (Tong et al., 2007).	This approach reflects the constructivist epistemology by prioritizing the perspectives of educators as co-constructors of knowledge (Moses et al., 2020). The relativist ontology is evident in the recognition of diverse teaching methods and curricular structures across academic institutions. The pragmatist perspective ensures that the findings are actionable, with direct implications for improving educational practices in the classroom and on placement.

5	Australian physiotherapy students' perceptions of neurological assessment and clinical reasoning after clinical placement: a qualitative interview study	Qualitative	Semi-structured qualitative interviews	Referred to COREQ checklist for reporting of qualitative interviews (Tong et al., 2007).	This method was chosen for its ability to capture in-depth, subjective experiences of the respondents. The constructivist epistemology informed the focus on students' interpretations and reflections, while the relativist ontology supported the exploration of how individual and contextual factors shape students' learning and practice (Higgs & Jones, 2019). Pragmatism further guided this study by focusing on how insights from students can inform both education and support during clinical placement.

CHAPTER 3 PHYSIOTHERAPY ASSESSMENT IN PEOPLE WITH NEUROLOGICAL CONDITIONS – EVIDENCE FOR THE MOST FREQUENTLY INCLUDED DOMAINS: A MIXED- METHODS SYSTEMATIC REVIEW

Chapter 1 introduced the concepts of physiotherapy assessment in people with neurological conditions and how assessment was part of the clinical reasoning process, guides decision making and management plan. It demonstrated the link between teaching and learning about assessment and clinical reasoning to practice. It highlighted that little is known about the domains routinely included in physiotherapy assessment of people with neurological conditions. Chapter 3 aimed to provide an in-depth evaluation of the domains included in clinical assessment and the factors influencing this. To achieve this a mixed-methods systematic review methodology was employed.

The protocol for this systematic review was prospectively registered with the International prospective register of systematic reviews (PROSPERO). The study was published in the Journal of Evaluation in Clinical Practice in 2023:

Garner, J., Berg, M. V. D., Lange, B., Vuu, S., & Lennon, S. (2023). Physiotherapy assessment in people with neurological conditions—evidence for the most frequently included domains: a mixed-methods systematic review. *Journal of Evaluation in Clinical Practice*, *29*(8), 1402-1424.

Following publication and prior to thesis submission, the search was updated. This Chapter presents a revised version of the systematic review, reflecting the latest findings, with the addition of two studies (Houlahan et al., 2023; Takahashi., 2024).

Statement of co-authorship: all authors were involved in establishing the concept and design of the review. JG and SV conducted the search and screening, and data analysis was undertaken by MvB and JG. JG completed the initial draft of the manuscript. All authors edited multiple versions of the manuscript. The signed approval form was submitted with this Thesis. No conflict of interest was reported by the authors and the work was unfunded.

3.1 Introduction

Physiotherapy commonly plays an important role in the overall care and management of people with neurological conditions, and this assessment is a cornerstone of clinical practice. The World Health Organization (WHO) has described assessment as a process that includes examination, history taking, screening and the use of specific tests and measures through analysis and synthesis within a process of clinical reasoning" (WHO, 2001). More specifically within the physiotherapy context, World Physiotherapy (WPT) highlights the clinical reasoning element of the assessment, by defining a physiotherapy assessment as an approach using clinical reasoning,

incorporating current evidence and the patient and care giver's perspectives, and ensures that the physiotherapist develops and evaluates an appropriate plan of care for each patient WPT (2011).

In preparation for clinical practice, physiotherapy students are taught many assessment domains such as pain; posture; range of movement; strength/weakness; sensation; balance; and co-ordination. Some of these domains, such as communication and mood, can also be assessed by other health professionals. Physiotherapy students often identify complexity in the assessment process and difficulties in developing an optimal treatment plan for people with neurological conditions (Walker, 2013).

The theoretical basis for assessment in expert textbooks recommends the inclusion of approximately 28 domains (Froment et al., 2019; Bassile & Lennon 2024). The detailed assessment students are taught at university for people with neurological conditions is often not reflected in expectations while on placement, suggesting that other factors may influence assessment such as experience or healthcare setting (Garner & Lennon, 2018). In addition to health care settings, geographical settings may also need to be considered. A large study investigating the scope of musculoskeletal physiotherapy practice tendencies between countries worldwide has demonstrated a large variability, discussing this in the context of educational requirements and models as well as differences in healthcare systems (Froment et al., 2019).

Current clinical practice in the assessment of people with a neurological condition is based on a diversity of resources, including textbooks (Garner et al., 2024), recommendations by professional associations, government bodies and disability frameworks such as the International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2001), or condition-specific guidelines such as stroke (Jollife et al., 2018). However, to date, there is a lack of formal consensus on the domains that physiotherapists should include in their assessment.

Different strategies have been described for clinical reasoning from novices to experienced physiotherapists (Higgs et al., 2019), suggesting differences in assessment practices. Evidence has demonstrated differences in clinical reasoning processes between expert and novice clinicians in musculoskeletal and cardiorespiratory physiotherapy practice, including information gathering and synthesis, communication, and assessment time (Langridge et al., 2015; Case, 2000). Little information is available on the factors that influence assessment practices in neurological physiotherapy training and practice. Moreover, the focus has been mainly on the assessment of a single domain, such as gait, and the use of standardised measurement tools in relation to specific conditions (Tyson, et al., 2008; Proud et al., 2013).

In summary, there is limited evidence in the literature related to the domains to be included in the physiotherapy assessment of a person with a neurological condition in varying clinical contexts. Although there is some evidence suggesting that certain factors, such as therapists' experience,

clinical and geographical setting, and clinical condition may play a role; historically, limited research has been published about factors influencing neurological physiotherapy assessment practice (Alexander, 1970; Ashburn, 1982; Nilsson & Nordholm, 1992; Lennon, 2003). Theory and practice may have changed since publication of these studies and there is little recent information to guide practice.

This mixed methods review aimed to determine:

1. What domains do physiotherapists routinely assess in clinical practice in people with neurological conditions?
2. Do the factors of clinical and geographical setting, therapists' experience and neurological conditions play a role in the choice of the assessment domains?

3.2 Methods

A mixed methods systematic review of the scientific and grey literature was conducted. The Joanna Briggs Institute (JBI) Convergent Integrated Approach to mixed-methods systematic reviews was used. The review findings were reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2015). The protocol for this review was registered with PROSPERO, the International prospective register of systematic reviews (CRD42020131463).

3.2.1 Search strategy

Searches were conducted in MEDLINE, PubMed, CINAHL, Scopus, Web of Science and Cochrane Library. The search strategy was developed in liaison with subject specialists, supervisors and a university librarian. Searches were limited to English publications, from 1946 to April 2024. Additionally, relevant grey literature was searched, such as websites of physiotherapy associations and councils, and targeted hand searching of references list supplemented the search strategy. The full search strategy is presented in Appendix A.

3.2.2 Selection Criteria

In the literature, terms like neurological conditions, conditions, or diseases, are often used interchangeably. For the purpose of this systematic review, the term 'neurological condition' as defined by WHO (2006) was used: "diseases of the central and peripheral nervous system, including the brain, spinal cord, cranial nerves, peripheral nerves, nerve roots, autonomic nervous system, neuromuscular junction, and muscles". These conditions include epilepsy, Alzheimer disease and other dementias, cerebrovascular diseases including stroke, migraine and other headache conditions, Multiple sclerosis, Parkinson's disease, neuroinfectious conditions, brain tumours, traumatic conditions of the nervous system due to head trauma, and neurological conditions as a result of malnutrition. Studies conducted in patient populations with headache,

dementia and vestibular dysfunction were excluded as assessment domains within these diagnostic cohorts, from a theoretical and clinical viewpoint, are different from other neurological assessments (Herdman, 2013; Luedtke et al., 2016; Pomeroy et al., 1999).

The term “clinical practice” was defined as the delivery of healthcare by a physiotherapist in any clinical setting.

Title and abstract, as well as full-text articles, were screened independently by two authors (JG, SV). Disagreements with regards to eligibility for study inclusion were discussed and resolved and involved two further members of the research team (MvB, BL) where deemed necessary.

3.2.3 Study screening and selection process

Screening occurred in three steps. Firstly, initial screening of title and abstract retrieved citations, and grey literature, was independently by two authors (JG and SV) based on the pre-defined inclusion and exclusion criteria previously discussed. Studies were identified as included, excluded or unsure. Any disagreements or papers marked as ‘unsure’ were discussed and resolved between the two reviewers. Secondly, the full texts of potentially eligible citations were independently screened by the same two authors (JG and SV). Disagreements related to the inclusion of any paper were discussed and resolved, involving two further members of the research team (MvB, BL). Screening was completed in Covidence software. Covidence stores references, manages, and monitors the screening process with customised forms and automated flowcharts and provides an audit trail for the review. Thirdly, the references list of eligible papers and recent studies from two physiotherapy journals (Journal of Physical Therapy and Journal of Neurologic Physical Therapy, 2010-2019) were hand searched for potentially eligible papers, and these were then manually added to the Covidence database for screening, using the two-step process outlined above. References of the included studies were reviewed and the two journals noted above had published many of the included studies. To ensure high inter-rater reliability, discussions were conducted prior to initiating the screening process.

3.2.4 Methodological quality

The methodological quality of the included studies was assessed using qualitative or quantitative McMaster University critical appraisal tools (Law et al.,1998; Law et al.,1998a). The quantitative assessment included the following items: study purpose, relevant background reviewed, study design, description of sample and justification, intervention description, contamination, reporting of results, appropriate analysis, clinical importance, reporting of dropouts, appropriate conclusion. The overall quality of each study was graded, and an overall percentage assigned. The qualitative assessment included the following domains: study purpose, study justification, study design, theoretical perspective, methods, sampling, context of study, what was missing, procedural rigour,

analytical rigour, auditability, and theoretical connections. Again, the overall quality of each study was graded, and an overall percentage assigned.

The research team identified four McMaster criteria that were deemed critical based on answering the questions for this review: procedural rigour; analytical rigour; auditability, and theoretical connections. If the study met all four criteria and scored 80% or more on the Mc Master critical appraisal tool for qualitative studies, these were judged as high quality. Studies which met three of the critical criteria and/or obtained an overall score of between 50-79% were judged medium quality. Studies which met two or less of the critical criteria and/or obtained an overall score of 50% were judged low quality.

3.2.5 Data extraction and analysis

Data were extracted by one researcher (JG) and checked for accuracy by the research team (MB, BL, SL) using a purposefully developed pro forma, based on the JBI Mixed Methods Data Extraction Form following a Convergent Integrated Approach (Stern et al., 2021).

Data related to study characteristics, participant characteristics, and assessment, were extracted from all quantitative and qualitative studies. The study characteristics included author, year, country, study design, study aim, clinical setting, study population and sample size. Data related to participant characteristics included age, sex, level of education, years of qualification, and neurological physiotherapy experience. Finally, collated information related to the assessment domains assessed, neurological condition assessed, assessment timing, and frequency of assessment. Classification of domains was decided on using a consensus approach, which was guided by the literature and discussed between the researchers until an agreement was reached. As part of this discussion, in the context of gait patterns, it was decided that individual impairments, such as strength and, somatosensation, were considered separately from gait-related parameters, such as distance and speed described as gait. Quantitative data were presented descriptively, tabulated, and synthesised using a narrative synthesis approach.

In parallel, further to the data extracted as described above, any additional qualitative data pertaining to assessment were also extracted and managed using NVivo 12 software (Edhlund & McDougall, 2019). An inductive thematic analysis approach was used to analyse and synthesise these data (Braun & Clarke, 2012). Codes were developed based on the identified content in these qualitative studies, then refined and grouped into sub-themes and themes. This was reviewed, and discussed with the research team (MvB, BL, SL) until a consensus was reached. The qualitative and quantitative data were then integrated to verify domains routinely assessed by physiotherapists in clinical settings in people with neurological conditions and to explore factors influencing the assessment. Data was synthesised based on the Joanna Briggs Institute (JBI) approach to mixed systematic reviews (Joanna Briggs Institute, 2014) following a ‘convergent

integrated approach', see Figure 3-1 (Joanna Briggs Institute, 2014). Quantitative and qualitative studies were synthesised separately, and the findings were then pooled to address the initial research questions.

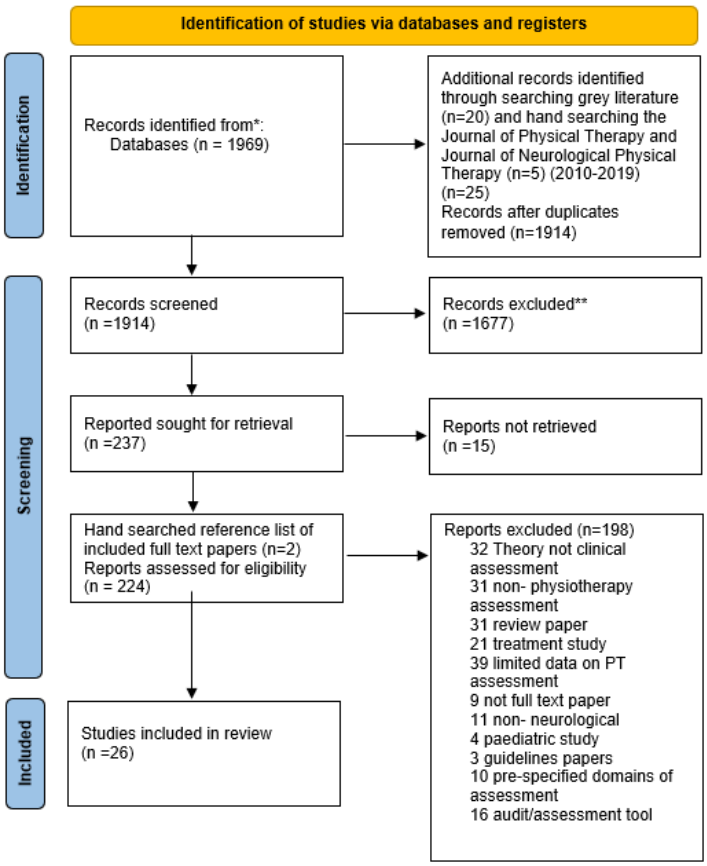
Figure 3-1 JBI convergent integrated approach

Image removed due to copyright restrictions

3.3 Results

Figure 3-2 presents the PRISMA flow diagram. Following removal of duplicates, 1914 studies were independently screened for eligibility. Two hundred and twenty-four full texts were assessed as potentially eligible. Most studies were excluded for assessment data that were theoretical in nature (n=32) or described non- physiotherapy assessment (n=31). In total 26 studies were judged eligible for inclusion in this review (18 quantitative studies and eight qualitative studies). The review findings are presented separately for quantitative and qualitative studies.

Figure 3-2 Prisma Flowchart (Moher et al., 2015) (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).



3.3.1 Quantitative studies

3.3.1.1 Study Characteristics

A total of 18 studies (Bailey et al., 1998; Blanchette et al., 2017; Carr et al., 1994; Cavanaugh & Schenkman, 1998; Checketts et al., 2021; Demers et al., 2019; Gervais et al., 2014; Houlahan et al., 2023; Lennon, 2001, Lennon et al., 2001; Lennon, 2003; Lyon et al., 2023; Proud et al., 2013; Sackley & Lincoln, 1996; Takahashi et al., 2024; Wilson et al., 2019; Winward et al., 1999; Yoward et al., 2008) contained relevant quantitative data, presented in Table 3-1. Only six (33%) quantitative studies were published in the five years prior to screening (Checketts et al., 2021; Demers et al., 2019; Houlahan et al., 2023; Lyon et al., 2023, Takahashi et al., 2024; Wilson et al., 2019) and eight (44%) were published >10 years prior (Carr et al., 1994; Cavanagh & Schenkman, 1998; Lennon, 2001, Lennon et al., 2001; Lennon, 2003; Sackley & Lincoln, 1996; Winward et al., 1999; Yoward et al., 2008). Studies were conducted in the United Kingdom (Lennon, 2003; Lennon, 2001, Lennon et al., 2001; Sackley & Lincoln, 1996), Canada (Gervais, 2014; Yoward, 2008; Wilson, 2019), Canada and India (Blanchette et al., 2017), Australia (Carr et al., 1994; Houlahan et al., 2023), Japan (Takahashi et al., 2024) and the United States of America (Cavanaugh & Schenkman, 1998). One study included participants worldwide (Checketts et al., 2021). Fourteen of the 18 quantitative studies used a cross-sectional survey design (Bailey et al., 1998; Blanchette et al., 2017, Carr et al., 1994; Checketts et al., 2021; Demers et al., 2019; Houlahan et al., 2023; Lennon, 2003; Lennon, 2001; Lyon et al., 2023; Sackley & Lincoln, 1996; Yoward et al. 2008; Wilson et al., 2019; Winward et al., 1999), three studies used a case study design (Lennon et al., 2001; Cavanaugh & Schenkman, 1998: Houlahan et al., 2023), and Gervais et al. (2014) used a retrospective chart audit.

Study aims were variable with seven studies exploring assessment and treatment considerations related to hemineglect (n=2) (Bailey et al., 1998; Checketts et al., 2021), upper limb (n=1) (Proud et al., 2013), gait (n=3) (Lennon, 2001; Takahashi et al., 2004; Wilson et al., 2019), spasticity (n=1) (Blanchette et al., 2017) and somatosensation (n=1) (Winward et al., 1999). Four studies explored the use of standardised measures (Demers et al., 2019; Gervais et al., 2014; Lyon et al., 2023; Yoward et al., 2008), and three studies explored the influences of assessment on treatment choice and decision making (Carr et al., 1994; Cavanagh & Schenkman, 1998; Sackley & Lincoln, 1996). Two studies aimed to develop an expert consensus related to beliefs underpinning physiotherapy assessment practice (Lennon et al., 2001; Lennon, 2003) and integration of goal setting and assessment tools (Houlahan et al., 2023).

Participant sample size ranged from no identified physiotherapy participants in a retrospective chart audit by Gervais et al. (2014) to 1022 (Lennon, 2003). Two study reported age of participants, with 89% of participants aged between 30 and 59 (Wilson et al., 2019; Gervais et al., 2014), and mean age 32.6 (SD 9.19). Gender, reported in five studies only, was mainly female (Blanchette et al., 2017; Demers et al., 2019; Lyon et al., 2023; Houlahan et al., 2023; Wilson et

al., 2019). The clinical practice area was the area of physiotherapy in which the physiotherapists mainly practiced, was described as neurology for all studies.

Years of clinical experience was reported in nine studies (Bailey et al., 1998; Carr et al., 1994; Checketts et al., 2021; Lennon et al., 2001; Lennon, 2001; Lennon, 2003; Wilson et al., 2019; Winward et al., 1999; Yoward et al., 2008) and ranged from seven (Winward et al., 1999) to 16 years (Proud et al., 2013 and Winward et al., 1999). Clinical experience in neurology was described by five studies (Blanchette et al., 2017; Carr et al.,1994; Demers., 2017; Lennon, 2001; Lennon et al., 2001) ranging from less than one year (Lennon et al., 2001) to greater than ten years (Lennon et al., 2001).

The clinical work setting was mixed in eleven studies (Bailey 1998; Blanchette et al., 2017; Carr et al., 1994; Checketts et al., 2021; Demers et al., 2017; Lennon et al., 2001; Lennon, 2003; Lyon et al., 2023; Proud et al., 2013; Sackley & Lincoln, 1996, Wilson et al., 2019). One study included mostly rehabilitation settings (Carr et al.,1994). Five studies were conducted in single settings, i.e. in inpatient (Gervais et al., 2014; Cavanaugh & Schenkman, 1998; Houlahan et al., 203; Takahashi et al., 2024), and outpatient (Lennon, 2001) units. See Table 3-1 for further details.

Clinical populations included stroke (n=10), (Bailey et al., 1998; Carr et al., 1994; Cavanagh & Schenkman, 1998; Checketts et al., 2021; Lennon, 2001; Lennon et al., 2001; Lennon, 2003; Sackley & Lincoln, 1996; Takahashi et al., 2024 and Winward et al., 1999), neurological conditions in general (n=4) (Blanchette et al., 2017; Demers et al., 2019; Gervais et al., 2014; Yoward et al., 2008), Parkinson’s Disease (n=1) (Proud et al., 2013), Guillain Barre syndrome (Houlahan et al., 2023) (n=1) and Acquired Brain Injury (n=2) (Wilson et al., 2019; Lyon et al., 2023).

Table 3-1 Study characteristics and quality of included quantitative studies (*n*=18) (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
1. Bailey et al., 1998 United Kingdom	To enhance research into assessment and treatment of hemineglect, and to increase knowledge about current practice in stroke	Survey	Stroke Outpatients - 18% Private practice - 2% Elderly care and General medical wards - 32% Specialist units - 25% Community - 23%	Physiotherapists (*n* =167) Years since qualifications: at least 6 years, 84% > 17 years	BIT, copy picture or draw figure, simultaneous extinction tests	No data	15% of physiotherapy respondents reported testing for neglect. 98% identified neglect as part of routine assessment, 40% by observation and 60% by observation and specific tests	Medium
2. Blanchette et al., 2017 Canada	Increase knowledge about current trends in spasticity management and treatment	Survey	General neurological Outpatients - 15.7% General wards - 10.3% Acute wards - 17.2% Extended care - 2.5% Rehabilitation - 53.4% Community - 10.3% Home care – 11.3%.	Physiotherapists (*n* = 204) Gender: Female (*n* = 88) Male (*n* = 16) Level of education: Diploma (*n* = 6) Bachelor (*n* = 146) Master (*n* = 49) PhD (*n* = 3) Neurological experience: < 1 year (*n* = 5, 2.5%) 1-3 years (*n* = 26, 12.7%) 4-10 years (*n* = 52, 25.5%) > 10 years (*n* = 121, 59.3%)	Clonus, Motor Assessment Scale, deep tendon reflexes functional scales, Original Ashworth Scale, Modified Ashworth Scale, rapid passive movements	83.3% of Occupational therapists and Physiotherapists believed spasticity should be assessed on admission to rehabilitation, with reassessment at an interim time, discharge, and follow up	83% performed spasticity assessment on admission with lower reassessment percentage	High

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
3. Carr et al., 1994 Australia	Investigate factors what influences treatment choice, theoretical basis for treatment choices	Survey	Stroke Rehabilitation (89%) Acute wards (77%) Nursing homes (36%) Other (28%)	Physiotherapists (*n* = 208) Level of education: Additional education post-qualifying (71%) Neurological experience (8 ±- 6.0 years)	Abnormal postural reactions, Action Research Arm Test, Functional Independence Measure, quantified motor performance, motor control, Motor Assessment Scale, tone	No data	Respondents had difficulty explaining the underlying theoretical basis for their treatment choices	High
4. Cavanaugh & Schenkman 1996 United States of America	Describe the decision-making process of a physiotherapist working with a stroke patient	Case report	Stroke Inpatient rehabilitation (100%)	Physiotherapists (*n* =1) No other data	Activity tolerance, bed mobility, behaviour, Berg Balance Scale, cognition, falls risk, Fugel Meyer, sensorimotor evaluation, divided attention, extinction, gait, goal identification, item cancellation, line bisection, Mini Mental State Exam, mood, multi-tasking, pain, postural control, range of movement, rolling, reaching, sitting balance, standing, transfers, Timed Up and Go Test, timed sitting and standing, trunk weakness, visual attention, 6 Minute Walk Test	Admission and discharge	The case illustrated how a physiotherapist uses models and frameworks to organise information and the value of analysing assessment findings that explore functional limitations, assisting in setting goals and prioritize treatment	High

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
5. Checketts et al., 2021 Worldwide	To determine which neglect tests are used, by which stroke clinicians, in which countries, and whether choice is by professional autonomy or institutional policy	Survey	Stroke Inpatients (74.5%) Outpatient (23.6%) Community (16.3%)	Physiotherapists (*n* = 55) Years since qualifications: 3 months - 34 years	Assessment of neglect	No data	For the assessment of neglect, cognitive tests were used for 82% of respondents, 80% used functional tests, and 20% used neuroimaging or neuromodulation Respondents agreed a combined approach is needed for screening and further training	High
6. Demers et al., 2018 Canada and India	Identify and compare the use of standardised outcome measures and factors that influence this	Survey	General neurological Outpatients (32%) General hospital (20%) Acute ward (20%) Extended care (6%) Rehabilitation (52%) Community (11%) Home care (20%) Other (8%)	Physiotherapists (*n* = 317) Gender: Female (*n* = 259) Male (*n* = 58) Level of education: Bachelor (*n* =183) Master (*n* = 123) PhD (*n* =11) Neurological experience < 3 years (*n* = 93) 4-10 years (*n* = 80) > 10 years (*n* =144)	No data	No data	10.8% of Canadians reported never using standardised outcome measures, compared with 3.3% of Indians	High

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
7. Gervais et al., 2014 Canada	Identify physiotherapy assessment tools in the assessment of balance in inpatient population	Retrospective chart review	Stroke and other (complex musculoskeletal, amputee, deconditioning after acute illness, cardiac surgery) Inpatients (100%)	No data	Activity tolerance, active range of movement, balance, orientation in space, individual sensory input, static stability control of dynamics, anticipatory movement strategies, reactive movement strategies, cognitive processing, Berg Balance Scale, Chedoke-McMaster Stroke Assessment Scale, co-ordination, gait, distance walked, internal perturbations, external perturbations, pain and temperature, postural alignment, proprioception, passive range of movement, light touch, stairs, strength, swelling, transfers, Timed Up and Go Test, vision, 2 Minute Walk Test, 6 Minute Walk Test	No data	There is variation in the assessment of balance	High

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
8. Houlahan et al., 2023 Australia	To explore the contemporary practice on the part of occupational therapists and physiotherapists, including how they integrate goal-setting tools, assessment tools, and interventions for people with Guillian Barre Sundrome during their hospitalization.	Survey	Guillain Barre Syndrome Inpatient	Physiotherapists (*n*=30, 41.7%). Gender: Female (*n*=26) Male (*n*=4)	Interview, goal setting, functional independence measure, strength assessment, upper limb, range of movement, sensation, muscle power, observation of function	-	A wide range of assessment and goal setting tools are used, the difference reflects individualised treatment approaches and lack of evidence-based practice protocols.	High
9. Lennon et al., 2001 United Kingdom	Provide expert consensus related to theoretical beliefs underpinning current Bobath practice	Survey	Stroke Stroke units (10-15%) More than one setting (15–17%)	Physiotherapists (*n* = 8) Years since qualifications: 7-13 years Neurological experience: 5-15 years (mean=9.4 years)	Bartel Index, outcome measures, self-devised outcome measures	No data	Bobath therapists believed normal tone was essential and use normal movement patterns to perform functional tasks If tasks affected tone adversely some tasks were delayed There was use of walking aids and orthotics	Medium

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
10. Lennon, 2001 United Kingdom	To describe the use of outcome measures to document recovery of movement within the gait cycle and walking ability an describe treatment process used by the physiotherapists to educate gait	Case description	Stroke Outpatients (100%)	Physiotherapists (*n* = 2) Years since qualifications: > 10 years Neurological experience: > 6 years	Communication ability, correct alignment, and block atypical movements, collaborative functional goals, current functional level, gait, pre-morbid functional level, goals, hearing, information gathering re: history, light touch, medical history, mental status, muscle tone, neglect, outcome measures, passive or active assisted movement, postural tone, problem list, proprioception in the limbs, social, history, vision	No data	Suggests recovery of more normal movement patterns and functional ability and gives insight into Bobath therapists practice	Medium
11. Lennon, 2003 United Kingdom	Provide expert consensus of the theoretical beliefs underlying physiotherapy practice in stroke rehabilitation	Survey	Stroke Inpatient (14 %) Mixed setting (17%)	Physiotherapists (*n* = 1022) Years since qualifications: > 10 years (58%)	Alignment of key points and the interaction between base of support with gravity in different postural sets, balance, Bartel Index, function, Functional Independence Measure, muscle strength, range of movement, Rivermead Motor Assessment,	31% would review at 6 weeks, 2% reviewed at 6 months	Four theoretical themes were in use in practice: the promotion of normal movement, the control of tone, the promotion of function, and recovery of movement with minimisation of compensations	Medium

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
					selective movement, sensation, self-devised tools, tone			
12. Lyon et al., 2022 United States of America	Explore current practices in use of balance outcome measures and the role of outcome measures in clinical decision making	Survey	Acquired brain injury Inpatient (29.5%) Outpatient (51.5%) Home (5.1%) Mixed (3.5%) Other (2.4%)	Physiotherapists (*n* = 373) Age: 23-67 (mean=32.65, *SD* = 9.19)	18 outcome measures most frequently used: Berg Balance Scale, Dynamic Gait Index, Timed Up and Go	No data	93% used outcome measures in people with acquired brain injury; comfort, equipment availability, and psychometric properties were the most frequent reasons for choosing the outcome measure; clinical decision making was impacted by outcome measure	High
13 Proud et al., 2013 Australia	Explore the upper limb assessment practices of Australian physiotherapists and occupational therapists, including frequency, impairments and activity limitations, and methods and outcome measures used	Survey	Parkinson's disease Inpatient (46%) Outpatient (51%) Residential (11%) Community (7)	Physiotherapists and Occupational therapists Physiotherapists (*n* = 122); Years since qualifications: 10 years (58%) Level of education: no data Neurological experience: no data	Active movement, bradykinesia, Coin Rotation Task, Canadian Occupational Performance measure, Disability Rating Scale, dyskinesia, Goal Attainment Scale, Motor Assessment Scale, muscle length, nine-hole peg test, passive range of movement, Parkinson's Disease questionnaire, Purdue Pegboard Test, sensation, strength, timed functional activities,	No data	54% of respondents regularly assessed the upper limb There was widespread use of non-standardised methods to assess Parkinson's Disease-specific impairments Standardised measures were more frequently used to evaluate activity limitations	Medium

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
					tone and rigidity, tremor, Unified Parkinson's Disease Rating Scale, JHF			
14. Sackley & Lincoln, 1996 United Kingdom	Explore current approaches to treatment and choice of assessment methods	Survey	Stroke Large variety in work settings. Most frequent community and hospital (39.5%)	Physiotherapists (*n* = 91) Gender: Female (*n* = 68) Male (*n* = 23)	Chartered Society of Physiotherapy published tools and local ones; Chedoke-McMaster Stroke Assessment Scale; Lindmark; Motor assessment Scale; Motor Club Assessment; Motricity index; Rivermead Motor Assessment; Rivermead Motricity Index; Sheffield Motor Assessment; Teler Standardised Assessment; timed; balance scores; walking distance	No data	Physiotherapists found it difficult to describe a theoretical basis for their treatment Limited use of standardised assessments	High

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
15. Takahashi et al., 2024 Japan	To describe physiotherapy management focusing on proprioceptive impairments in a person with gait and balance impairments post stroke	Case report	Stroke Inpatients	No data pertaining to the assessing physiotherapist	Assessment based on ICF framework. Domains selected in accordance with the Koninklijk Nederlands Genootschap voor Fysiotherapie (KNGF) guidelines (Royal Dutch Society for Physical Therapy) for stroke and the core set for mobility assessment from the Stroke Recovery and Rehabilitation Roundtable (KNGF, 2014; Van Criekinge et al., 2024). Muscle strength-Motricity Index Selective movement-FMA- 10-meter walk test. Trunk control test Berg Balance Scale Gait assessment and intervention tool (GAIT), Functional Ambulation Category, cognitive and executive function and readiness to resume driving, proprioception testing.	Non-specific	Recovery of proprioceptive impairment aligned with improvements in balance and gait ability as measured by BBS and GAIT scores	Medium

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
16. Wilson et al., 2018 Canada	Describe the current practice patterns of Canadian physiotherapists regarding the assessment and treatment of gait dysfunction	Survey	Moderate to severe acquired brain injury (not including stroke) Inpatient (52%) Outpatients (67%) Community (14%) Residential (5%) Other (3%)	Physiotherapists (*n* = 59) Age: 30-59 years (89.8%) Gender: Female (*n*=36) Male (*n*=23) Years since qualifications: 0.5-5 (*n*=9, 15%) 6-10 (*n*=15, 25%) 11-15 (*n*=7, 12%) 16-20 (*n*=6, 10%) 21-25 (*n*=11, 19%) 26-30 (*n*=7, 12%) 31-35 (*n*=4, 7.5%) Level of education: Diploma (*n*=1, 2%) Bachelor (*n*=27, 46%) Master (*n*=29, 49%) PhD (*n*=2, 3%)	Dynamic balance, functional independence of gait, gait efficiency, gait endurance, gait kinematics, gait speed, goal setting	Admission and discharge	Domains of assessment most frequently included "often or very often" at initial and discharge - visual observation (≥88.2% for adults with mild-moderate and severe ABI) and the Berg Balance Scale (≥76.3% for adults with mild-moderate ABI) Higher level gait training exercises were used more often for adults with mild-moderate than severe Acquired brain injury	High
17. Winward et al., 1999 United Kingdom	Identify perceived clinical relevance of somatosensory testing for health professionals (doctors, occupational therapists, and physiotherapists)	Survey	Stroke No data on setting	Physiotherapists (*n*=95) Gender: Female (85%) Male (15%) Years since qualifications: 7-16 years	Light touch, pain, proprioception, pin prick, pressure, stereognosis, temperature, vibration, two-point discrimination, extinction	93% assess somatosensation on admission, 7% assess weekly, 12% assess monthly, 24% assess pre-discharge	82 physiotherapists (84%) indicated performance of routine somatosensory assessment; most commonly included domains were proprioception and light touch; 88 physiotherapists (90%) believed somatosensory assessment is important in	Medium

Author/year/ country/ study number	Aims/scope	Design and methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
							determining prognosis	
18. Yoward et al., 2008 United Kingdom	To explore the current use of outcome measures of balance, walking, and gait in physiotherapy clinical practice	Survey	General neurological, stroke, multiple sclerosis, brain injury, Parkinson's disease, spinal cord injury, central nervous system tumours No data on setting	Physiotherapists (*n*=269) Years since qualifications: 2-38 years (mean=12.6)	Balance, Elderly Mobility Scale, range of movement, co-ordination, sensory system, postural alignment , Berg Balance Scale, Timed Up and Go, Functional Reach, Motor Assessment Scale, muscle strength, POAM, postural sway, Rivermead Mobility Index, Rivermead Mobility Index incorporating, modified Rivermead Mobility Index, sitting balance, timed standing (incorporating timed unsupported standing/TUSS), Tinetti/modified Tinetti, 6-minute (or other time) walk test, tone, Turn tests combined (180°and 360°), walking, 10-metre (or other distance) walk test	No data	91% percent of respondents (245/269) reported using standardised measure The most commonly used outcome measures were: 10-metre (or other distance) walk test; the Berg Balance Scale; the Get Up and Go/Timed Up and Go Test; and the Functional Reach Test	Medium

**Abbreviations: BIT: Behavioural Inattention Test; POAM: Tinetti Performance Oriented Mobility Assessment. JHF: Jebsen-Taylor Hand Function Test*

3.3.1.2 Study Quality

Details of the quality assessment according to our four critical McMaster criteria (intervention description, sample description, appropriate analysis, and conclusion) are provided in Appendix B. Eight studies were judged medium quality (Bailey et al., 1998; Demers et al., 2019; Lennon, 2003; Lennon et al., 2001; Proud et al., 2013; Takahashi et al., 2024; Winward et al., 1999) and ten studies were judged high quality (Blanchette et al., 2017; Carr et al., 1994; Cavanaugh & Schenkman, 1998; Checketts et al., 2021; Gervais et al., 2014; Houlahan et al., 2024; Sackley & Lincoln, 1996; Wilson et al., 2019; Yoward et al., 2008). The main limitations related to lack of analysis and limited description of the methods.

3.3.1.3 Assessment Domains

The assessment domains identified in the quantitative studies are summarised in Table 3-2. The most frequently assessed domains, described in five or more studies, included function (n=10) (Bailey et al., 1998; Blanchette, 2017; Carr et al 1994; Gervais et al., 2014; Houlahan et al., 2023; Lennon et al., 2001; Lennon, 2003; Proud et al., 2013; Sackley & Lincoln, 1996; Wilson et al., 2019), strength (n=10) (Bailey et al., 1998; Blanchette et al., 2017; Carr et al 1994; Gervais et al., 2014; Houlahan et al., 2023; Lennon, 2003; Proud et al., 2013; Sackley & Lincoln, 1996; Takahashi et al., 2024;Yoward et al., 2008), balance (n=8) (Blanchette et al., 2017; Carr 1994; Gervais et al., 2014; Lennon, 2003; Wilson et al., 2019; Yoward et al., 2008; Cavanaugh & Schenkman, 1998; Takahashi et al., 2024), range of movement (n=7) (Blanchette et al., 2017; Gervais et al., 2014; Cavanaugh & Schenkman, 1998: Houlahan et al., 2023; Lennon, 2001; Proud et al., 2013; Winward et al., 1999; Yoward, 2008), postural alignment and symmetry (n=6) (Carr et al., 1994; Cavanaugh & Schenkman, 1998; Lennon, 2003; Lennon, 2001; Gervais et al., 2014; Yoward et al., 2008), gait (n=7) (Carr et al., 1994; Gervais et al., 2014; Lennon, 2001; Sackley & Lincoln, 1996; Takahashi et al., 2024; Wilson et al.,1999; Yoward et al., 2008), and somatosensation (n=7) (Cavanaugh & Schenkman, 1998; Gervais et al., 2014; Houlahan et al., 2023; Lennon, 2001; Proud et al., 2013; Yoward et al., 2008; Winward et al., 1999).

Table 3-2 Assessment domains included in quantitative studies (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

Study number / Assessment domains	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Function			•	•				•	•	•	•		•	•		•		•	10
Muscle strength and length	•	•	•				•	•		•			•	•	•			•	10
Balance	•	•	•						•	•					•	•		•	8
Somatosensation				•			•	•	•		•					•		•	7
Gait			•				•			•				•	•	•		•	7
Range of movement	•	•					•	•		•		•						•	7
Postural alignment and symmetry			•	•			•			•	•							•	6
Outcome measures non-specific							•		•	•				•					4
Perception	•			•	•												•		4
Diagnostic specific measures							•					•	•			•			4
Upper limb			•					•					•						3
Co-ordination							•											•	2
Quantified motor practice			•	•															2
Tremor/bradykinesia													•						1
Activity tolerance				•															1
Psychological and higher brain function			•																1
Mood			•																1
Selective movement										•									1
Spasticity		•																	1
Pain														•					1
Deep tendon reflexes	•																		1
Goal setting								•											1

Domains that were reported only once included spasticity (Bailey et al.,1998), tremor (Proud et al., 2013), deep tendon reflexes (Bailey et al 1998), pain (Wilson et al., 2019), psychological and higher brain function (Carr et al., 1994), mood (Carr et al., 1994), goal setting (Takahashi et al., 2024), and quantified motor practice (Carr et al., 1994).

3.3.1.4 Standardised measures

The most frequently used standardised measures were related to muscle strength (n=6) (Bailey et al., 1998; Blanchette et al., 2017; Lennon, 2001; Proud et al., 2013; Yoward et al., 2008), function (n=5) (Blanchette et al., 2017; Gervais et al., 2014; Houlahan et al., 2023; Lennon, 2001; Lennon, 2003) balance (n=4) (Carr et al.,1994; Gervais et al., 2014; Houlahan et al., 2023; Yoward et al., 2008), gait (n=4), (Carr et al., 1994; Gervais et al., 2014; Takahashi et al., 2024; Yoward et al., 2008) and diagnostic specific measures (n=3) (Gervais et al., 2014; Lennon, 2003; Yoward et al., 2008).

3.3.2 Qualitative Studies

3.3.2.1 Study Characteristics

Eight qualitative studies, published between 2006 and 2023, were included in this review and their characteristics are summarised in Table 3-3. Studies were conducted in Canada (McGlynn & Cott, 2007; Pattison et al., 2015), Norway (Normann et al., 2014), Australia (Bainbridge et al., 2024; Plummer et al., 2006), United States of America (Seale & Utsey, 2020), Japan (Takahashi et al., 2014) and Saudi Arabia (Alatawi et al., 2022). The aim of all studies related to clinical reasoning or clinical decision making (Alatawi et al., 2022; Bainbridge et al., 2024; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Plummer et al., 2006 Takahashi et al., 2014), with no studies aiming to explore assessment or treatment considerations

Seven studies used interviews, and one study used focus groups to collect data. In addition, one study used observation of physiotherapy assessment and treatment to gather information (Normann et al. 2014).

Participant sample size ranged from ten (Normann et al., 2014) to 33 (Plummer et al., 2006). Age and sex of participants were described in only three studies (Alatawi et al., 2022; Pattison et al., 2015; Takahashi et al., 2014), ranging from 20 to 50 years and over. Fifty percent of participants were female in the study by Takahashi et al. (2014) and the majority (89%) of participants were female in the study by Pattison et al. (2015). Five studies reported years of clinical experience (Alatawi et al., 2022; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Seale & Utsey, 2020), ranging from 1-21 years. The clinical work setting of participants was described in seven studies and included inpatient rehabilitation (Takahashi et al., 2014), outpatients (Normann et al., 2014) and mixed settings (Alatawi et al., 2022; Bainbridge et al., 2024; McGlynn & Cott, 2007).

Clinical populations assessed by participants included stroke (Alatawi et al., 2022; Bainbridge et al., 2024; Plummer et al., 2006; Pattison et al., 2015., Seale & Utsey, 2020; Takahashi et al., 2014), Multiple Sclerosis (Normann et al., 2014), and mixed neurological conditions (McGlynn & Cott, 2007).

Table 3-3 Study characteristics of qualitative studies (*n*=8) (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

Author/year country/ study number	Aims/scope	Design & Methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
1. Alatawi et al., 2022 Saudi Arabia	To integrate the PARIHS framework as a way of categorizing evidence, context, and facilitation elements for effective implementation of evidence based Painful hemiplegic shoulder rehabilitation from a vast dataset of rigorous stroke sources of evidence	Interviews and consensus approach	Stroke Rehabilitation centre	Physiotherapists (*n*=21) Age and gender: no data, Years since qualification: 1-5 years (9.5%) 6-10 years (42.9%) 11-15 years (33.3%) >15 years (14.3%) Level of education: Dip (9.5%) Bsc (66.7%) Msc (19%) PhD (4.8%)	range of movement, pain, sensation, function	No data	Total of 74 recommendations, 63 recommendations reached the consensus level for PHS practice, Secondary prevention of Painful hemiplegic shoulder (*n*=10), assessment (*n*=14), Painful hemiplegic shoulder care management (*n*=19), and service delivery (*n*=20) Each recommended guideline was integrated into the appropriate element of the PARIHS framework	Medium
2. Bainbridge et al., 2024 Australia	To explore the factors influencing decision-making of physiotherapists in this situation.	Semi structured interviews	Stroke Mixed clinical setting	Physiotherapists (n=15) Year since qualification: 1-20+	Gait, muscle power, sensation, cognitive function, Balance, safety and falls Standardised measures Observation of walking	-	Decision- making about independence of walking is complex, suggestion of more guidance about clinical assessment capacity and determining risk may enable increased shared decision making.	High

Author/year country/ study number	Aims/scope	Design & Methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
3. McGlynn & Cott, 2007 Canada	Explore clinical decision-making process and sources of information or evidence that are used in daily practice	Semi-structured interviews	Stroke Inpatients (66.6%) Outpatients (16.6%) Community (1.6%)	Physiotherapists (*n*=12) Gender: Female (*n*=11) Male (*n*=1) Years since qualifications: mean=13.5 years Level of education, neurological experience: *n*=1-21 years (mean 9 years)	gait, goal setting outcome measures muscle tone, movement restriction subjective, information Timed up and Go Test 2 Minute Walk Test, 6 Minute Walk Test	No data	Preference for informal information sources to guide decision making-sight, touch, discussions with clients, clinical experience, and consultation with peers Formal information including outcome measures for professional development, evidence review, ongoing education and to support decisions	High
4. Normann et al., 2014 Norway	Identify what aspects community physiotherapists perceived as significant when guided by a neurological physiotherapist	Semi-structured interviews	Multiple sclerosis Outpatients (100%)	Physiotherapists (*n*=10) Age: no data Gender: no data Years since qualifications, level of education: no data Neurological experience:2->10 years	alignment, balance, gait	No data	Community physiotherapists identified movement analysis of a familiar patient as significant for professional development, especially the analysis of interaction between different parts of the body and analysis of movement	High

Author/year country/ study number	Aims/scope	Design & Methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
5. Pattison et al., 2015 Canada	Describe the methods used to evaluate walking and the reasons for choosing these methods	Semi-structured interviews	Stroke Inpatients (67.8%) Outpatients (39.3%)	Physiotherapists (*n*=28) Age: 20-29 years (*n*=5) 30-39 years (*n*=9) 40-49 years (*n*=10) 50+ years (*n*=4) Gender: Female (*n*=25) Male (*n*=3) Years since qualifications: > 10 years (*n*=18) ≤ 5 years (*n*=8) 6-9 years (*n*=3) Level of education: Bachelor (*n*=20) Master (*n*=7) Certificate (*n*=1) Neurological experience: no data	information from peers, modified standardised measures, standardised measures, Timed up and Go Test, Chedoke-Mcmaster Stroke Assessment, 2 Minute Walk Test		Physiotherapists used observation of movement and standardised assessment tools Factors that influenced choice of tools were characteristics of tool, the therapists' familiarity with using the tool, the workplace, and patients.	High
6. Plummer et al., 2006 Australia	Identify how physiotherapists assess, record and measure Unilateral neglect (ULN) and the clinical reasoning processes used	Focus groups and one-on-one phone interviews	Stroke No data on clinical setting	Physiotherapists (*n*=33) Age: no data Gender: no data Years since qualifications: no data Level of education: no data Neurological experience: no data	function, attention - sustained and in complex environments, grooming, hand positioning, hygiene, maintenance of midline, pen and paper tests, posture, response of the patient to the therapist, response of the patient to verbal cueing	No data	Physiotherapists use observation of functional tasks to assess for unilateral neglect and do not differentiate between the different types of Unilateral neglect Unilateral neglect is rarely measured Physiotherapists use hypothesis testing and pattern recognition to clinical reason in the assessment of Unilateral neglect	High

Author/year country/ study number	Aims/scope	Design & Methodology	Clinical population and setting	Therapist population demographics	Key assessment domains (list)	Timing of assessment	Key findings	Quality rating
7. Seale & Utsey, 2020 UNITED STATES OF AMERICA	Investigate the current trends in physiotherapist' clinical reasoning in assessing and managing gait in persons with hemiplegia	Semi-structured interviews and focus groups	Stroke Inpatients (100%) Outpatients (4.5%) Home (4.5%) Gait lab (4.5%)	Physiotherapists (*n*=22) Age: mean=46 years Gender: Female (*n*=19) Male (*n*=3) Years since qualifications: mean=7 years Level of education: Diploma (*n*=10) Master (*n*=4) Baccalaureate (*n*=1) Neurological experience: <2 years (*n*=7)	gait, tone, standardised measures	No data	Novice and experienced clinicians take systematic approach to the examination of a person with a hemiplegia, they agree on common deficits found	High
8. Takahashi et al., 2014 Japan	Determine the physiotherapy focus when deciding on level of independence of a patient with walking aids and the reasoning process	Semi structured interviews	Stroke Inpatients-(100%)	Physiotherapists (*n*=15) Age: mean=32.5± 4.5 years Gender: Female (*n*=5) Male (*n*=10) Years since qualifications: mean=8.0±3.2 years Level of education: no data Neurological experience: no data	Brunstruum stage, cognitive ability, mental stability, daytime drowsiness, direction changes, falls, functional analysis, gait, understanding and responding to the environment, light-headedness, pain, stability, shortness of breath, standing, stepping, walking aids, walking to a target		Walking independence was decided by observation of behaviour during walking or treatment. Most of the physiotherapist4s focused on the "patients' state" whilst walking, brain function, ability to balance Additionally, asking other involved healthcare professionals	Medium

3.3.2.2 Study Quality

Details of the quality assessment are provided in Appendix C. Six of the studies were rated high quality (Bainbridge et al., 2024; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Plummer et al., 2006; Seale & Utsey, 2020) and two were considered medium quality (Alatawi et al., 2022; Takahashi et al., 2014). Limitations related to theoretical connections and procedural rigour.

3.3.2.3 Assessment Domains

The assessment domains identified from the qualitative studies are presented in Table 3-4. The domains described in at least three of the eight studies included: postural alignment and symmetry (McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Plummer et al., 2006; Takahashi et al., 2014), gait (Bainbridge et al., 2024; McGlynn & Cott, 2007; Pattison et al., 2015; Normann et al., 2014; Seal & Utsey, 2020), and function (Bainbridge et al., 2024; Plummer et al., 2006; McGlynn & Cott, 2007; Seale & Utsey, 2020).The domains of activity tolerance (Takahashi et al., 2014), and goal setting (McGlynn & Cott, 2007) were reported only once.

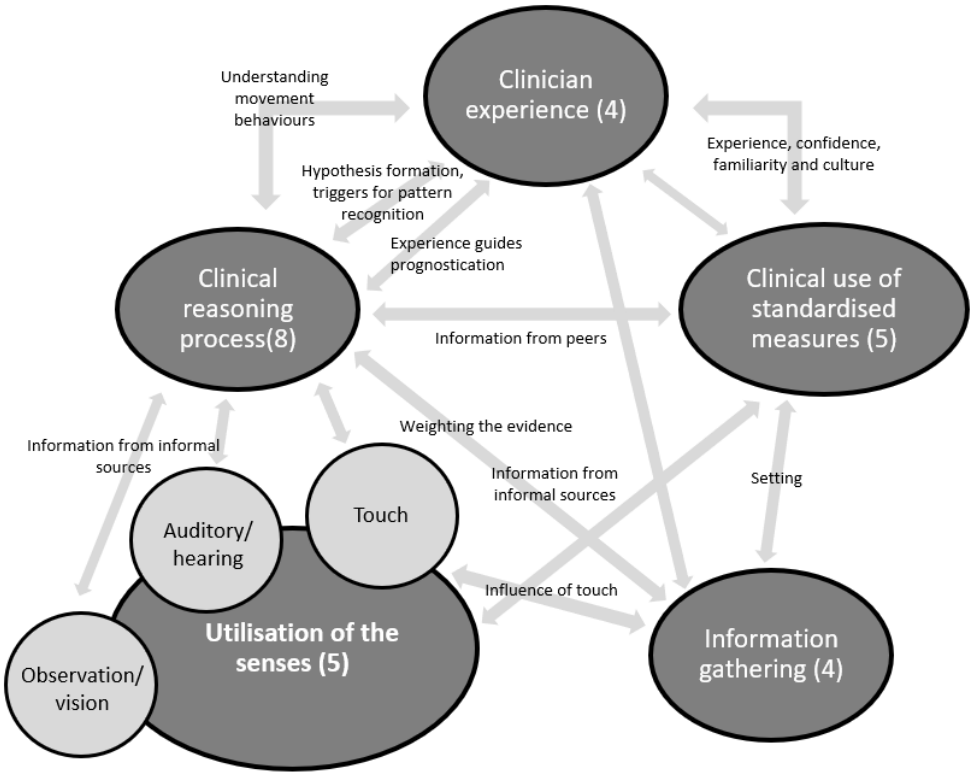
Table 3-4 Assessment domains included in qualitative studies (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

Study number / Assessment domains	1	2	3	4	5	6	7	8	Total
Gait		•	•	•	•		•	•	6
Postural alignment and symmetry			•	•	•	•		•	5
Function		•	•		•	•		•	5
Balance		•		•					2
Outcome measures		•	•		•		•		4
Falls and safety		•						•	2
Initial information gathering		•	•						2
Pain	•							•	2
Somatosensation	•	•							2
Muscle tone			•				•		2
Diagnostic specific measures					•			•	2
Cognition		•						•	2
Range of movement	•		•						2
Activity tolerance								•	1
Goal setting			•						1

3.3.3 Key themes identified in relation to physiotherapy assessment of people with neurological conditions

Thematic analysis of the qualitative studies identified five key themes related to physiotherapy assessment of people with neurological conditions. These included clinical reasoning process, clinical use of standardised measures, utilisation of the senses, clinician experience and information gathering. A thematic schema (see Figure 3-3) was developed, based on the approach by Farrance et al. (2016). The authors utilised a thematic schema to illustrate the conceptual interactions between the themes generated from qualitative synthesis in the results section of their study. This schema and shows how the themes and associated concepts interact. Note, themes are presented in circles and concepts along arrow lines.

Figure 3-3 Impact of contributory factors on key themes (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).



**Note numbers in brackets correspond to the number of studies.*

3.3.3.1 Clinical Reasoning process

All eight studies (Alatawi et al., 2022; Bainbridge et al., 2024; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Plummer et al., 2006; Seale & Utsey, 2020; Takahashi et al., 2014) considered the clinical reasoning process, including the concepts of hypothesis formation, trigger for pattern recognition, experience guiding prognostication, and understanding movement behaviours.

One study found that experienced physiotherapists often used a ‘form of pattern recognition’ approach when making clinical decisions during the assessment process, assessing for deficits such as neglect, without relying on a specific assessment tool (Plummer et al., 2006). They used their experience to guide prognostication, supported by an in depth understanding of movement behaviours. These concepts, under the overarching theme of clinical reasoning, were noted as important foundations for the assessment and planning of treatment.

3.3.3.2 Clinical use of standardised measures

Five studies (Bainbridge et al., 2024; Normann et al., 2014; Pattison et al., 2015; McGlynn & Cott, 2007; Seale & Utsey, 2020) mentioned the clinical use of standardised measures. Concepts of familiarity, suitability and confidence were believed to influence the use of standardised outcome measures in clinical practice (McGlynn & Cott, 2007; Pattison et al., 2015). Therapists were not comfortable using standardised measures with which they were not thoroughly familiar and / or trained. Their choice of standardised measures was primarily based on how suitable the measure was for a patient. They also considered factors such as time and prognostic value when deciding which measure to use (Pattison et al., 2015).

> The time to complete an assessment influenced the adoption of a measure across all care settings. For example, the 2MWT (Two-minute Walk test) was used instead of the 6MWT (Six-minute Walk test) because of the shorter testing time. The CMSA (Chedoke-McMaster Stroke Assessment) was noted as taking a long time to administer. Finally, physical therapists were more likely to use a measure if they perceived the test to be informative about multiple physical functions and provide prognostic value (Pattison et a., 2015)

3.3.3.3 Information gathering

Four studies referred to information gathering during assessment (Alatawi et al., 2022; Plummer et al., 2006; McGlynn & Cott, 2007; Pattison et al., 2015) describing it as a continuous process throughout management. Physiotherapists reported using information to continually generate and test hypotheses (McGlynn & Cott, 2007). The amount of information received, time taken, and source of information gathering was suggested to be dependent on the clinical setting, with some physiotherapists in the acute setting generating a hypothesis after reading medical records or referral letters. Information gathering from peers was valued especially if provided therapy was not effective (McGlynn & Cott, 2007).

> Although some of the participants described a systematic method for collecting clinical data from the patient, it was clear that the physiotherapists interpreted the assessment findings continuously, generating and testing hypotheses and modifying the assessment accordingly (McGlynn & Cott, 2007)

3.3.3.4 Utilisation of the senses in assessment

Clinicians use their senses to guide their assessment and adjust and tailor their responses and interactions with patients. Five out of eight studies (Alatawi, et al., 2022; Bainbridge et al., 2024; McGlynn & Cott, 2007; Normann et al., 2014; Seale & Utsey, 2020) referred to utilisation of the senses. Physiotherapists described the use of more than one sense at a time, such as observation and ‘hands on’ when assessing people with neurological conditions and expressed the importance of knowing when and when not to use touch during assessment.

3.3.3.5 Clinician experience

In four out of eight studies (McGlynn & Cott, 2007; Normann et al., 2014; Plummer et al., 2006; Seale & Utsey, 2020) physiotherapists talked about clinical experience and how this influenced assessment practices. Physiotherapists believed that clinical experience guided prognostication. Those with five or more years of clinical experience particularly valued this, using it to predict patient recovery and inform decision-making (McGlynn & Cott, 2007).

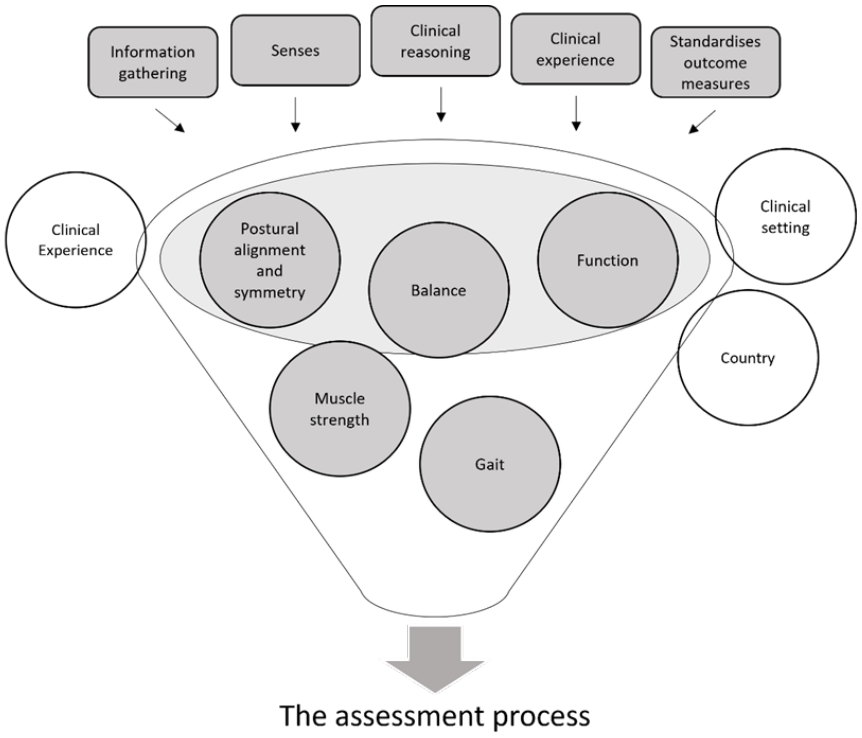
> Participants with 5 years or more of neurological physiotherapy work experience mentioned their clinical experience as an important source of information guiding their practice (McGlynn & Cott, 2007)

The authors reported that prior experience influenced how judgements were made regarding anticipated outcomes (McGlynn & Cott, 2007).

3.3.4 Integration of quantitative and qualitative studies in context of the research aim

The key findings across all 26 studies were integrated, noting that the frequently assessed domains in neurological assessment included gait, balance, muscle strength, postural alignment and symmetry, and function. See Figure 3-4. The findings suggest that the type of information gathered contributes to the clinical reasoning process and clinician experience and utilisation of the senses may play a role in the choice and interpretation of assessment. However, the role of factors thought to influence the selection of assessment domains, including country, clinical experience, healthcare setting, and type of neurological condition remains unclear. Novice clinicians use standardised measures to assist with prognostication. All but one of the studies focusing on stroke (Checketts et al., 2021) referred to the domains of muscle strength and range of movement, inferring that this was essential when assessing people with this condition.

Figure 3-4 Integration of qualitative and quantitative data (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).



This figure depicts the frequently assessed domains (postural alignment and symmetry, balance, function, muscle strength and gait), key themes related to assessment as identified in the literature (clinical reasoning process, information gathering, utilisation of the senses, clinical use of standardised measures, and clinical experience), and how this comes together in the assessment process. The figure illustrates the contributory factors which influenced the assessment process that remain unclear (geographical and clinical setting, clinical condition, and clinical experience).

3.4 Discussion

The primary aim of this systematic review was to systematically identify the domains that physiotherapists assess in individuals with neurological conditions in a clinical setting. This review identified the five most frequently included assessment domains in the physiotherapy assessment of people with neurological conditions in the clinical setting: function, postural alignment and symmetry, gait, balance, and muscle strength. Minimal data were provided on factors thought to influence the inclusion of assessment domains such as country, clinical experience, healthcare setting, and type of neurological condition. Clinical experience has been found to influence the use of standardised measures.

Expert textbooks are used as a reference for physiotherapy practice and to inform physiotherapy students about assessment. Expert textbooks recommend a varied set of domains, including cognition, mental state, motivation, coping, memory, vision awareness, awareness of self- movement, quality of life, attention, orientation, appropriate interaction communication, understanding blood pressure, and activities of daily living. This review identified only a limited number of domains commonly assessed in clinical practice, in contrast to the multiple domains recommended in expert theoretical textbooks (Garner & Lennon, 2018; Porter, 2013). A potential explanation for this may be that some of these domains are viewed as remits of other health professionals (Tyson et al., 2008) or may be specific to each patient presentation; therefore, the number of domains may vary depending on the individual case (Porter, 2013). Further work is needed to identify how appropriate it would be to include these five domains in clinical practice.

The clinical reasoning process is the sum of thinking and decision-making processes associated with clinical practice (Higgs et al., 2019). It has been defined as “a process in which the therapist, interacting with significant others (e.g., family and other health-care team members), structures meaning, goals and health management strategies based on clinical data, patient choices, and professional judgement and knowledge” (Carr et al., 1994). The International Professional Body for Physiotherapy WPT (2011) recommends that treatment should be based on a comprehensive assessment involving a clinical reasoning process of 1. Information gathering (subjective, objective); 2. Interpretation (hypothesis formation from a problem list linked to collaborative goal setting); 3. Treatment planning, and 4. Evaluation/review (use of standardised measures; goal achievement). Nineteen of the 23 included studies referred to clinical reasoning processes (Bailey et al., 1998; Blanchette et al., 2014; Carr et al., 1994; Cavanaugh & Schenkman, 1998; Checketts et al., 2021; Demers et al., 2019; Gervais et al., 2014; Lennon et al., 2001; McGlynn & Cott, 2007; Normann, et al., 2014; Pattison et al., 2015; Plummer et al., Proud et al, 2013; 2006; Seale & Utsey, 2019 Sackley & Lincoln, 1996; Wilson et al., 2019; Winward et al., 1999), but not all studies reported on the four key components described by the WPT. Only four studies (Bailey et al., 1998; Cavanaugh & Schenkman, 1996; Lennon, 2001) discussed all four components. Most studies included information gathering, and only eight studies discussed this interpretation. References to treatment planning were noted in more than half of the included studies. Evaluation and review were described by twelve studies. Evaluation and review were mainly discussed in relation to the use of standardised outcome measures. The use of standardised measures has been recommended for monitoring changes in the patient’s health status over time (Moore et al., 2018; Tyson et al., 2008; Lennon et al., 2024). More than half of the studies included in this review reported using them (n=13) (Blanchette et al., 2017; Carr et al., 1994; Cavanaugh & Schenkman, 1998; Gervais et al., 2014; Lennon et al., 2001; Lennon, 2003; McGlynn & Cott, 2007; Pattison et al., 2015; Proud et al., 2013; Sackley & Lincoln, 1996; Yoward et al., 2008).

Only two studies looked at goal achievement (McGlynn & Cot, 2007; Cavanaugh & Schenkman, 1998).

Lexell and Brogardh (2015) recommend that therapists interpret the results of an assessment based on the ICF rehabilitation framework (WHO, 2001). The ICF-based framework enables physiotherapists to understand and manage their patients holistically. The therapist generates a hypothesis of how impairments impact movement dysfunction, function (activity), and participation to come up with a movement diagnosis (Lexell & Brogardh, 2015). None of the reviewed studies directly referred to the WHO ICF framework. However, some domains identified in this systematic review have incorporated ICF concepts. Examples are 'impairments, activity and participation' which can be linked to the frequently included domain of 'postural alignment and symmetry', and activity that can be linked to function, balance, and gait. No studies in this review discussed the environmental factors that affect patient progress or recovery as described in the ICF framework\. This concurs with the review by Allet et al. (2008) who concluded that the WHO ICF framework has not been integrated into physiotherapy clinical practice.

The neurological condition being assessed may influence the domains assessed in the clinical setting. The Australian Stroke Guidelines (Stroke Foundation, 2023) direct the healthcare professional to assess in a specific way and focus on rehabilitation needs, suggesting that following the guidelines will influence the included assessment domains. However, in this review, studies that explored assessment in people with stroke had no common domains that set them apart from other studies. A single study of people with Parkinson's disease was the only study to include bradykinesia, tone, and dyskinesia (Proud et al., 2013). Five studies explored the clinical assessment in general neurological conditions (Gervais et al., 2014; Yoward et al., 2008; Blanchette et al., 2014; Demers et al., 2019; McGlynn & Cott, 2007). All these studies included the domains of muscle strength and range of movement. This is important as many neurological conditions can present with reduction in muscle strength and loss of joint range over time. Physiotherapists working clinically may expect to see changes in these domains overtime and have the skills to help modify them.

Clinical experience can be defined as the time spent practising clinically after qualification. Clinical experience has been reported by 14 studies (Bailey et al., 1998; Carr et al., 1994; Checketts et al., 2021; Lennon et al., 2001; Lennon, 2001; Lennon, 2003; McGlynn & Cott, 2007; Normann et al., 2007; Plummer et al., 2006; Seale & Utsey, 2020; Wilson et al., 2019; Winward et al., 1999; Yoward et al., 2008). There is little evidence to support how clinical practice may or may not change related to experience, but some evidence supports changes in practice with increasing expertise (Little & Davenport, 2012). Clinical experience is influenced by the knowledge and requirements of the organisation (Noll et al., 2001 in Vaughan-Graham, 2017).

Expert clinicians are defined by “their ability to combine knowledge with experience, to know what is important, and recognize and appreciate the significance of critical cues” (Lennon et al., 2001). In our thematic schema (see Figure 3-3) the theme of ‘clinician experience’ was linked to clinical reasoning with formation of hypotheses and pattern recognition. As clinical experience develops, there is an increasing understanding of movement behaviours (Lennon et al., 2001). Clinician experience was linked to the use of standardised measures in this review. The use of measures is dependent on confidence and familiarity with their use (Garner & Lennon, 2018; Lennon, 2001). The most frequently used standardised measures were timed walking measures (n=6) (Lennon et al., 2001; Lennon, 2001; Sackley & Lincoln, 1996, Yoward et al., 2008; Wilson et al., 2019) and Motor Assessment Scale (n=5) (Blanchette et al., 2017; Carr et al., 1994; Lennon, 2003; Proud et al., 2013; Sackley & Lincoln, 1996). Clinician experience was linked to the theme of ‘information gathering’, suggesting that experienced clinicians were used as a resource for information gathering by less experienced clinicians.

The methods of assessment were described by 12 studies (Alatawi et al., 2022; Bailey et al., 1998; Carr et al., 1994; Cavanaugh & Schenkman, 1998; Gervais et al., 2014; Lennon, 2001, Lennon et al., 2001; McGlynn & Cott, 2007; Normann et al., 2014; Sackley & Lincoln, 1996; Seale & Utsey, 2020; Yoward et al., 2008).The use of touch, including terms such as ‘hands on and hands off’, was described in two studies (McGlynn & Cott, 2007; Normann et al., 2014), suggesting the use of touch as a method of assessment. Observation was described in all qualitative studies and seven quantitative studies. Observation skills was needed for movement analysis which is the ‘systematic study of movement produced during human action using skilled observational assessment’ (Wallace et al., 2024). Movement analysis, as an assessment method is a core component of physiotherapy clinical practice (Vaughan- Graham, 2017; Bassile & Lennon 2024). Twelve studies in our review including some of the above domains related to more common aspects of movement analysis.

These skills are used in neurological assessment to assess walking, sit to stand, bed mobility, reaching and grasping, posture, and balance (Wallace et al., 2024). With the increased use of telerehabilitation as a method for delivering care to people in their homes with neurological conditions (Knepley et al., 2021), physiotherapists assessing and treating patients with these conditions, such as stroke; may need to the enhance observation-based analysis necessary for tele- therapeutic interactions.

The strength of this review is that it is the first systematic review, to our knowledge, to identify the domains that are frequently included in physiotherapy assessment of people with neurological conditions in the clinical setting, taking an inclusive approach including all study designs.

3.5 Conclusion

Only limited guidance has emerged from this review regarding frequently assessed domains that are included in the assessment of people with neurological conditions in clinical practice. The appropriateness of these five most frequently assessed domains, and the need to include more domains, requires exploration in future work. This limited number of domains is in stark contrast to the full neurological physiotherapy assessment recommended by expert textbooks. This review demonstrates that the physiotherapy profession has yet to reach a consensus on the frequently assessed components that underpin neurological assessment. With literature supporting the use of the ICF framework to guide assessment and management in the clinical setting, physiotherapists should look at a more structured approach to assessment in their clinical practice. Further research is needed to explore the assessment of people with neurological conditions in clinical practice.

3.6 Implications

In 2005 Bernhardt and Hill stated, “we only treat what we choose to assess”. Is this still true? As research into best practice continues, do clinicians base their treatment on best practice guidelines (Stroke Foundation, 2023)? Do physiotherapists prioritise what is important to their patient or their organisation, and adjusting their assessment accordingly (Levack et al., 2011)?

What should physiotherapists assess in people with neurological conditions? There was some agreement across studies on the most commonly used assessment domains, including function, postural alignment and symmetry, gait, muscle strength and balance. In the ten studies that explored clinical reasoning, there were two methods of information gathering that informed clinical decision making, these were: the use of standardised measures as well as using the senses, specifically touch and observation. The inclusion of these methods could be considered when teaching physiotherapy students about assessment and clinical reasoning of people with neurological conditions?

How can we teach students the assessment process in an evidence-based practice way (Sackett, 1997)? There is little evidence on what physiotherapists assess in practice, in different settings, in different states both within Australia and around the world. This lack of information makes it difficult to develop a decision tree to guide assessment priorities in various contexts.

Further research is needed to explore which assessment domains are included in clinical practice, and when and why assessment occurs. The findings from this review informed a survey of clinical practice in Australia, presented in the next chapter.

CHAPTER 4 PHYSIOTHERAPY ASSESSMENT OF PEOPLE WITH NEUROLOGICAL CONDITIONS IN AUSTRALIA: A NATIONAL SURVEY OF CLINICAL PRACTICE

Chapter 3 identified some emerging guidance from the literature on the domains included in the physiotherapy assessment of people with neurological conditions, but it also highlighted the need for further research into physiotherapy assessment in clinical practice, and potentially influencing factors. To explore this further within the Australian context a national survey was conducted amongst physiotherapists working with people with neurological conditions.

An amended version of this Chapter was published in Health Science Reports in 2024.

Garner, J., Lange, B., Lennon, S., & van den Berg, M. (2024). Physiotherapy assessment of people with neurological conditions in Australia: A national survey. *Health Science Reports*, *7*(6), e2117.

Statement of co-authorship: all authors were involved in the conceptualisation and design of the review. JG drafted the initial version of the survey, and it was edited by all authors until a final version was established. JG and MB performed the data analysis and JG drafted the first version of the manuscript. All authors contributed to the final version of manuscript. A signed co-authorship approval form was submitted with this Thesis. No conflict of interest was reported by the authors and the work was unfunded. This work has been presented as a poster at The World Conference in Neurological Rehabilitation, Vancouver, Canada, 2024.

4.1 Introduction

Neurological conditions may result in a variety of impairments that can result in participation restrictions and activity limitations that require rehabilitation. Physiotherapists are key members of the team involved in the evaluation and management of people with neurological conditions. However, there is a lack of consensus in the literature as to what domains physiotherapists working in clinical settings include in their assessment of people with neurological conditions.

Traditional models of evaluation or assessment, such as those described by Ashburn (1982), Nilsson & Nordholm (1992) and Lennon (2003) have formed the theoretical basis for physiotherapy assessment in people with neurological conditions. More recently, the theory of assessment has been explored using expert consensus (Tyson et al., 2008), interviews (Kleynen et al., 2017), and observational studies (Lahelle et al., 2020; Tyson & Desouza, 2003). These studies together with expert textbooks (Carr & Shepherd, 2019; Gjelsvik, 2008; Kersten, 2004; Lennon et al., 2023; Porter, 2013) and guidelines for people with specific conditions such as stroke (Joliffe et al., 2018) form the

basis of what is taught to physiotherapists pre-registration. It is suggested that this informs what may be assessed by physiotherapists once qualified.

We hypothesized that assessment in clinical practice may not be undertaken solely based on expert textbooks. What factors influence the assessment? The physiotherapist's preferred treatment approach was identified in a survey of practice by Lennon (2003) to influence the assessment. A study exploring the application of motor learning options in neurological rehabilitation included experienced clinicians (Kleynen et al., 2017). However, how preferred treatment approach and experience may influence assessment practices has not been explored. The systematic review presented in Chapter 3 included 26 studies describing the clinical physiotherapy assessment of people with neurological conditions. The review findings suggested there is a lack of consensus in the literature regarding domains included in the physiotherapy assessment of people with neurological conditions and was unable to draw conclusions on impacting factors. The healthcare setting was reported in 22 studies (Alatawi, 2023; Bailey et al., 1998; Bainbridge et al., 2024; Blanchette et al., 2017; Carr et al., 1994; Cavanaugh & Schenkman, 1998; Checketts et al., 2021; Demers et al., 2019; Houlahan et al., 2023; Lennon, 2001; Lennon, 2003; Lennon et al., 2001; Lyon et al., 2023; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Sackley & Lincoln, 1996; Seale & Utsey, 2020;Takahashi et al., 2014; Takahashi et al., 2024; Wilson et al., 2019; Winward et al., 1999) but as demographic information only and not to attest to the influence on assessment. It was unclear at what timepoints assessments occurred or whether clinical assessments differed across neurological conditions and settings, as only four studies described this (Blanchette et al., 2017; Lennon, 2003; Wilson et al., 2018; Winward et al.,1999).

In summary, there are gaps in the current literature regarding physiotherapy assessment of people with neurological conditions and routinely assessed domains. To contribute to the body of knowledge, this study aimed to survey Australian physiotherapists regarding their current clinical assessment practices with people with neurological conditions. The specific research questions were as follows:

1. What is current physiotherapy clinical practice in the assessment of people with neurological conditions?
2. What domains do physiotherapists include in the assessment of people with neurological conditions?
3. Does the clinical setting, geographical location, and/or clinical experience influence how physiotherapists assess patients with neurological conditions?
4. What outcome measures are used as part of the assessment of people with neurological conditions?
5. What are the barriers and enablers to assessment of people with neurological conditions?

4.2 Methods

4.2.1 Design

A cross-sectional survey was conducted in two phases. The first phase involved the development of an online survey using Qualtrics software (Qualtrics, Provo, Utah, UNITED STATES OF AMERICA) and pilot testing. The second phase involved the administration of a national survey in Australia. This study was approved by the Southern Adelaide Clinical Human Research Ethics Committee (OFR 73.20). We referred to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) (Eysenbach, 2004) to guide the reporting of this survey.

4.2.2 Respondents

The respondents were Australian physiotherapists. The inclusion criteria included being a registered physiotherapist and assessing adults with neurological conditions as part of clinical practice. Physiotherapists who did not assess people with neurological conditions, only treating children, or residing outside Australia were ineligible to participate.

Respondents were recruited using convenience sampling through the website of the Australian Physiotherapy Association (APA). In addition, the survey link was emailed to all the State-wide Chief Allied Health Officers. They were asked to forward the email to physiotherapists working in public hospitals (see appendix D).

The recruitment material contained a link to an online participant information sheet containing information regarding the survey length, data storage, chief investigator (JG), study purpose, and consent. Those who consented to participate in the study were directed to the start of the survey. This was then linked to online consent. Data were collected between August and December 2020, including the initial distribution of the recruitment material and two reminders.

4.2.3 Survey

Prior to widespread online distribution, the survey was pilot tested for clarity, flow, and time to completion. Ten physiotherapists, identified through the find-a -physio function on the APA website representing all states in Australia, completed the pilot survey. Based on feedback, four questions were omitted, in 11 questions the wording was modified, and additional instructions and guidance were provided throughout the survey. Pilot data were excluded from analysis.

The final survey was a voluntary open e-survey consisting of 39 items divided into two sections (see Appendix E). The final survey was distributed through a digital flyer on the APA website. Section one (questions 1-13) gathered demographic information, such as sex, age, years qualified, qualifications

obtained, courses attended, clinical setting, and clinical experience. Section two (questions 14-38) was related to the assessment content and processes. The questions explored neurological case load, resources accessed for assessment, therapeutic approach, core domains included in assessment, assessment completion time, factors influencing assessment, clinical reasoning, documentation, and the use of measures for assessment. The survey consisted of single-answer questions (n=29), multiple-answer questions (n=8), rank questions using Likert scales (n=2) (5 points), and open-ended questions (n=5).

4.2.4 Data analysis

The online platform Qualtrics was used for data collection. Quantitative data were collated and analysed using the Statistical Package for Social Sciences (SPSS) version 27.

Data from the respondents who answered Sections 1 and 2 of the survey were included in the analysis. Descriptive statistics were used to summarize demographic data, and to examine data generated from the questions about the neurological assessment content and processes. Data from Likert scales were treated as continuous data and the means were calculated. To gain insight into the variation of domains assessed with regards to years of clinical experience, geographical location and clinical setting, a one-way analysis of variance (ANOVA) was applied. Statistical significance was set at $p < 0.05$. The responses to open-answer questions and comments were imported into an Excel spreadsheet for qualitative analysis. Using a content analysis approach, text responses were grouped to capture key concepts related to the corresponding question.

4.3 Results

4.3.1 Participant demographics

Unique visitors to the survey were determined using IP addresses, and 395 respondents consented to participate in the survey; 216 answered the first four questions of Section 1 (if working clinically, gender, age, and years qualified) of the 212 respondents who completed every question in the survey. The participation rate was calculated by dividing the number of people who agreed to participate by the number who agreed to provide informed consent (395/395). The completion rate was 53.67%, calculated by dividing the number of participants who submitted the final survey page by those who agreed to participate (212/395). The IP address of the respondent's computer was used to identify potential duplicate entries, and no two entries from the same IP address were allowed within 24 hours. All surveys were analysed, except four surveys that only had questions completed on consent and respondent demographics. Most respondents were female (n=181, 85.4%) and the mean (SD) age was 35.7 (9.6) years. Most respondents trained in Australia (n=179, 84.4%). Respondents were from all states in Australia and worked predominantly in New South Wales (n=76, 35.8%) and Victoria

(n=52, 24.5%). The geographical setting was mainly metropolitan (n=151, 71.2%), with most respondents working in a rehabilitation setting (n=119, 56.1%). Nearly half of the respondents received a bachelor's degree as the highest level of educational qualification (n=94, 44.3%).

Respondents had experience working with neurological patients ranging from less than one year to more than 40 years. About a third (n=15.1, 32.5%) of respondents had attended one neurology course of ≤ 1 day duration in the last two years, and respondents reported to have reviewed relevant resources at least once within the last six months (n=160, 75.5%), including scientific literature, web-based information, and online videos. A minority of respondents (n=34, 16.0%) subscribed to a named therapeutic approach, noting the most frequently used approach being Carr and Shepherd/motor relearning (n=13, 38.2%).

Table 4-1 Respondent characteristics (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

Characteristic		*n* (%)
Gender	Female	181 (85.4)
Age (years)	35.7 (9.6)	
Years qualified (years)	12.8 (9.9)	
Country/region qualification obtained	Australia	179 (84.4)
	United Kingdom	11 (5.2)
	New Zealand	10 (4.7)
	Asia	6 (2.9)
	South Africa	3 (1.4)
	United States of America	1 (0.5)
	Argentina	1 (0.5)
Highest level of education	Diploma	5 (2.5)
	Bachelor	94 (44.3)
	Pre-registration Masters	19 (9)
	Pre-registration PhD*	7 (3.3)
	Master by coursework	9 (4.2)
	PhD	4 (1.9)
	Bachelor with Honours	31 (14.8)
Number of neurology courses (of 1+ day) attended during the last 2 years	0	2 (0.9)
	1	69 (32.5)
	2	52 (24.5)
	3	16 (7.5)
	>3	32 (15.1)
Hours currently working clinically, per week	<7.5	2 (1.0)
	7.5-20	25 (12.9)
	21-37+	162 (83.9)
	Fluctuating caseload	4 (2.0)

Characteristic		*n* (%)
State in which working currently	Australian Capital Territory	2 (1.0)
	New South Wales	76 (35.8)
	Northern Territory	2 (1.0)
	Queensland	25 (11.8)
	South Australia	37 (17.5)
	Tasmania	1 (0.5)
	Victoria	52 (24.5)
	Western Australia	17 (8.0)
Geographical setting in which working currently	Metropolitan	151 (71.2)
	Regional	44 (20.8)
	Rural and remote	17 (8.0)
Primary clinical setting in which working currently	Acute	70 (33)
	Rehabilitation	119 (56.1)
	Outpatient	29 (13.7)
	Community	35 (16.6)
Years of clinical experience with neuro conditions	<1	8 (2.0)
	1-5	82 (20.8)
	6-10	55 (13.9)
	11-15	19 (4.8)
	16-20	20 (5.1)
	>20	27 (6.8)
Last review of resources related to neurological assessment	Within the last 6 months	160 (75.5)
	Within the last 12 months	32 (15.1)
	When studying as a student pre-registration	9 (4.2)
	Other	9 (4.2)
Therapeutic approach	Subscribing to a therapeutic approach (yes)	34 16.0)

*Pre-registration PhD- masters extended DPT

4.3.1.1 Current practice in physiotherapy assessment of people with neurological conditions

Table 4-2 displays frequency of assessment of neurological conditions. A total of 123 (58%) respondents reported assessing the condition of stroke most often. Motor Neuron Disease was the condition least frequently assessed with 38 (17.9%) respondents reporting they never assess this condition.

Table 4-2 Frequency of assessment of neurological conditions (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

Frequency of assessment / Neurological conditions	daily/weekly/often *n* (%)	Sometimes *n* (%)	Rarely/never *n* (%)
Stroke	169 (79.7)	30 (14.2)	9 (4.2)
Multiple Sclerosis	68 (31)	61 (28.8)	22 (10.3)
Parkinson's Disease	107 (50.5)	63 (29.7)	34 (7.1)
Guillain Barre syndrome	126 (59.4)	60 (28.3)	17 (8.1)
Spinal Surgery	66 (31.1)	73 (34.3)	66 (31.1)
Brain Cancer	66 (31.1)	59 (27.8)	123 (58.0)
Traumatic Brain Injury	73 (34.5)	74 (34.9)	63 (29.7)
Spinal cord Injury	40 (18.8)	62 (29.2)	106 (50)
Motor Neuron Disease/ALS	24 (11.3)	60 (28.3)	119 (56.1)
Cerebral Palsy	28 (13.2)	41 (19.3)	135 (63.7)
Other upper motor neuron conditions	37 (17.5)	69 (32.5)	98 (46.3)
Other lower motor neuron conditions	104 (49.1)	75 (35.4)	25 (11.8)

Respondents reported the timing of assessment, with most taking approximately one hour to perform an assessment (53.3%), which occurred mostly on admission (55.7%). Additional data through free-text responses noted that assessment may occur throughout multiple therapy sessions and may vary depending on thoroughness, the condition itself, the complexity of the condition, goals, and the clinical setting.

The elements of the assessment process were identified as evaluation of subjective and objective findings, hypothesis formation, use of standardised measures, goal setting, patient's problem list, the treatment plan, and clinical pattern recognition. Respondents when asked what elements of assessment were used to inform their clinical reasoning, they reported multiple elements, with 156 (73.6%) of respondents reporting they used all elements. See Table 4-3 for further details of assessment performance.

Table 4-3 Assessment performance

Feature of assessment		*n* (%)
Time taken to perform an assessment (in minutes)	≤ 60	108 (50.9)
	≤ 30	64 (30.2)
	≤ 15	18 (8.5)
	Other	22 (10.4)
Time point of assessment	On admission	180 (89.6)
	On discharge	118 (55.7)
	At set time points	60 (28.3)
	Other	118 (55.7)
Components used to inform clinical reasoning	Evaluation of objective findings	211 (99.5)
	Evaluation of subjective findings	167 (78.8)
	Hypothesis formation	194 (91.5)
	Goal setting	199 (93.9)
	Patient's problem list	198 (93.4)
	Treatment plan	184 (86.8)
	Pattern recognition	156 (73.6
	All elements used	156 (73.6%)
What assessment information was used for	Form hypothesis	165 (77.8)
	Write a problem list	157 (74.1)
	Develop patient/patient problem list	204 (96.2)
	Plan treatment	206 (96.7)
	Handover to another PT	170 (80.2)
	Handover to HCPs	189 (89.2)
	Handover to carers	163 (76.9)
	Other	33 (15.6)
Documentation	As per organisational format	61 (28.8)
	SOAP format	127 (59.9)
	Other	22 (10.4)

A total of 195 (92%) respondents reported that they assessed the same domains in every patient, with the number of domains ranging from 1 to 19. However, there was great variability in the specific domains that respondents identified when answering a free-text response question. When respondents were asked to identify domains from a pre-determined list, the most frequently assessed

domain in all patients/patients was strength (n=131, 76.2%). Other frequently assessed domains included goal setting (n=107, 54.8%), mobility (n=99, 50.7%), and function (n=99, 50.7 %).

Figure 4-1 displays how frequently respondents reported assessing prespecified domains. When ≥ 75% of respondents reported to include a certain domain always or often, it was considered that a consensus had been reached (Diamond, 2014). This was the case for the following domains: balance (n=207, 98.1), muscle strength (n=205, 96.7%), gait (n=203, 97.6%), falls and safety (n=201, 94.9%), function (n=200, 94.7%), goal setting (n=197, 93.8%), range of movement (n=180, 85.3%), pain (n=179, 84.4%), coordination (n=171, 81,1%), activity tolerance (n=162, 76.8%), postural alignment and symmetry (n=161, 76%), and upper limb (n=158, 79.4%). Domains identified as being assessed rarely or never by more than half of respondents were deep tendon reflexes (n=116, 55%).

Figure 4-1 Frequency of assessment of pre-specified domains (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).

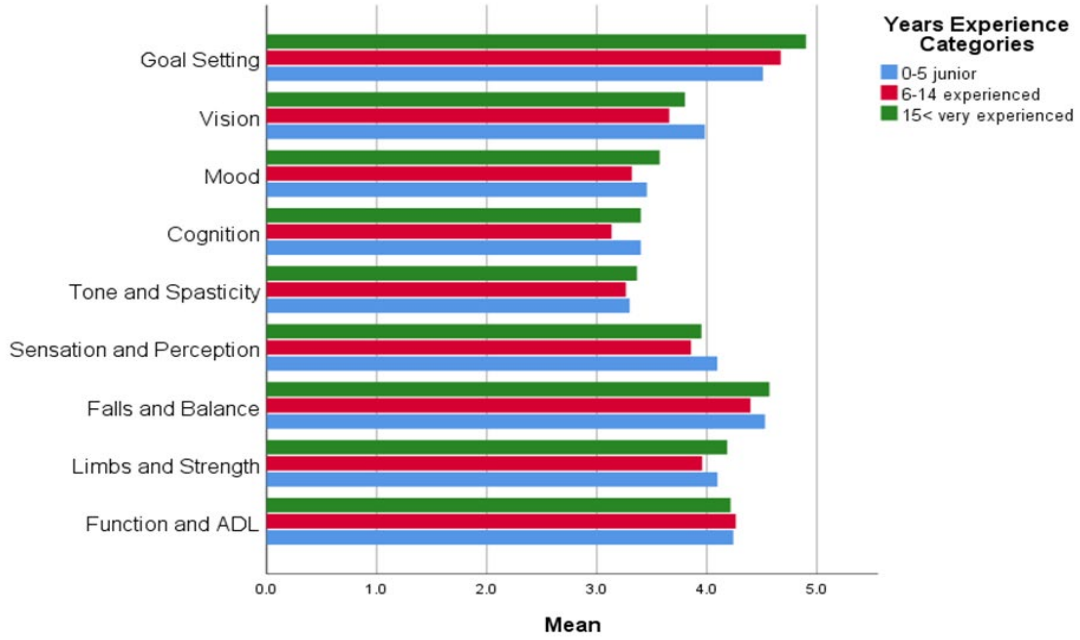
Domain %	Always/often	Sometimes	rarely/never
Balance	98.1	1.4	0.5
Gait	97.6	1.9	0.5
Muscle strength	96.7	2.8	0.5
Falls and safety	94.9	4.7	0.5
Function	94.7	0.5	4.7
Goal setting	93.8	6.2	0
ROM	85.3	10.9	3.8
Pain	84.4	13.2	2.4
Coordination	81.1	6.6	2.4
Upper limb	79.4	18.6	2
Activity tolerance / Endurance	76.8	20.4	2.8
Postural alignment and symmetry	76	16.6	7.5
Somatosensation	72.5	21.8	5.6
Trunk core	70.3	20.8	8.9
Stairs	70.1	26.1	3.8
ADLs	68.1	20.5	11.4
Vision	65.1	27.4	7.5
Tone	62.7	30.7	6.6
Neglect	61.3	29.2	9.5
Muscle strength	58.5	31.1	10.4
Perception	55.7	32	12.3
Spasticity	56.6	35.4	8
Mood	46.7	36.3	17
Cognition	42	34	44.1
Deep tendon reflexes	16.1	28.9	55

Associated with the question in the survey that asked about the frequency of assessment of pre-specified domains was a free-text comments section. Eighty-one respondents answered this part of the questionnaire. Fifty-seven (26.9 %) respondents felt the identified domains listed in Figure 4-1

were not all-inclusive, with 24 (11.3%) reporting on other essential domains of vestibular assessment, self-management, patient's motivation to participate, respiration, and ataxia.

Figure 4-2 below identifies domains included in assessment compared between three levels of clinical experience and shows that experienced respondents included fewer grouped domains in their assessment compared to both junior and very experienced respondents. There was a statistically significant difference in inclusion of the limbs and strength ($F(2, 206 = 3.6, p = 0.03)$) as well as goal setting domains ($F(2, 204 = 7.7, p < 0.001)$) domains between the three groups. Post-hoc comparisons indicated that very experienced clinicians included the grouped domain of limbs and strength more often than experienced clinicians, however this difference was small only (mean (SD) 3.95 (0.51) and 4.18 (0.60) respectively, $p = 0.023$). Similarly, very experienced clinicians also included the goal setting domain more frequently in their assessment (mean (SD) 4.90 (0.30)) than their experienced (mean (SD) 4.67 (0.61)) and junior (mean (SD) 4.51 (0.72), $p<0.01$) colleagues.

Figure 4-2 Frequency of inclusion of assessment domain in relation to years of clinical experience



Respondents reported the timing of assessment, with most taking approximately one hour to perform an assessment (53.3%), which occurred mostly on admission (55.7%). Additional data through free-text responses noted that assessment may occur throughout multiple therapy sessions and may vary depending on thoroughness, the condition itself, the complexity of the condition, goals, and the clinical setting.

Figure 4-3 presents the frequency with which the respondents included grouped domains in neurological physiotherapy assessment by geographical location. Respondents in rural and remote settings reported to include all but two domains (goal setting, tone, and spasticity) slightly less frequently than respondents in metropolitan and regional areas (see Figure 3-3 below). Observed differences in the grouped domains of sensation and perception (F (2, 209 = 6.3, p =0.002)), and vision (F (2, 209 = 5.07, p =0.007)) were statistically significant. The grouped domain of 'sensation and perception' was significantly more often assessed by metropolitan respondents than by those working in rural / remote geographical locations with a mean (SD) of 4.03 (0.64) versus 3.48 (0.44), p = 0.02. The same pattern was observed in the domain of vision with a mean (SD) of 4.03 (0.64) for the metropolitan group versus 3.48 (0.44) for the rural and remote group (p = 0.06).

Figure 4-3 Frequency of inclusion of assessment domain in relation to geographical location

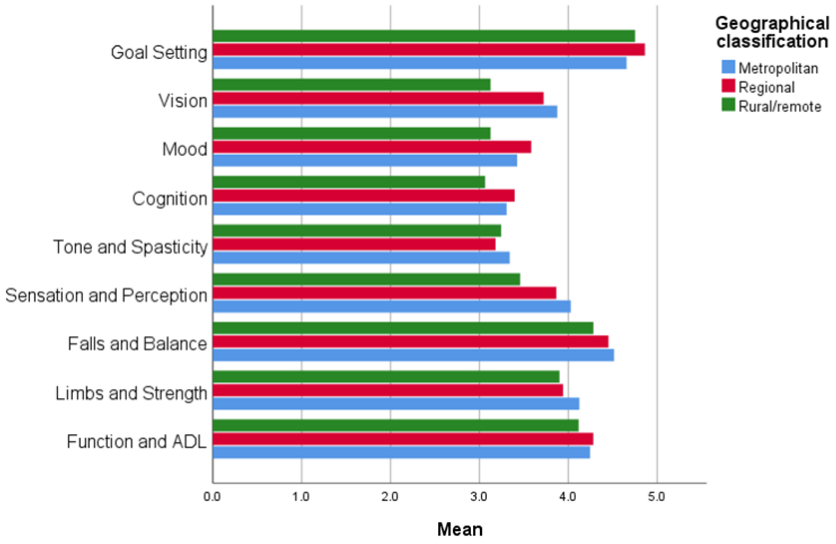
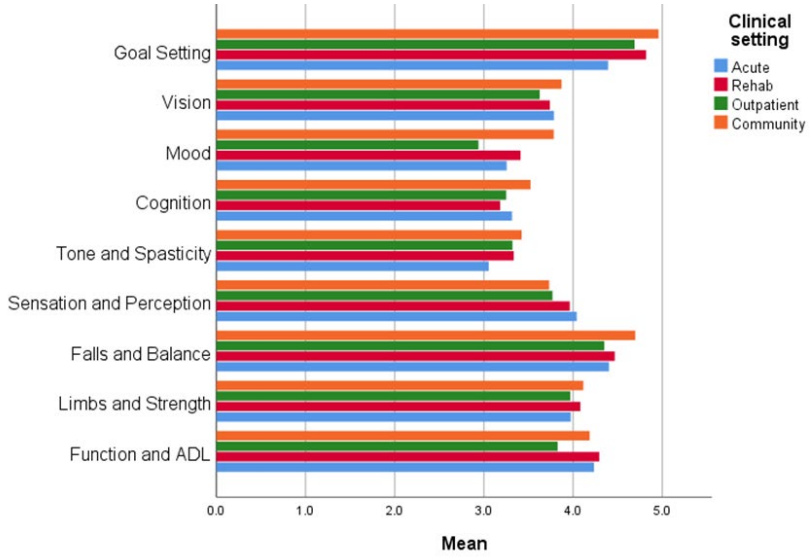


Figure 4-4 presents the same data, frequency of inclusion of grouped domains, in neurological physiotherapy assessment by clinical setting. Respondents working in community settings included goal setting, mood, cognition, falls and balance, and function and activities of daily living slightly more often than respondents from other clinical settings (see Figure 4-4 below). This between-group difference was statistically significant for the goal setting domain (F (3, 174 = 8.5, p < 0.001)), with goal setting being done more in the community (mean (SD) 4.96 (0.21) and rehabilitation (mean (SD) 4.82 (0.44)) settings than in the acute setting (mean (SD) 4.39 (0.78), both reaching significance with p <0.001. In addition, a small but statistical between-group difference was observed in the function and ADL domain. Respondents working in the outpatient setting assessed less in the grouped domain of function and ADL (mean (SD) 3.83 (0.69)), compared to those working in the other settings and this

was statistically significant compared to the acute group (mean (SD) 4.23 (0.36), p = 0.008) and rehabilitation groups (mean (SD) 4.30 (0.41), p < 0.001).

Figure 4-4 Frequency of inclusion of assessment domain in relation to clinical setting of respondent



The results showed that 38 (17.9%) respondents used the same approach in their assessment across all people with a neurological condition. When asked how therapeutic approaches influenced their assessment of people with neurological conditions using an open text question, the importance of clinical reasoning, experience, use of evidence-based practice, movement facilitation, and flexibility in approaches was reported. Of the 99 respondents who indicated that therapeutic approaches informed their assessment, nearly all (n=91) of them used more than one approach: "*Look at trunk control based on Bobath training. I may take a very task -based approach at times based on influence of Carr and Shepherd*" (ID 2).

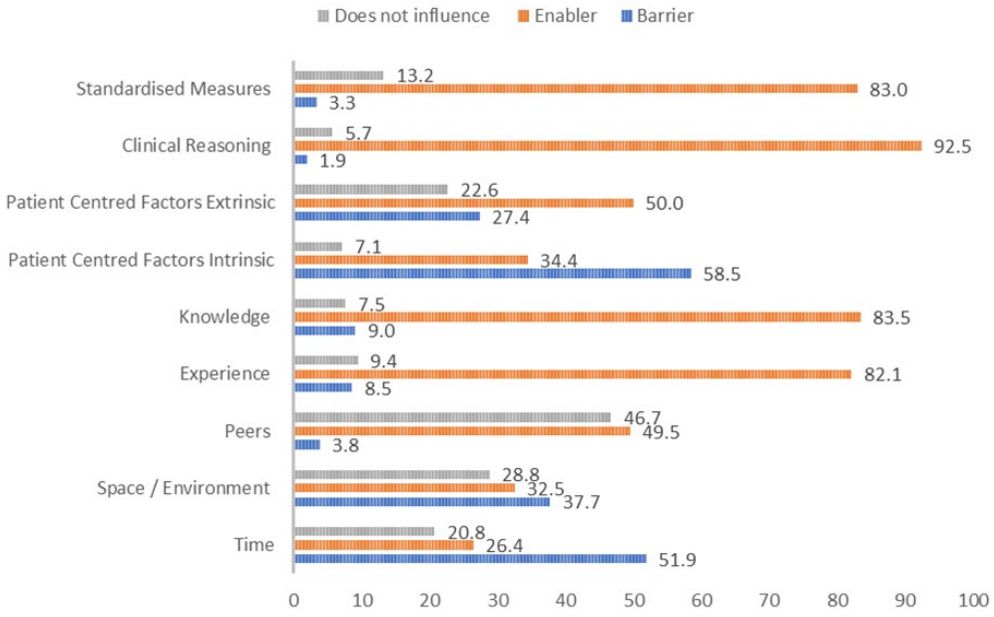
> The Feldenkrais Method influences how I do my assessments. I pay attention to how the patient is able to engage in movement in a variety of starting positions (e.g. side lying or getting up and down from the floor). I also take a very functional approach and am interested in how a person is living their life, not just how they are moving a limb (ID 37).

4.3.1.2 Barriers and enablers influencing the assessment of people with neurological conditions

The most frequently reported enablers or facilitators of neurological physiotherapy assessment were clinical reasoning skills (43.6%), use of standardised measures (39.1%), therapist knowledge (39.3%),

and experience (38.7%). Barriers to assessment included lack of time (51.9%) and intrinsic patient centred factors (58.5%), such as medical stability and motivation. Twenty-one percent of respondents reported that peers did not influence their assessment practices (see Figure 4-5 below).

Figure 4-5 Factors influencing assessment (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/).



Free text input regarding influences on the time taken to perform an assessment revealed that organizational barriers such as environmental constraints and availability of equipment impacted the time to complete an assessment. Therapist-related factors impacting time for assessment included subjective findings and therapists' caseload. Finally, patient-related factors were also mentioned, including patient availability for assessment and issues impacting the patient's ability to participate in the assessment, such as arousal levels, behaviour, and engagement. The severity and complexity of the patients were referred to most frequently, suggesting that the more complex the patient, the longer the time taken for assessment.

A total of 189 (89.2%) respondents specified that they used measures as part of assessment. The most used measures were standardised outcome measures (73.1%) and the least used were self-devised measures (15.1.%). Free-text responses included measuring items that were specific to the patient: "Depends on what the patient identifies as a problem. I.e. if turning is, I would time turning". (ID 11)

The choice of standardised measures was mostly influenced by clinical experience (69.3%), evidence-based practice (61.3%) and familiarity (61.3%). Less than a third of respondents (n=57, 26.9%) used standardised outcome measures at the initial assessment, with less than 10% used them on

subsequent assessments or discharge. Free-text responses indicated that many respondents used standardised outcome measures at all the identified time points, measures were also included if change in the patient was noted. Just under half of the respondents (n=100, 47.2%) reported using measures that were not standardised (Table 4-4). Free-text responses indicated that non-standardised measures included patient goals, patient satisfaction, gait quality and counting repetitions of an exercise.

Table 4-4 Use of measures in assessment (data from survey results, 2020)

Question		*n* %
Do you use any measures as part of your assessment?	Yes	189 (89.2)
	No	18 (8.5)
Do you use the following measures?	Standardised activity measures	89 (42.0)
	Standardised diagnostic specific measures	88 (41.5)
	Standardised participation/quality of life measures	68 (32.1)
	Standardised outcome measures	155 (73.1)
	Self-devised measures	32 (15.1)
	Other	14 (6.6)
How often do you use standardised measures?	Always	93 (43.9)
	Often	76 (35.8)
	Sometimes	21 (9.9)
	Rarely	4 (1.9)
	Never	1 (0.5)
What influences your choice of standardised measures?	Evidence based practice	130 (61.3)
	Familiarity	130 (61.3)
	Experience	147 (69.3)
	As directed by organisation	64 (30.2)
	What will most reflect change in my patient	64 (30.2)
When do you use standardised outcome measures?	Initial assessment	57 (26.9)
	Subsequent assessment	13 (6.1)
	On discharge	8 (3.8)
	Other	117 (55.2)
Do you use measures of outcome that are not standardised?	Yes	100 (47.2)
	No	96 (45.3)

4.4 Discussion

We aimed to obtain a representative sample of physiotherapists in Australia who assessed people with neurological conditions. This was difficult to ascertain, as not all registered physiotherapists would assess this population in their clinical practice. The results of this survey suggest that there is variability in assessment practice, with an emerging consensus between registered physiotherapists in Australia for the assessment domains of balance, muscle strength, gait, falls and safety, function, goal setting, range of movement, pain, coordination, activity tolerance, postural alignment, symmetry, and upper limb. There is little data to support how setting, approach, or clinical experience influence the assessment of people with neurological conditions.

In this survey, most respondents (> 90%) reported assessing domains that are related to movement such as balance, function, gait, falls, safety, and strength. These findings are similar to those of a recent systematic review of assessment by Garner et al. (2023) that identified five key domains in multiple studies (at least 10 out of 26 included studies), including function, postural alignment and symmetry, gait, balance, and muscle strength.

Balance was the most frequently assessed domain, reported by 98% of the survey respondents. A systematic review and meta-analysis investigating exercise training on balance in people with chronic stroke (van Duijnhoven et al., 2016) highlighted that independence in activities of daily living, an important focus of rehabilitation, is underpinned by the ability to balance, especially standing balance. In addition, achievement of standing balance is a predictor of functional recovery (Van de Port et al., 2006; Tyson et al., 2007). In the stroke literature, the assessment of balance deficits has been discussed and emphasized in relation to an increased risk of falls after stroke (Groen et al., 2008). The fact that assessing balance is essential in all phases of recovery has been supported by the findings of this survey, including all domains that may influence balance, such as postural alignment and symmetry, muscle strength and falls, and safety.

Function was identified by most respondents as a key assessment domain. Function and movement are typically assessed through observation (McGinnis et al., 2009). The performance of functional activities is known as movement analysis (Wikström-Grotell & Eriksson, 2012). Assessment of the movement system is a key component of neurological physiotherapy and one of the many factors that lead to effective neurorehabilitation (Schenkman et al., 2006; Deutsch et al., 2022). Movement and functions are undeniably linked. In a qualitative study by McGinnis et al. (2009) exploring clinical decision-making in assessment, the observation of patients' movements was reported to be an important source of knowledge for physiotherapists, comparing their observations with what is known as normal and atypical movement.

Over half of survey respondents reported to assess mood or cognition only sometimes (34%) or rarely or never (44%), even though depressive moods are commonly identified in people with neurological conditions and may impact the effect of therapeutic intervention (Ibeneme et al., 2016; Patten et al., 2017). As part of neurorehabilitation, there are certain shared domains that may be assessed by physiotherapists, as well as by other healthcare professionals. The fact that mood was not frequently assessed by the survey respondents is possibly due to this domain being included in the assessment of other multidisciplinary healthcare team members (Tyson et al., 2007). However, it is unsatisfactory that physiotherapists do not assess this domain more often.

Respondents reported that the assessment occurred at variable times, ranging from admission to multiple times throughout the therapy sessions. These results suggest blending assessment and treatment, and thus more of a continual process of clinical reasoning. This aligns with theories of critical reflection in practice (Paterson & Chapman, 2013).

The geographical location appeared to have an impact on the inclusion of the grouped domain of sensation/perception and vision as this was included more in metropolitan settings compared to rural ones. The reason for this is unclear. However, there appear to be many factors that impact service provision rurally including population, funding models, and availability of services, this may indicate that with the limited-service provision in rural areas, sensation/ perception and vision are not prioritized. Health care setting appeared to impact on the inclusion of the grouped domains of function/ADL and goals setting, with the former assessed less in outpatient settings compared to acute and rehab and the latter more in the rehabilitation and community settings. It is known that goal setting in the initial stages after a stroke can be inconsistent (Brown et al., 2014). Physiotherapy respondents in this qualitative study perceived that patients/clients did not always want to be closely involved in making decisions at this stage. In c practice assessments were generally based more on professional choice or patient goals, with 54.8% of respondents reporting to include goal setting as part of their assessment.

The tendency to perform assessments based on professional judgement aligns with findings from a study surveying clinical practice in the screening and diagnosis of spatial neglect post-stroke among healthcare professionals (Checketts et al., 2021). This suggests a shift from a more structured, comprehensive assessment to one that is patient-centred and goal-orientated (Morgan and Yoder, 2012). Morgan and Yoder (2012) observed that the practice of patient-centred care has increased over time, emphasising a holistic approach to patient management. Goal setting and the patient's problem list were key components of the assessment; with 75% of respondents indicating that these components informed their clinical reasoning process. Jones and Rivett (2003) identified this as a

crucial aspect of clinical reasoning, and this study suggests that it is more commonly practiced by those with extensive experience.

Moreover, clinical experience did not appear to influence the domains included in the assessment. The survey results indicated no significant difference in the inclusion of assessment domains between the novice and experienced physiotherapists. While it is known that methods of clinical reasoning, including assessment as part of this process, can vary between novice and experienced clinicians (Boshuizen et al., 2018), this difference was not evident in our findings.

Over one-third of the respondents reported using a named therapeutic approach for their assessment. The reported approaches were motor relearning, Bobath concept, and a flexible or eclectic approach (Lennon, 2003). McGinnis et al. (2009) noted therapeutic approach influenced balance assessment, leading to therapists' balance assessment inclusion being highly individualized. The approach or philosophy identified by the respondents may reflect the age and popularity of the respondents and the training approach popular at the time.

The factors reported to influence the time taken for assessment included organizational, therapist, and patient factors. Organizational factors identified time and availability which links to the therapist factor of caseload, suggesting that with increasing therapist caseload, there may be less available time to complete an assessment. The most influential patient factors were severity of condition and complexity, suggesting tailoring of the assessment based on the patient's profile and therapist expectations (Checketts et al., 2021).

Assessment enablers included experience, knowledge, clinical reasoning skills, and standardised measures, which is in agreement with findings from a systematic review by Garner et al. (2023) that identified these areas as key themes influencing the assessment process.

In response to a free text question asking respondents to identify essential domains included in the assessment of all patients with neurological conditions, a variety of terms were used to describe the same domains. For example, the domain of gait was referred to as mobility, ambulation and walking. Similarly, mobility was sometimes used to describe bed mobility and, at other times, walking or general mobility. A recent study by Mcloughlin (2020), exploring guiding principles for movement highlighted the issue of inconsistent labelling and terminology, which can lead misinterpretation and conflict. He suggested that 'a common language of movement training principles may assist clinicians in the process of clinical reasoning and improve communication among the healthcare team' (as cited by Hart et al., 2014 in Mcloughlin, 2020). The importance of a common terminology in describing

movement-related concepts within physical therapy has been recognised as important for effective communication among clinicians and researchers alike (Mcloughlin, 2020; Deutsch et al., 2022).

Jones and Rivett. (2003) as cited in Dimitriades et al. (2016) described clinical reasoning as “a process in which the therapist, interacting with significant others (e.g., family and other health-care team members), structures meaning, goals and health management strategies based on clinical data, patient choices, and professional judgement and knowledge”. In neurological physiotherapy, clinical reasoning is thought to often reflect the approach taken. Respondents were asked what components of assessment informed their clinical reasoning, and more than three-quarters reported using all the suggested items to inform their clinical reasoning process. Clinical reasoning was used for developing treatment plans and to develop problem lists. This process of information gathering, followed by the development of a plan and problem list, aligns with the clinical reasoning framework developed by Garner and Lennon (2018).

Dimitriades et al. (2016) proposed a clinical reasoning framework for assessing people with neurological conditions, designed to guide clinical practice and facilitate clinical decision making. The authors emphasise that this framework should remain flexible to accommodate individual therapeutic preferences. Kleynen et al. (2017) described the development of clinical reasoning from novice to expert, noting that experienced physiotherapists often use a diverse range of treatment options in neurorehabilitation (Kleynen et al., 2017), though they may struggle to articulate their clinical reasoning process (Vaughan-Graham et al., 2017). Wasserman and Wasserman (2017) used neurocognitive learning theory (NCLT) to better understand the development of expert clinical reasoning. NCLT, along with other action readiness models, suggests that the automaticity of responses where habitual behaviours triggered by environmental stimuli without conscious deliberation is a desired outcome of learning. This automaticity is crucial given the limited capacity of our working memory, allowing us to handle routine tasks without expending higher-order cognitive resources. Additionally, the ability to organize knowledge is essential, particularly as knowledge organisation is recognized as fundamentally different between novice and expert problem solvers. Studies have found that denser neural networks associated with knowledge organisation enable deeper problem comprehension and abstract reasoning, making knowledge retrieval and application more efficient. This study did not reveal differences in the inclusion of assessment domains between novice and experienced clinician, however it is possible that we did not ask the right questions. Specifically, we did not address questions related to clinical decision making and the outcomes of those decisions, which are central to the process of clinical reasoning.

Measures are recognised as a vital component in assessing people with neurological conditions (Tyson et al., 2008). Nearly three-quarters of respondents reported using standardised outcome

measures. However, previous studies have indicated that the use of such measures is limited in many areas of practice. Nationwide surveys conducted in the United States by Anderson and Sullivan (2016) and in the Netherlands by Van Peppen et al. (2008) reported that less than half of physiotherapists working in stroke rehabilitation used the standardised outcome measures recommended in their clinical practice guidelines. Standardised outcome measures have been associated with clinical excellence (Kapur, 2009) and are considered a crucial element of evidence-based practice in neurological physiotherapy.

Demers et al. (2019) defined outcome measures as 'qualitative or quantitative assessment of health status used to determine change in ability due to an intervention'. These measures enable clinicians to gain an enhanced understanding of a patient's health status, support decision making, identify deterioration, and evaluate the effectiveness of interventions through reassessment using the same measure. Demers and colleagues (2019) explored factors influencing the use of standardised outcome measures in Canada and India, finding that over 89% of therapists in both countries were facilitated in their use of these measures by known tool reliability and validity, training, and recommendations in clinical practice guidelines. This aligns with the survey results, where over half of respondents indicated that their choice of standardised measures was influenced by evidence-based practice, while the same proportion cited familiarity as a key factor. This is consistent with findings from Pattison et al. (2015), which identified familiarity as the largest influence on therapists when selecting measures for their practice.

Interestingly, less than half of the respondents reported using non-standardised measures, such as achieving individualised patient goals as an outcome of therapy and counting the number of repetitions of exercises. Counting repetitions of exercises can be utilised as a measure of improvement by noting change in the number of repetitions This agrees with the findings from a systematic review by Desouza et al. (2018) which noted that repetitive practice forms a significant component of stroke rehabilitation. Demers et al. (2019) also identified a lack of training and resources as barriers to the use of standardised measures. It is possible that a focus on person-centred care may lead clinicians to assess and review what is most important to the patient, which may sometimes be difficult to measure with a standardised tool.

Over half of the respondents reported supervising physiotherapy students during their clinical placements and shared suggestions on how to teach students to perform neurological assessments. The identified themes included supervisor led activities, cold learning activities that have been designed to actively engage students, and student experience and progression. Christensen et al. (2017) supports the need to use multiple resources and methodologies to address students' needs in this area, making it a critical component of their theoretical and clinical learning. This is seen as a

threshold skill for practice (Pinnock et al., 2019). Supervisor-led activities, as described by Hudson (2006) and Watson (1999) and in a doctoral thesis by Walker (2013), include methods such as presenting material from real case studies and providing a framework to organise all relevant information from a case, both of which are aimed at improving neurological clinical reasoning. Clinical reasoning skills, essential for clinical placements, have been described by students as 'troublesome', with skills learnt in the classroom often proving difficult to transfer to the healthcare environment (Pinnock, et al. 2019). However, studies suggest that these skills can be developed with repeated practice under supervision (Giles, 2010).

4.5 Strengths and limitations

The strength of this study is the foundation for consensus regarding the domains included when assessing people with neurological conditions in Australia. Recruitment for this study was conducted through the Australian Physiotherapy Association (APA), a national professional body, and the study sample represented physiotherapists from across all states and territories within Australia, from metropolitan rural and remote settings, and a variety of clinical settings. A few limitations should be acknowledged. First, the study has a small sample size and unknown potential participant pool. The participants as members of the APA, may also represent a group of physiotherapists who are more engaged with the physiotherapy profession, and knowledgeable about evidence-based practice than those who are not members and are possibly more 'up to date' with assessment processes. Observed power associated with significant between-group differences suggests that the sample size was sufficient (>0.80) to support the detected differences in all assessment domains except for the limbs and strength domain. This study did not consider the practice variability associated with expert practice in neurological physiotherapy which may impact on practice and assessment patterns. Future research may include additional demographic questions related to expertise. Finally, a few domains, such as vestibular, respiration, and motivation, were mentioned in the free-text responses. We do not know whether these assessment domains would have been reported on more frequently if the question asking about options for assessment domains was asked earlier in the survey.

4.6 Conclusion

In conclusion, the findings of this study provide a rich data source for the current clinical practice in the assessment of people with neurological conditions in Australia. The survey demonstrated consensus among respondents on the inclusion of 12 domains of assessment for people with neurological conditions. The survey indicated that the most assessed condition was stroke. Geographical location, clinical work setting, clinical experience, and therapeutic approach did not appear to influence the assessment practices. A large variety of standardised measures are used at various time points

across the patient journey. Therapist, patient, and organizational factors were all reported as barriers or enablers to the assessment process.

The findings from this survey, along with the findings of the systematic review on assessment in the previous chapter, informed the development of the scoping review on clinical reasoning frameworks presented in the next chapter.

CHAPTER 5 CLINICAL REASONING IN NEUROLOGICAL PHYSIOTHERAPY – A SCOPING REVIEW

This chapter answers Thesis aim 6 and presents a scoping review that examines the evidence base supporting the clinical reasoning process and its components in neurological physiotherapy, along with the theoretical frameworks that guide this process. Following the findings from the assessment systematic review in Chapter 3 and the survey in Chapter 4, which together provided insights into assessment practices in clinical settings, this study delves further into clinical reasoning of which assessment is a key element, before investigating the application of assessment and clinical reasoning with students, and educators.

5.1 Introduction

Physiotherapy plays an important role in the overall care and management of people with neurological conditions. Physiotherapy assessment of people with neurological conditions including clinical reasoning, guides treatment choice and management (World Confederation for Physical Therapy [WCPT], 2011).

Clinical reasoning is a process in which the therapist interacts with the patient and others (such as family members or others providing care), structures meaning, goals, and health management strategies based on clinical data, patient choices, and professional judgement and knowledge (Higgs et al., 2019), based on a comprehensive assessment (Physiotherapy Board of Australia & New Zealand, 2023; WCPT, 2011). For clinical reasoning skills to be used effectively in patient assessment, physiotherapists require content knowledge, technical knowledge, and personal attributes of reflection (Higgs et al., 2019; Jones & Rivett, 2019). This knowledge must be organized into a wide variety of patterns relevant to fields of practice, to develop and test hypotheses, to enable diagnosis and development of a management plan for the patient (American Physical Therapy Association [APTA], 2020; APC, 2016).

Physiotherapy is broadly segregated into three core areas: cardiorespiratory, musculoskeletal, and neurological. The literature suggests that the focus in relation to clinical reasoning is different (Thackray & Roberts, 2017) between these three core areas of physiotherapy practice (Te, Blackstock, & Chipchase, 2019). Much of the research on clinical reasoning has focused on musculoskeletal physiotherapy (Karvonen et al., 2017; Cruz et al., 2012a). In musculoskeletal physiotherapy practice, diagnostic reasoning is important for developing a management plan with the patient (Jones & Rivett, 2019), whereas in neurological physiotherapy, patients are commonly referred to a physiotherapist with a confirmed diagnosis. Therefore, developing a diagnosis is not the focus

(Garner et al., 2024) and instead, the physiotherapist generates a hypothesis of how impairments affect movement dysfunction, function (activity), and participation within the International Classification of Function (ICF) known as movement diagnosis (Lexell & Brogardh, 2015; Deutsch et al, 2022).

Standards and thresholds exist to guide to the clinical practice of physiotherapy. The WCPT (2011) *Standards of physical therapy practice,* Standard 2.10.1.1 (patient/client management) recommends "the physical therapist performs an initial examination/assessment and evaluation to establish a diagnosis and prognosis/plan of care prior to intervention/treatment". In the *Physiotherapy Practice Thresholds Australia & Aotearoa New Zealand* (Physiotherapy Board of Australia & New Zealand, 2023) key competency 1.1l states "Registered physiotherapists are able to plan and implement an efficient, effective, culturally safe and responsive and client-centred physiotherapy assessment," and competency 1.2 recommends "Involve the client and relevant others in the planning and implementation of safe and effective physiotherapy using evidence-based practice to inform decision-making." In the UK *Health & Care Professions Council, Standards of Proficiency for Physiotherapists (Health & Care Professions Council, 2023)* standard 13.16 states "Registered physiotherapists apply problem solving and clinical reasoning to assessment findings to plan and prioritize appropriate physiotherapy." Despite these recommendations, there is limited evidence on how physiotherapists assess individuals with neurological conditions and utilize the clinical reasoning process in practice (Garner et al., 2024a; Brentnall et al., 2022; Elven & Dean, 2017). In a systematic review of physiotherapy assessment in people with neurological conditions, 19 of 23 included studies referred to the importance of clinical reasoning in physiotherapy assessment (Garner et al., 2023). In addition, the findings of a recent national survey of registered physiotherapists in Australia suggested that clinical reasoning was informed by multiple elements, including the evaluation of subjective and objective findings, hypothesis formation, use of standardised measures, goal setting, patient's problem list, treatment plan and clinical pattern recognition. Most respondents (73.6%) reported using all elements to inform assessment. This finding suggests that clinical reasoning is an important part of the assessment process. However, the mechanisms underlying this phenomenon remain unclear (Garner et al., 2024a).

A systematic review by Elven and Dean (2017), synthesizing the qualitative literature on factors influencing clinical reasoning in physiotherapists, reported a lack of consensus regarding essential components of clinical reasoning, stating a lack of a 'gold standard instrument' for clinical reasoning. This study also revealed that the physiotherapists individual abilities and beliefs influenced the clinical reasoning process. Beliefs of physiotherapists have been shown to influence how therapy is delivered (Lennon, 2003). Theory has explained the clinical decisions and interventions made by physiotherapists (Lennon et al., 2024). Theory and the use of theoretical frameworks have been

shown to positively affect existing interventions and the time taken to design novel interventions (Lennon et al., 2024, Peterson et al., 2019). Although several theoretical conceptual frameworks or models have been developed to guide assessment and clinical reasoning, it is unclear if and how these are utilized in practice (Dimitriadis et al., 2016; Gillbody et al., 2021). Conceptual frameworks have been defined as “a network, or a plane of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena. The concepts that constitute a conceptual framework support one another, articulate their respective phenomena, and establish a framework- specific philosophy” (Jabareen, 2009). Conceptual models have been applied to make sense of theoretical foundations of aspects of physiotherapy practice. This was highlighted in a study by Pacheco-Brousseau et al. (2022) that utilised theory analysis of shared decision-making conceptual models in physiotherapy to further understand the theoretical underpinnings of shared decision making. The terms conceptual models and conceptual frameworks are often used interchangeably in the literature.

This scoping review aimed to explore and synthesize available literature pertaining to clinical reasoning in neurological physiotherapy. We sought to describe conceptual frameworks relevant to clinical reasoning and to characterize the components of the clinical reasoning process in (1) conceptual frameworks developed to guide clinical reasoning in neurological physiotherapy and (2) in the clinical practice of neurological physiotherapy. Additionally, we intended to assess commonalities and differences between theory and practice, and map study findings to standards of clinical practice.

5.2 Methods

This scoping review was conducted according to the preferred reporting items for systematic review and meta-analysis extension for scoping review guidelines (Tricco et al., 2018). The research questions identified were broad based on those suggested by Arksey and O’Malley (2010), and more recently expanded upon by Peters et al. (2022). The protocol was registered with OSF pre-registration number: osf.io/af8x3.

5.2.1 Search strategy

Six electronic bibliographic databases were searched on January 16, 2022, and July 23, 2024. from data base inception including Medline (Ovid), PubMed, CINAHL, Scopus, Web of Science, and Cochrane Library, using keywords such as ‘clinical reasoning’, ‘clinical decision making,’ and ‘neurological physiotherapy’, as well as indexing. The search was conducted by a medical librarian. Clinical reasoning has been defined as a process which has various components or steps, actions or events of the clinical reasoning process (Holder, 2018). As applied to health professionals, it is a ‘context-dependent, complex, encultured, and professional way of thinking and decision-making to

guide high-quality, professionally responsible practice actions' (Higgs, 2020). Clinical decision-making is enabled by clinical reasoning (Corrao & Argano, 2022) and has been described in the literature as a process of choosing between two or more courses of action (Thomas et al., 1991, as cited in Smith et al., 2008). The terms clinical reasoning and clinical decision-making are typically used interchangeably in the literature (Higgs & Jensen, 2019); therefore, both were included in the search strategy. However, for readability purposes, we have only referred to the term clinical reasoning in the reporting of this manuscript. See Appendix F for the full search strategy.

5.2.1.1 Inclusion criteria

Papers describing conceptual frameworks or models informing the clinical reasoning process were eligible for inclusion. Clinical practice studies were eligible for inclusion if they described the clinical reasoning processes of neurological physiotherapy in the adult population. Studies were not limited by research design; they could be quantitative or qualitative in nature and use an observational or interventional design. Studies without a primary focus on clinical reasoning, but containing relevant data related to clinical reasoning, were deemed eligible for inclusion.

5.2.1.2 Exclusion criteria

Studies describing assessment practices without reference to clinical reasoning or describing standardised tools to measure clinical reasoning were excluded. Studies not specific to neurological physiotherapy, and/or with a paediatric focus, were also ineligible for inclusion. Research studies not published in full text, such as conference proceedings or those not published in English were also excluded.

5.2.2 Critical appraisal

Studies were not critically appraised as directed by the Preferred Reporting Items for Systematic Review and Meta-Analysis Extension for Scoping Review Checklist (Tricco et al., 2018).

5.2.3 Screening process and data extraction

Two independent review authors (JG and BL) screened the titles and abstracts of citations for eligibility using Covidence software (Veritas Health Innovation, Melbourne, Australia). Any discrepancies were resolved through discussions between the two reviewers or through consulting a third reviewer (MB or SL) where required. Included studies were categorized as (1) papers describing conceptual frameworks or (2) clinical practice studies reporting on clinical reasoning data.

Data were extracted using an a priori purposefully designed and tested data-extraction form. For the conceptual framework papers, the extracted data consisted of: (1) study characteristics, including author, year, country of publication, and focus of the paper; and (2) framework characteristics,

including purpose of the framework, clinical reasoning framework description, how the framework was developed, and processes and components of clinical reasoning.

For clinical practice studies, the extracted data included: (1) study characteristics, including author, year of publication, country of publication, study aims, and study design (qualitative, quantitative, or mixed methods); (2) participant characteristics, including sample size, gender, age, and level of experience; and (3) processes and components of clinical reasoning process and associated study findings.

5.2.4 Data analysis

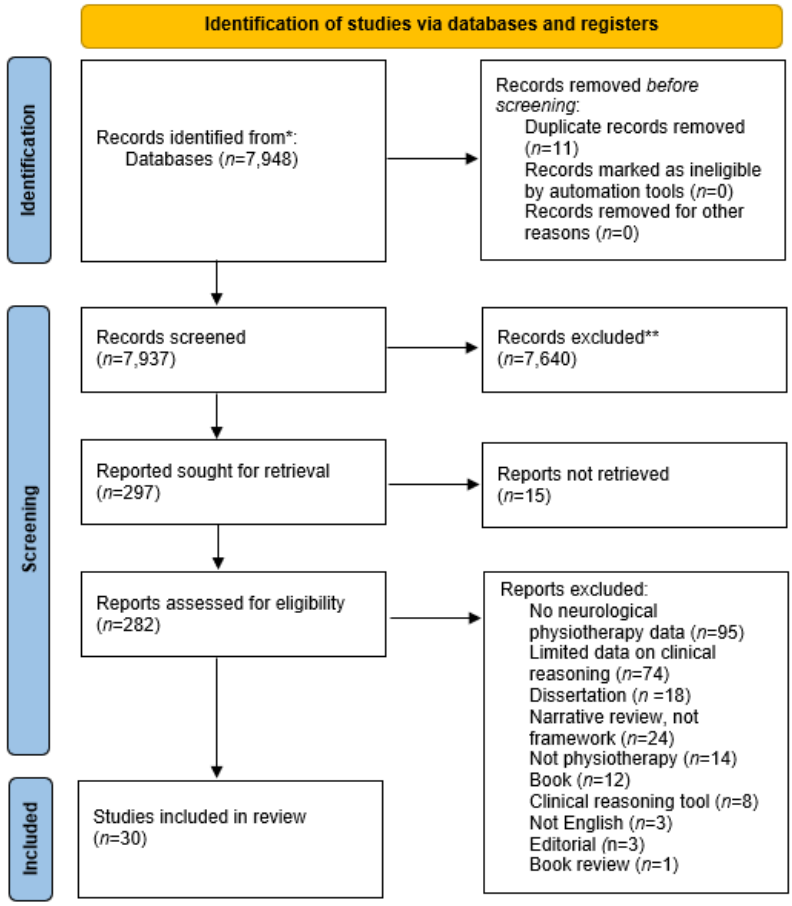
Data from all included papers was tabulated and narratively analysed. Next, the identified components of the clinical reasoning process in conceptual framework papers and clinical practice studies were charted for a side-by-side comparison to gain insight into the potential differences between theory and practice. Finally, we collated all items of the World Physiotherapy Standards (World Physical Therapy, 2011) and Physiotherapy Practice Thresholds in Australia & Aotearoa New Zealand (Physiotherapy Board of Australia & New Zealand, 2023) relevant to clinical reasoning (16 in total) and mapped our findings against these set of practice standard items.

5.3 Results

5.3.1 Selection of sources of evidence

The search yielded 7,948 citations. After duplicates were removed 7,937 study titles and abstracts were screened, and 282 potentially eligible full-text articles were reviewed. A total of 30 studies met the inclusion criteria and were deemed eligible for inclusion in this scoping review. Of these, 13 (43%) papers described conceptual frameworks for clinical reasoning, and 17 (56.6%) were primary research papers reporting clinical reasoning. See the PRISMA flowchart for details of the study selection process (Figure 5-1).

Figure 5-1 PRISMA 2020 flowchart (figure reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/), data from search, 2024).



5.3.2 Characteristics of conceptual framework papers

Of the 13 conceptual framework papers included, most originated in the United States of America (n=8) (Briggs, 2011; Cohen, 2020; Gill-Body et al., 2021; Potter et al., 2011; Schenkman et al., 2006; Sullivan, 2011; Sullivan, 2004; Sullivan, 2000). Four papers described frameworks for clinical reasoning (Dimitriadis et al., 2016; Sullivan, 2004; Sullivan, 2000; Watson, 1999), two aimed to increase understanding of clinical practice (Normann, 2015; Oberg, 2015) by explaining the importance of 'somatosensory activation in combination with motor recovery' in relation to clinical reasoning (Normann et al, 2015) and addressing the sequalae of neurological disease (Oberg, 2015). Two articles primarily focused on the selection of outcome measures (Potter et al., 2011; Sullivan, 2011). Other studies focused on clinical decision-making at the end of life (Briggs, 2011), fatigue management (Cohen, 2020), The Bobath Concept (Michielsen et al., 2019) and linking concepts of enablement and disablement to provide a structure for teaching clinical decision-making (Schenkman et al., 2006). For further details refer to Table 5-1.

Most papers focused on a mixed neurological population (n=9) (Cohen, 2020; Dimitriadis et al., 2016; Michielsen et al., 2019; Oberg, 2015; Potter et al., 2011; Schenkman et al., 2006; Sullivan, 2011; Sullivan, 2004; Watson, 1999).

Table 5-1 Characteristics of conceptual framework papers (*n*=13) (data from search, 2024)

Author/date/country/ study number	Focus of the article and purpose of the framework	Framework description	Clinical reasoning processes or components	Development
1. Briggs, 2011 UNITED STATES OF AMERICA	To describe four clinical decision-making models used to guide physiotherapy outcomes at the end of life for people with Amyotrophic lateral sclerosis and Parkinson's disease. This is intended for physiotherapists working in a hospice setting.	This paper describes 4 models to guide optimal physical therapy outcomes in end-of-life care. Hypothesis-Oriented Algorithm for Clinicians (HOAC II), Framework for Rehabilitation of Neurodegenerative Diseases, Framework for Assessment in Oncology Rehabilitation, Models of Practice in Palliative Care.	Patients presenting problem(s) Collaboration with patient re assessment and goal setting Differential diagnosis/hypothesis formation Management and treatment planning Monitoring effectiveness Reflection action Prognostication Re-evaluation Discharge planning	Different authors developed each of the four models according to their area of expertise. The HOAC 11 tool was developed to promote Evidence based decision making for treating functional deficits.
2. Cohen, 2020 UNITED STATES OF AMERICA	To present a clinical reasoning framework for physiotherapists in managing fatigue, and its application.	This frameworks guides clinicians to appropriate examination, considering the patient situation and the patient description of being tired.	Information gathering Objective examination Outcomes Patients presenting problems Differential diagnosis Collaboration on goal setting Management and treatment planning Monitor effectiveness of treatment Re-evaluation Discharge planning	This framework was developed based on the definition by Jensen and colleagues. The authors consider clinical reasoning of fatigue as a subsection of the clinical reasoning process.
3. Dimitriadis et al., 2016 Greece	To propose a new framework for clinical reasoning and clinical decision making.	This framework highlights function as the basis for goal setting and the important role of patients and carer in clinical decision-making and flexibility with assessment and management.	Information gathering Objective examination Outcomes Patients presenting problems Movement analysis Collaboration on goal setting Management and treatment planning Monitor effectiveness of treatment Re-evaluation Discharge planning	The developed framework has been influenced by several authors. It is designed to be flexible to allow physiotherapists to plan their treatments in 'accordance 'with their own clinical preferences.

Author/date/country/ study number	Focus of the article and purpose of the framework	Framework description	Clinical reasoning processes or components	Development
4. Gill-Body et al., 2021 UNITED STATES OF AMERICA	To summarize the process used by physical therapists to develop an initial set of movement system-related diagnoses, to determine a balance diagnosis and develop a plan of care.	An APTA taskforce identified 10 distinct movement system diagnoses reflecting balance dysfunction, together with descriptions of examination findings associated with each balance diagnosis. The Framework for Movement Analysis was integrated into the examination and diagnostic process.	Information gathering ICF Objective examination Outcomes Movement analysis Monitor effectiveness of treatment Re-evaluation	A framework was developed based on two conceptual elements: the first was control strategies, the second were body systems that contribute to maintaining balance.
5. Michielsen et al., 2019 Belgium, Canada, United Kingdom, Italy, Japan	To describe the development process culminating in the model of Bobath clinical practice by physiotherapists.	The clinical application of the Bobath concept in terms of the integration of posture and movement with respect to the quality of task performance. Application was illustrated in two patients with neurological conditions.	Information gathering ICF Patients presenting problems Movement analysis Collaboration on assessment findings and goal setting Differential diagnosis and hypothesis formation Movement analysis Management and treatment planning Monitor effectiveness of treatment Reflection in action prognostication Re-evaluation	The education committee of the International Bobath Instructors Training Association (IBITA)) developed this model from 2008 to 2013 using two cases to illustrate the concepts.
6 Normann, 2015 Norway	Theoretical notions. intended for physiotherapists working with people post stroke who have somatosensory impairment in the upper limb.	This framework utilises clinical examples to provide a deeper understanding of somatosensory disturbances post stroke.	Objective examination Collaboration on assessment findings Differential diagnosis/hypothesis formation Movement analysis Monitor effectiveness of treatment Re-evaluation	Based loosely on concepts derived from the ICF.
7. Oberg, 2015 Norway, UNITED STATES OF AMERICA, United Kingdom, Australia	To outline the phenomenologically informed enactive perspective on clinical reasoning, with special reference to clinical work that addresses impairments as sequelae of diseases.	The phenomenologically informed enactive perspective on clinical reasoning, in people with neurological conditions.	Collaboration on assessment findings and goal setting Movement analysis Monitor effectiveness of treatment Reflection in action Prognosis Re-evaluation	The phenomenological approach to the body starts with Edmund Husserl. Noting the difference between body as an object and a body that subjectively has experiences. This framework was influenced by many different CR models. Based on work by Gallagher, 2005.

Author/date/country/ study number	Focus of the article and purpose of the framework	Framework description	Clinical reasoning processes or components	Development
8. Potter et al., 2011 UNITED STATES OF AMERICA	To describe decision making frameworks for physiotherapists to guide selection of outcome measures.	This framework guides outcome measure selection and discusses 6 factors that should be considered when selecting outcome measures.	Information gathering ICF Objective examination Outcomes Collaboration on assessment findings and goal setting Re-evaluation	Based on Evidence based practice regarding use of outcome measures, surveyed physiotherapists identified the six factors to consider when selecting outcome measures: what to measure, purpose of measure, type of measure, patient and clinic factors, psychometric factors, feasibility.
9. Schenkman et al., 2006 UNITED STATES OF AMERICA	To link the larger concepts of health (enablement and disablement) to the scope of physical therapist practice and provide a structure for teaching clinical decision making	This framework is patient-centred, Hypothesis-Oriented Algorithm for Clinicians (HOAC)	Information gathering ICF Objective examination Outcomes Patients presenting problems Differential diagnosis/hypothesis formation Movement analysis Collaborative goal setting Management and treatment planning Monitor effectiveness of treatment Prognostication Re-evaluation	Developed from enablement, enablement model, perspectives of health, and a persons' role in society. It included the Hypothesis Oriented Algorithm for clinical decision making (HOAC) and (Patient Management) the Guide to Physical Therapist Practice. The framework was based on knowledge at that time regarding neural plasticity. Motor learning was emphasized as a critical component of examination.
10. Sullivan, 2011 UNITED STATES OF AMERICA	To describe a process for selecting outcome measures.	The application is illustrated with a case example of a person post stroke. Links are emphasised between selecting objective outcome measures and tracking patient progress.	Information gathering ICF Objective examination Outcomes Patients presenting problems Collaboration on assessment findings and goal setting Differential diagnosis/hypothesis formation Movement analysis Prognostication Re-evaluation	Little detail of how it was developed.

Author/date/country/ study number	Focus of the article and purpose of the framework	Framework description	Clinical reasoning processes or components	Development
11. Sullivan, 2004 UNITED STATES OF AMERICA	To describe a framework for physiotherapists in clinical practice focused on determining appropriateness for Physiotherapy care.	This framework focuses on determining appropriateness of Physiotherapy intervention. Case studies are used to illustrate the application.	Information gathering ICF Objective examination Patients presenting problems Collaboration on assessment findings Differential diagnosis/hypothesis formation Prognostication Re-evaluation	Developed from the Guide to Physical Therapists Practice (2nd ed).
12 Sullivan 2000 UNITED STATES OF AMERICA	To detail the Clinical decision-making process guided by the framework of Clinical Practice of a patient with Multiple Sclerosis.	A Framework of Clinical Practice, illustrated by a case example for people with Multiple Sclerosis.	Information gathering ICF Objective examination Patients presenting problems Collaboration on assessment findings Differential diagnosis/hypothesis formation Movement analysis Management and treatment planning Prognostication Re-evaluation	Guided by the Framework of Clinical Practice.
13. Watson, 1999 United Kingdom	To describe the format of Perry's model intended for educators who teach physiotherapy students about clinical reasoning	The focus is to describe a simple model of clinical reasoning using Perry's model from engineering that can be utilised in undergraduate teaching.	Information gathering Differential diagnosis/hypothesis formation	Initially examples are given re the car and subsystems this is then related to the human body.

**ICF: International Classification of Functioning*

5.3.3 Characteristics of clinical practice studies

The majority of the studies were conducted in the United Kingdom (n=5) (Beeston & Simmons, 1996; Kleynen et al., 2017; McGlinchey & Davenport, 2015; Nikopoulou-Smyrni & Nikopoulos, 2007; Plummer et al., 2006) and the U.S.A (n=6) (Galgon et al., 2024; Heldbradford et al., 2018; O'Brien et al., 2021; Seale & Utsey, 2020; Wainright et al., 2010; Wainright et al., 2011). Of the 17 clinical practice studies most (n=12) adopted a qualitative research design (Bainbridge et al., 2024; Beeston & Simmons, 1996; Galgon et al., 2024; Kleynen et al., 2017; McGlinchey & Davenport, 2015; McGlinchey et al., 2023; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Plummer et al., 2006; Seale & Utsey, 2020; Wainright et al., 2010; Wainright et al., 2011).

With regard to study aims, 14 studies explored clinicians' perspectives on clinical reasoning (Bainbridge et al., 2024; Carr et al., 1994; Galgon et al., 2024; Heldbradford et al., 2018; Kleynen et al., 2017; McGlinchey & Davenport, 2015; McGlynn & Cott, 2007; Normann et al., 2014; Pattison et al., 2015; Wainright et al., 2010; Wainright et al., 2011; Nikopoulou-Smyrni & Nikopoulos, 2007; O'Brien et al., 2021; Seale & Utsey, 2020), and individual studies explored perceptions and frames of reference for neurological rehabilitation (Beeston & Simmons, 1996), methods of assessment (Plummer et al., 2006) and identifying the roles and responsibilities of healthcare professionals (Hubbard & Parsons, 2007).

Clinical populations in which the concepts of the clinical reasoning process were explored included stroke (n=8) (Bainbridge et al., 2024; Carr et al., 1994; Hubbard & Parsons, 2007; McGlinchey & Davenport, 2015; Nikopoulou-Smyrni & Nikopoulos, 2007; Pattison et al., 2015; Plummer et al., 2006; Seale & Utsey, 2020), Multiple Sclerosis (n=2) (Heldbradford et al., 2018; Normann et al., 2014), concussion (n=1) (Galgon et al., 2024), and mixed neurological conditions (n=6) (Kleynen et al., 2017; Beeston & Simmons, 1996; McGlynn & Cott, 2007; O'Brien et al., 2021; Wainright et al., 2010; Wainright et al., 2011). For further details refer to Table 5-2.

Table 5-2 Characteristics of clinical practice studies (*n*=17) (data from search, 2024)

Author/year/ country/study number	Study aims	Study design	Participants	Clinical reasoning processes or components	Outcomes/findings
1. Bainbridge et al., 2024 Australia	To explore the factors influencing decision-making of physiotherapists in this situation.	Semi structured interviews	Physiotherapists (*n*=15) Years since qualification: 1-20+	Initial information gathering, objective examination, movement analysis, goal setting, management/treatment planning, standardised outcome measures, referrals/discharge planning, Evaluation/reassessment	Decision- making about independence of walking is complex, suggestion of more guidance about clinical assessment capacity and determining risk may enable increased shared decision making.
2. Beeston & Simmons, 1996 United Kingdom	To discover perceptions of practice and frame of reference in neurological rehabilitation	Qualitative Interviews	Expert physiotherapists (*n*=10) Age/gender: no data	Initial information gathering, objective assessment, patient identified problems, hypothesis testing, movement analysis, collaboration with patient re assessment findings, management planning, providing therapy prognosis, reflection in action	Movement analysis as a component of clinical reasoning with social and psychological considerations' (Cott et al, 1995). Other influencing components are patient-centred values, practice-centred knowledge and profession-specific action.
3. Carr et al., 1994 Australia	To establish: treatment choice in stroke rehabilitation, influencing factors, theoretical bases for treatment; attitudes towards changing interventions.	Mixed methods, Questionnaire	Physiotherapists (*n*=208) Age/gender: no data	Initial information gathering, objective assessment, standardised outcome measures, reassessment.	Clinical experience was the most important factor influencing choice of treatment. Respondents had difficulty explaining the underlying theoretical basis for their choice.
4. Galgon et al., 2024 United States of America	To explore factors related to clinical decision making of experienced physiotherapists who treat people with concussion	Semi structured interviews	Physiotherapists (*n*=10) Years since qualification: 6-35	Initial information gathering, objective assessment, patient identified problems, hypothesis testing, movement analysis, collaboration with patient re assessment findings, management planning, prediction, reflection in action, standardised outcome measures, reassessment, monitor effectiveness of therapy.	Four themes identified were: expert practice behaviours; listening and observing; therapeutic alliance building adaptability.

Author/year/ country/study number	Study aims	Study design	Participants	Clinical reasoning processes or components	Outcomes/findings
5. Held Bradford et al., 2018 United States of America /Canada	Describe decision making processes of physiotherapists and persons with Multiple sclerosis around maximising gait and balance.	Multi-method case series design with matched pairs, semi structured interviews and questionnaires.	Physiotherapists and persons with Multiple Sclerosis (*n*=12) with 7 matched pairs Age 27-56 (no age for 2 PTs) Gender: no data Years qualified of physiotherapists: 2-34 years with (no data for 2 pts).	Initial information gathering, objective assessment, patient identified problems, movement analysis, goal setting, management planning, prognosis,	Persons with MS identified challenging self by pushing but respecting limits and physical therapists (finding the right fit). “One overarching theme, keeping their lived world large, or participation in valued life roles, emerged integrating both perspectives driving decision-making”.
6. Hubbard & Parsons, 2007 Australia	Identify the roles and responsibilities of the Occupational therapists and Physiotherapists in an acute stroke unit? Can a model of practice be developed? Compare practice to Australian NSF's acute management guidelines (NSF, 2003).	Mixed methods. Case study in an acute stroke unit. Audit of patient and service delivery documentation and semi structured interviews of Occupational therapists and Physiotherapists .	Physiotherapist and Occupational therapist (*n*=2). Age/gender: no data	Initial information gathering, objective assessment, patient identified problems, hypothesis testing, goal setting, management planning, therapy intervention, prognosis, discharge planning.	Roles of both therapists were to perform an initial examination as efficiently as possible, and this was noted to place in a pressured environment. Skills identified were hypothesis-driven clinical reasoning were highlighted. Therapy provided by the therapists met the national stroke guidelines.
7. Kleynen et al., 2017 United Kingdom	Explore which motor learning options are applied by experienced physiotherapists in neurological rehabilitation	Qualitative semi-structured interviews	Physiotherapists (*n*=5) Age 30-56 Gender: no data.	Initial information, hypothesis testing, movement analysis, management planning, therapy intervention, reflection in action, prognosis reassessment.	‘Five verbs were identified that indicated how physiotherapists made decisions between differing motor learning options these were: ‘‘act’’, ‘‘know’’, ‘‘observe’’, ‘‘assess’’ and ‘‘argue’’. The ‘‘act’’ operator consisted of 34 motor learning options, which were clustered into ‘‘instruction’’, ‘‘feedback’’ and ‘‘organization’’. The ‘‘know’’, ‘‘observe’’, ‘‘assess’’ and ‘‘argue’’ operators explained how therapists chose one of these options’.

Author/year/ country/study number	Study aims	Study design	Participants	Clinical reasoning processes or components	Outcomes/findings
8. McGlinchey & Davenport, 2015 United Kingdom	Explore the decision-making process in a Stroke unit	Qualitative, semi-structured interviews	Physiotherapists (*n*=7) Age: no data Gender: Male (*n*=2) Female (*n*=5)	Goal setting, providing therapy, reflection in action, reassessment.	Influencing factors on clinical decision making were the therapist's clinical experience, patient's presentation and response to therapy, prioritisation, organisational constraints, and compliance with organisational practice. 'All physiotherapists highlighted the importance to involve patients in planning and delivering their physiotherapy.'
9. McGlynn & Cott, 2007 Canada	Clinical decision making in neurological physiotherapy practice	Qualitative, semi- structured interviews	Physiotherapists (*n*=12) Gender: no data Years qualified: 9-21 years.	Initial information gathering, objective assessment, standardised outcome measures, movement analysis, goal setting, hypothesis testing, management planning, providing therapy, prognosis, reassessment.	Therapists use informal sources for clinical decision-making including observation, goal setting and peers more than formal sources of evidence.
10. Nikopoulou-Smyrni & Nikopoulos, 2007 United Kingdom	To develop and development and collect data on the Application of a new clinical reasoning model with patients suffering a stroke or Transient Ischemic Attack (TIA).	Quantitative, pre-test post-test Control group design	Healthcare professionals (*n*=12) (2 doctors,2 nurses, 4 senior physiotherapists, 4 senior occupational therapists) working in the neurological and the Accident and Emergency (A&E) units of an acute general hospital. Gender: no data	Initial information gathering, objective assessment, patient problems, goal setting, management planning, reflection in action, reassessment.	Median percentages of correct clinical reasoning responses were higher in the experimental group by using the Amadysis model for Clinical reasoning. This Model follows the steps of initial information gathering, problem identification, 'predicted risk adjusted outcomes', goal development, develop management plan, 'specify treatment target', provide therapy and monitor effectiveness, complete discharge plans and evaluate outcomes, community integration, need for further intervention.
11. Normann et al., 2014 Norway	To identify what community physiotherapists, perceive to be significant in clinical guidance and how this guidance may affect their treatment of people with Multiple Sclerosis (pwMS).	Qualitative, interviews and observations	Community physiotherapists (*n*=9) Age: no data Gender: Female (*n*=7) Male (*n*=2).	Initial information gathering, movement analysis, prognosis.	Significant clinical guidance includes 'movement analysis, observation of patient handling and body alignment, exploration of improvement of movement embedded in explanations and discussion promoting clinical reasoning through reflection during action as well as following action.

Author/year/ country/study number	Study aims	Study design	Participants	Clinical reasoning processes or components	Outcomes/findings
12. O'Brien et al., 2021 United States of America	To describe Clinical reasoning processes during inpatient rehabilitation for the prescription of walking aids and to determine if clinical reasoning processes differed in two different facilities and diagnosis.	Online Survey and Focus Group	Physiotherapists (*n*=67) Age/Gender: no data Years qualified: <1-5 (*n*=9) 6-20 (*n*=20) >20 (*n*= 23) unknown (*n*=4)	Initial information, objective assessment, standardised outcome measures, movement analysis, goal setting, management planning, prognosis, discharge planning.	The clinical reasoning process included five primary factors: assessment of safety, balance, cognition, strength, and function to determine the need and justification for a walking. Three therapist-related factors were experience/preference, training parameters, and use of objective tools; seven patient-related factors were experience/preference, fluctuations, fear, age, diagnosis/comorbidities, discharge environment, and payer individualized care.
13. Pattison et al., 2015 Canada	To explore the methods physiotherapists, use to evaluate walking poststroke, reasons for their choice, and the use of assessment results in clinical practice.	Qualitative, semi-structured interviews	Physiotherapists (*n*=28) Age: 20-29 years(*n*=5) 30-39 years (*n*=9) 40-49 years (*n*=10) 50+ years (*n*=4) Gender: no data	Movement analysis, reassessment.	Movement observation and standardised assessment tools. This was influenced by characteristics of the tool, the therapist, the workplace, the patients, as well as 'influential individuals or organizations.' The main influence was familiarity and 'assessment repertoire', and patient factors. Results of walking assessments were used to communicate progress to the patient and health care professionals.
14. Plummer et al., 2006 Australia	To identify methods used by physiotherapists to assess hemi spatial neglect.	Qualitative, focus groups and interviews	Physiotherapists (*n*=33) Age/Gender; no data.	Initial information, hypothesis testing, movement analysis, management planning.	Physiotherapists are primarily concerned with the functional implications of unilateral neglect; this is not commonly measured with standardised tools. Physiotherapists appear to use both hypothesis testing and pattern recognition approaches to clinical reasoning in the assessment of unilateral neglect.

Author/year/ country/study number	Study aims	Study design	Participants	Clinical reasoning processes or components	Outcomes/findings
15. Seale & Utsey, 2020 United States of America	To explore clinical reasoning when assessing and managing gait in people with hemiplegia.	Qualitative, focus groups	Physiotherapists (*n*=22). Age: average age of novice 26.7 years, average age of experts 38.45. Gender: Novice, female (*n*=5), male (*n*=3) Expert, female (*n*=14). Years qualified: average novice 1.42 years, expert 12.64 years.	Initial information, objective assessment, patient problems, hypothesis testing, goal setting, reassessment.	Assessment of common gait deficits found in persons with hemiplegia. Five themes emerged: all participants take a systematic approach to examination and evaluation; all participants agree that treatment differs according to experience; and orthotics management.
*16. Wainright et al., 2010 United States of America	To determine reflection that informs the clinical decision-making process comparing clinical decisions made by novice and experienced physiotherapists.	Qualitative, observation and videotaping that lead to semi structured interviews.	Physiotherapists (*n*=6), Age: 26-30 years (*n*=3) 31-35 years (*n*=2) 36-40 years (*n*=1) Gender: Female (*n*=3) Male (*n*=3) Years qualified: <1 year (*n*=3) 8 years (*n*=3)	Objective examination, Management planning, outcomes, reflection in action, prognosis, reassessment.	Three types of reflection were identified for clinical decision making: reflection on specific action, reflection-in-action, reflection on professional experience. There were differences noted between novice and experienced therapists regarding reflective practices. For reflection in action, novice therapists discussed patient performance relative to their expectations of the patient and experienced therapists in addition discussed their own thought processes and outcomes.

Author/year/ country/study number	Study aims	Study design	Participants	Clinical reasoning processes or components	Outcomes/findings
*17. Wainright et al., 2011 United States of America	To identify differences in clinical decision-making abilities and processes between novice and experienced physiotherapists.	Qualitative, observation, interviews	Physiotherapists (*n*=6), Age: 26-30 years (*n*=3) 31-35 years (*n*=2) 36-40 years (*n*=1) Gender: Female (*n*=3) Male (*n*=3) Years qualified: < 1 (*n*=3) 8 (*n*=3)	Movement analysis, reflection in action, prognosis.	The factors that influenced clinical decision making were categorized as informative or directive. Novice participants relied more on informative factors such as: predicted patient performance and personal experiences. Experienced participants were more likely to rely on directive factors such as protocols, information from medical records and observation of patient movement.

**Note that papers 16 and 17 were derived from the same study but were both included, as the papers explored different aspects of clinical reasoning*.

5.3.4 Conceptual frameworks that guide clinical reasoning

The conceptual framework papers described a total of 25 different frameworks. The most frequently reported frameworks include the ICF (n=4) (Dimitriadis et al., 2016; Potter, 2011; Schenkman et al., 2006; Sullivan, 2011), The Guide to Physical Therapist Practice (n=3) (Dimitriadis et al., 2016; Potter, 2011; Schenkman et al., 2006), and the Hypothesis-Oriented Algorithm for Clinicians (HOAC II) (n=3) (Briggs, 2011; Schenkman et al., 2006, Deutsch et al., 2006). For further details, refer to Appendix H.

Four of the included papers described a sequential approach to the clinical reasoning process (Cohen, 2020; Gill-Body et al., 2021; Potter et al., 2015; Sullivan, 2011). Three papers described frameworks using a complex non-sequential approach to clinical reasoning, guiding the user to revisit assessment or to generate a hypothesis (Dimitriadis et al., 2016; Michelsen et al., 2021, Shenkman et al., 2006).

5.3.5 Components of the clinical reasoning process

Components of the clinical reasoning process reported across the 30 included papers are presented in Table 4-3 (conceptual framework papers) and Table 4-4 (clinical practice studies). When mapped against the 16 practice standard items retrieved from the World Physiotherapy Standards (2011) and The Physiotherapy Practice Thresholds In Australia and Aotearoa New Zealand (Physiotherapy Board of Australia & New Zealand, 2023), all the identified components fitted to 15 of the 16 items. Initial information gathering was reported in 23 (76.6%) of 30 studies included. Other frequently reported components included evaluation/reassessment (n=21; 70%), movement analysis/diagnosis (n=20; 66.6%), objective examination (n=19; 63%), and predicted patient performance (n=19, 63%).

Table 4-3 presents the clinical reasoning components identified in the conceptual framework papers (n=13) mapped against the 16 practice standard items (World Physiotherapy Standards, 2011; Physiotherapy Board of Australia & New Zealand, 2023). Evaluation and reassessment (n=12) and collaboration with patients (n=11) were the most frequently reported components of the clinical reasoning process, followed by initial information gathering (n=10), and differential diagnosis (n=10). Documentation was not identified in any of the conceptual framework papers. None of the conceptual framework papers included all of the identified components as identified in the World Physiotherapy Standards (2011) and The Physiotherapy Practice Thresholds in Australia and Aotearoa New Zealand (Physiotherapy Board of Australia & New Zealand, 2023).

Table 5-3 Clinical reasoning components identified in conceptual framework papers mapped against Practice Thresholds and standards (data from search, 2024)

AUS/NZ Thresholds	World Physiotherapy Standards	Briggs 2021	Cohen 2020	Dimitriadis 2016	Gill-body 2021	Michelsen 2019	Normann 2015	Oberg 2015	Potter 2011	Schenkman 2006	Sullivan 2011	Sullivan 2004	Sullivan 2000	Watson 1999
Initial information gathering 1.1g	2.10.1.1 and 2.10.1.2		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
ICF 1.1a, 1.1f	-				✓	✓			✓	✓	✓	✓	✓	
Objective examination including function (diagnostic tests) 1.1h	2.10.1.1 and 2.10.1.2		✓	✓	✓				✓	✓	✓	✓	✓	
Outcomes including standardised measures 1.1h	2.10.1.2 and 2.10.2.4	✓	✓	✓	✓	✓			✓	✓	✓			
Patients presenting problems 1.2a	2.10.1.2	✓	✓	✓		✓				✓	✓	✓	✓	
Collaboration with patient regarding assessment findings 1.1e	2.2.2	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Differential diagnosis/hypothesis formation 1.1i	2.10.1.1	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓
Movement analysis/diagnosis 1.1k	-			✓	✓	✓	✓	✓		✓	✓	✓	✓	
Collaborative goal setting 1.2c	2.10.2.1	✓	✓	✓		✓		✓	✓	✓	✓			
Management/treatment planning 1.3c	2.10.1.1 and 2.10.1.2	✓	✓	✓		✓				✓			✓	

AUS/NZ Thresholds	World Physiotherapy Standards	Briggs 2021	Cohen 2020	Dimitriadis 2016	Gill-body 2021	Michelsen 2019	Normann 2015	Oberg 2015	Potter 2011	Schenkman 2006	Sullivan 2011	Sullivan 2004	Sullivan 2000	Watson 1999
Monitor effectiveness of therapy 1.3c	2.10.5	✓	✓	✓	✓	✓	✓	✓		✓				
Reflection in action 1.1j	-	✓				✓		✓						
Predicted patient performance (prognostication) 1.2b, 1.2e	2.10.1.1	✓				✓		✓		✓	✓	✓	✓	
Evaluate/reassessment 1.2d	2.10.1.1 and 2.10.4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Referrals/ discharge planning 1.1l	2.10.1.2 and 2.10.2.3	✓	✓	✓										
Documentation	2.10.4.2 and 2.5													

Table 5-4 displays the clinical reasoning components identified in the clinical practice studies (n=17), mapped against the 16 practice standard items. The most frequently reported components of clinical reasoning included initial information gathering (n=11), predicted patient performance (prognostication) (n=10), movement analysis/diagnosis (n=9), management/treatment planning (n=9), and objective examination including function (diagnostic tests) (n=9). No reference was made to the use of ICF, or to documentation.

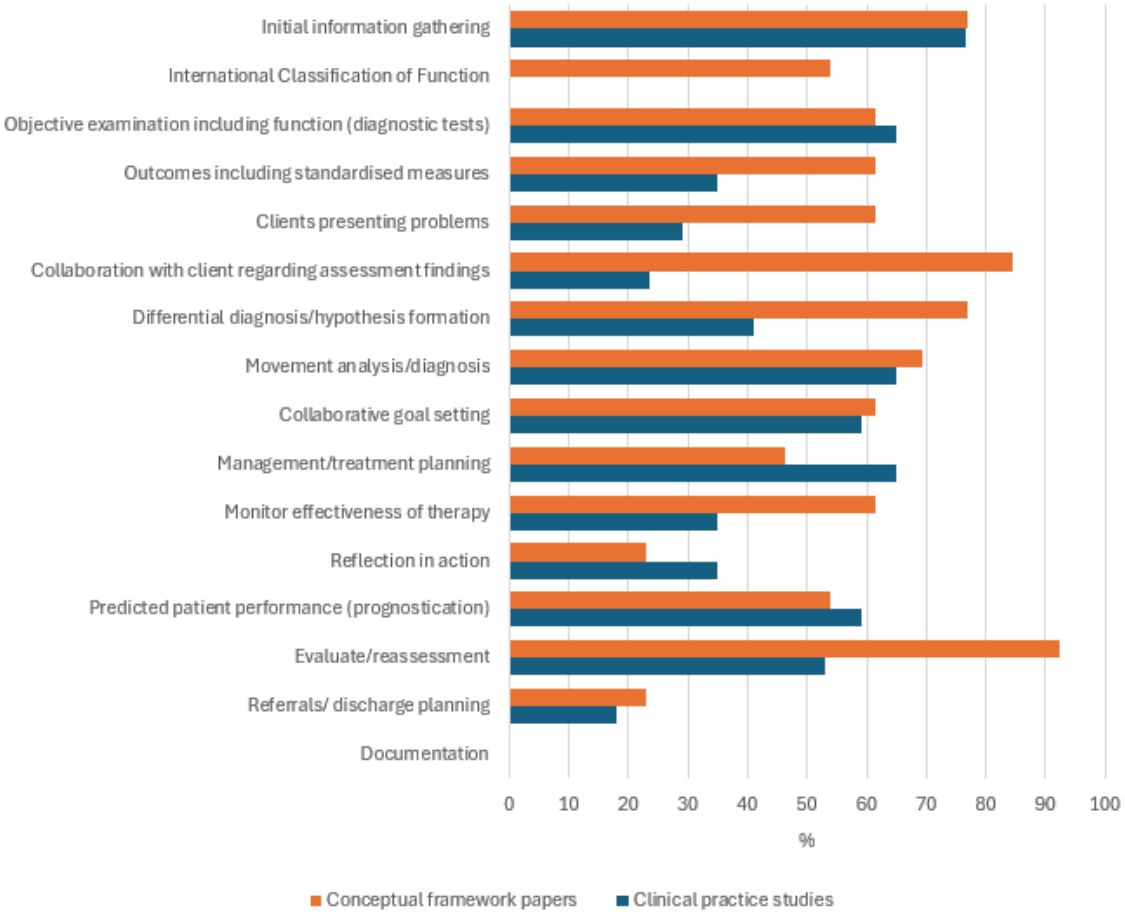
Table 5-4 Clinical reasoning components identified in clinical practice studies mapped against Practice Thresholds and standards (data from search, 2024)

Aus/NZ Thresholds	World Physiotherapy standards	Bainbridge et al., 2024	Beeston & Simmons, 1996	Carr et al., 1994	Galgon et al., 2024	Held Bradford et al., 2021	Hubbard & Parsons, 2007	Kleyynen et al., 2017	Mcglinchey & Davenport, 2015	McGlynn & Cott, 2007	Nikopoulou-Smyrni & Nikopoulos, 2007	Normann et al., 2014	O' Brien et al., 2021	Pattison et al., 2015	Plummer et al. 2006	Seale & Utsey, 2020	Wainright et al., 2010	Wainright et al., 2011
Initial information gathering 1.1G	2.10.1.1 and 2,10.1.2	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓		
ICF 1.1A, 1.1F	-																	
Objective examination including function (diagnostic tests) 1.1H	2.10.1.1 and 2.10.1.2	✓	✓	✓	✓	✓	✓			✓	✓		✓			✓		✓
Outcomes including standardised measures 1.1H	2.10.1.2 and 2.10.2.4	✓		✓	✓					✓			✓					✓
Patients presenting problems 1.2A	2.10.1.2		✓		✓	✓	✓					✓				✓		
Collaboration with patient regarding assessment findings 1.1E	2.2.2		✓		✓	✓	✓											
Differential diagnosis/hypothesis formation 1.1I	2.10.1.1		✓		✓	✓	✓		✓						✓	✓		
Movement analysis/diagnosis 1.1K	-	✓	✓		✓	✓		✓		✓		✓	✓	✓	✓			✓
Collaborative goal setting 1.2C	2.10.2.1	✓	✓			✓	✓		✓	✓	✓		✓			✓		

Aus/NZ Thresholds	World Physiotherapy standards	Bainbridge et al., 2024	Beeston & Simmons, 1996	Carr et al., 1994	Galgon et al., 2024	Held Bradford et al., 2021	Hubbard & Parsons, 2007	Kleyynen et al., 2017	Mcglinchey & Davenport, 2015	McGlynn & Cott, 2007	Nikopoulou-Smyrni & Nikopoulos, 2007	Normann et al., 2014	O' Brien et al., 2021	Pattison et al., 2015	Plummer et al. 2006	Seale & Utsey, 2020	Wainright et al., 2010	Wainright et al., 2011
Management/treatment planning 1.3C	2.10.1.1 and 2.10.1.2	✓	✓		✓	✓	✓	✓		✓	✓		✓		✓		✓	
Monitor effectiveness of therapy 1.3C	2.10.5		✓		✓	✓	✓	✓	✓									
Reflection in action 1.1J	-				✓			✓	✓		✓						✓	✓
Predicted patient performance (prognostication) 1.2B, 1.2E	2.10.1.1		✓		✓	✓	✓	✓	✓	✓		✓	✓				✓	✓
Evaluate/reassessment 1.2D	2.10.1.1 and 2.10.4	✓		✓	✓			✓		✓	✓			✓		✓	✓	
Referrals/ discharge planning 1.1L	2.10.1.2 and 2.10.2.3	✓					✓						✓					
Documentation	2.10.4.2 and 2.5																	

Figure 5-2 presents the findings of the conceptual framework papers and clinical practice studies. This illustrates that although the same clinical reasoning components were covered in conceptual framework papers and clinical practice studies, this occurred more consistently in conceptual framework papers. Collaboration with patients regarding assessment findings was reported more than four times as frequently in the conceptual framework papers compared to the clinical practice studies (85% vs. 20%). The use of outcomes including standardised measures, differential diagnosis, patients presenting problems, and monitoring effectiveness of therapy were all reported approximately twice as frequently in the conceptual framework papers compared to the clinical practice studies. The ICF was referred to in over half (54%) of the conceptual framework papers but in no clinical practice studies. Documentation was not reported at all.

Figure 5-2 Side by side comparison between conceptual framework papers and clinical practice studies (data from search, 2024)



5.4 Discussion

This review explored the literature pertaining to clinical reasoning in neurological physiotherapy. Twenty-five conceptual frameworks were identified. Components of the clinical reasoning process identified in 30 included studies (13 conceptual framework papers and 17 clinical practice studies) were mapped against a set of 16 practice standards based on the World Physiotherapy Standards

(World Physical Therapy, 2011) and Physiotherapy Practice Thresholds in Australia & Aotearoa New Zealand (Physiotherapy Board of Australia & New Zealand, 2023). Initial formation gathering was the most frequently (82%) reported component of clinical reasoning, followed by evaluation/reassessment (75%) and movement analysis/diagnosis (71%). Overall, components of clinical reasoning were referred to more frequently in conceptual framework papers than in clinical practice studies, but no papers included all of the clinical reasoning components from the World Physiotherapy Standards (2011) and The Physiotherapy Practice Thresholds In Australia and Aotearoa New Zealand (Physiotherapy Board of Australia & New Zealand, 2023). Documentation was not mentioned in any study or conceptual framework paper. Collaboration with patients regarding assessment findings was referred to four times more frequently in the conceptual framework papers compared to the clinical practice studies. The ICF was only referred to in conceptual framework papers but not in clinical practice studies. This framework was the most frequently referred to (Dimitriadis et al. 2016; Potter 2011; Schenkman et al. 2006; Sullivan 2011). The ICF framework has been developed as a statistical instrument, review tool, clinical tool, and social and pedagogical policy (Levack et al., 2004; Steiner et al., 2002; Cerniauskaite et al., 2011). A study by Wiegand et al. (2012) on occupational therapists in clinical practice noted that 70% of them knew of the ICF, but only 30% used this tool in clinical practice. This is in agreement with findings from a recent cross-sectional study by Pernambuco et al. (2018) who evaluated the knowledge of physiotherapists working in rehabilitation regarding the ICF and its application. The findings showed that although 83% of physiotherapists believed it was feasible to use this tool in practice, the extent of the tool and its complexity hampered its use in clinical practice (Stucki et al., 2002).

5.4.1 Conceptual frameworks

Most of the conceptual framework papers included in this review aimed to develop a guiding framework for physiotherapy management along the trajectory of a specific condition, or for neurological conditions in general (Briggs, 2001; Cohen, 2020; Dimitriades, 2016; Normann, 2015; Oberg, 2015; Michelsen, 2019; Sullivan, 2004; Sullivan, 2000). Many of the concluding frameworks were based on existing published frameworks (n=10), whereas others were guided by research evidence without an existing published framework (n=3).

It could be argued that the skills of clinical reasoning are difficult to teach to students or novice clinicians because of the implicit nature of the process (Marcum, 2012), and that having a framework to guide thinking may help with the leap from novice to expert practitioner. How can the structure of these frameworks assist in guiding clinical reasoning? Only three (Cohen, 2020; Gill-body, 2021; Sullivan, 2011) of the included frameworks had a sequential structure, suggesting a predictable learning paths for clinical reasoning, with others suggesting processes with varying components that could be revisited during the process. From this study, it appears that there is no one size that fits all, and that frameworks have been developed to provide guidance in clinical

reasoning in different clinical situations. These conceptual frameworks can be used to explore the process of clinical reasoning and may be useful towards developing clinical reasoning skills in neurological physiotherapy practice.

The lack of consistency in the design and flow of the included conceptual frameworks mirrors the implicit nature of clinical reasoning processes that often occur in clinical practice. Making this process more transparent and explicit may make it easier to understand for those less experienced. Corrao and Argano (2022) suggest that with regard to clinical reasoning, clinicians should focus more on the how they think, rather than what. They note six core elements of clinical reasoning to be evidence-based skills, interpretation and use of diagnostic tests, understanding cognitive biases, human factors, metacognition, and patient-centred evidence-based healthcare. Only the use of diagnostic tests, such as standardised measures and person-centred care, reflected in the inclusion of collaborative goal setting and the patients' presenting problems, were identified in this review.

5.4.2 Commonly identified components of clinical reasoning

The component 'Initial information gathering' was included in most papers (82%). It refers to the usual assessment process of collecting information from various sources including a conversation with a patient. This initial information gathering leads to a physical or objective examination (Garner & Lennon, 2018), which in turn leads to the development of a movement-related hypothesis. Findings from a recent review by Garner et al. (2023), showed that movement analysis and diagnosis, treatment planning, and re-assessment are commonly included in the physiotherapy assessment of people with neurological conditions. These elements have been identified as core components of clinical reasoning and are supported in this scoping review and by recent literature. The core components of collaboration with patients regarding assessment findings and the discharge planning process have not been justified in this review or supported by recent evidence. Could the reason be that this core component is not needed or possibly that this component is incorporated into treatment discussions or re-evaluation sessions between physiotherapists and clients?

Approximately 70% of the included papers reported movement analysis as a component of clinical reasoning. Movement analysis plays a crucial role in the physiotherapy assessment of people with neurological conditions (Buckley et al., 2019; Fisher, 2020). During this process, physiotherapists observe whether movement is typical or atypical. According to Fisher (2020) the primary aim of movement analysis is to determine the patient's movement capacity. This, combined with other assessment findings, helps physiotherapists hypothesize a movement diagnosis, guiding clinical decisions regarding management and predicting of patient outcomes.

Physiotherapists utilise the information gathered during the assessment and management of a person with a neurological condition to predict the degree of progression of the condition, including

functional levels, needs at the end of their service, or at discharge from the clinical setting, whether favourably or unfavourably. Neurological conditions may be stable, progressive, or degenerative (Lennon et al., 2018), and the prediction of improvement is based on the research evidence along with the physiotherapist's knowledge and experience. Prediction and prognostication were identified in 61% of the included papers as integral aspects of the clinical reasoning process. Even though the percentage of papers including predication and prognostication were just over half, skills and knowledge in the area of predication and prognostication is an expected part of clinical practice.

Flew et al. (2023) explored areas of underperformance in high-stakes, clinically based simulation assessments of overseas-trained physiotherapists seeking registration in Australia, in all areas of practice. The ability to make clinical decisions about treatments emerged as a frequent area where participants did not achieve competency requirements. Similarly, Judd et al. (2016) explored student competency using simulation and found that reflection, goal setting, and interpretation of assessment findings were common areas of failure. This suggests that clinical decision making, reflection, goal setting and interpretation of findings as aspects of clinical reasoning require greater emphasis to assist students in achieving competency. This aligns with findings from a systematic review by Brentnall et al. (2022) which highlighted that students tend to focus more on diagnostic reasoning than on reasoning for patient management during health professional placement simulations and consideration of the needs expressed by the patient. In this review reflection was only identified by a limited number of papers, goal setting and interpretation of findings to form a hypothesis were frequently included components.

5.5 Limitations

Limitations of this scoping review include the potential for language bias, as only studies published in English were included. This may have resulted in the exclusion of relevant research published in other languages, and perspectives other than western, potentially limiting the global perspective on clinical reasoning in neurological physiotherapy.

Additionally, while a comprehensive search strategy was employed, it's possible that some relevant studies may have been missed, particularly those using terminology not captured by our search terms.

5.6 Conclusion

This review aimed, within the context of neurological physiotherapy, to outline the conceptual frameworks currently used in assessment and to identify key components of the clinical reasoning process. Five components were cited in over 70% of the studies: information gathering; hypothesis formation; collaboration with clients; movement analysis/diagnosis; and evaluation/reassessment.

Twenty-five frameworks were identified, the most frequently referenced was the ICF. Further research is required to develop a comprehensive clinical reasoning framework for neurological physiotherapy. The findings from the previous chapters, which explored assessment and clinical practice, informed the web-based audit and interviews presented in the next chapter.

CHAPTER 6 WHAT DO WE TEACH PHYSIOTHERAPY STUDENTS ABOUT THE ASSESSMENT OF PEOPLE WITH NEUROLOGICAL CONDITIONS? A MIXED METHODS STUDY EXPLORING THE AUSTRALIAN CURRICULUM AND EDUCATOR PERCEPTIONS

The systematic review, survey and scoping review, described in chapters 3,4 and 5 have provided a comprehensive exploration of assessment and clinical reasoning in neurological physiotherapy clinical practice as well as frameworks aimed to guide this practice. These findings formed a foundation and informed the interview component of the study presented in Chapter 6. This chapter presents the findings from a mixed-method study examining curriculum content from a sample of Australian physiotherapy pre–registration courses. The study combines desktop-audit and interview methodologies to explore what is currently taught to physiotherapy students regarding the assessment of people with neurological conditions and how this is achieved.

6.1 Introduction

Neurological physiotherapy taught at pre-registration level is concerned with functions and disorders of the nervous system, including the brain, spinal cord, and nerves, with the focus on gaining and regaining function (Walker, 2013). Physiotherapy skills taught at universities must meet the required standards for graduates to be competent in assessment and management of people with neurological conditions in real-life settings. Little is known about entry-level physiotherapy curricula (Te et al., 2019) and how the curricula and content are delivered with respect to the assessment of people with neurological conditions.

Current physiotherapy practice threshold statements, published by the physiotherapy boards of Australia and New Zealand, set the requirements for all New Zealand and Australian physiotherapy graduates; however, they do not prescribe curriculum content (Physiotherapy Board of Australia & New Zealand, 2023). The structure and content of physiotherapy programs are designed by the teaching team and the Australian Physiotherapy Council (APC) assesses whether pre-registration programs meet the approved accreditation standards derived from physiotherapy practice threshold statements (McMeeken, 2007).

In the physiotherapy pre-registration program, students are taught the key components of neurological physiotherapy, which include assessment, movement analysis, exercise prescription, and treatment (WPT, 2011). Students are encouraged to adopt a problem-solving approach grounded in evidence-based practice, integrating skills learned throughout their degree in neurological physiotherapy (Walker, 2013). A challenge in teaching the assessment of people with neurological conditions is the range of potential deficits– physical, cognitive, behavioural, and/or perceptually based in nature – that must be considered to effectively treat patients (Garner &

Lennon, 2018). This complexity can be daunting for students, as there are fewer prescriptive techniques or clearly defined protocols for neurological problems compared to other areas of physiotherapy (Walker, 2013). As a result, students perceive the assessment and the associated clinical reasoning process as complex, which may hinder their ability to develop and deliver optimal treatment plans for this population (Walker, 2013; Abasıyanık et al., 2022).

There is a gap in knowledge with regards to what physiotherapists are taught about neurological assessment, and how this translates into clinical practice. Two studies have explored aspects of the physiotherapy curriculum. The first focused on cultural responsiveness (Te et al., 2019), noting variability in structure, teaching and assessment methods. The second study on paediatric physiotherapy (Mistry et al., 2019) noted crowded curricula and a lack of qualified staff to teach paediatric physiotherapy. This study highlighted the need for a standalone topic to teach this content. However, no studies to date have specifically explored the physiotherapy curriculum, and methods used for teaching and assessing neurological assessment.

This study aimed to investigate what physiotherapy students are taught about the assessment of people with neurological conditions and how this is achieved.

6.1.1 Study objectives

1. To describe the learning objectives of modules (a topic/subject or course that runs over several weeks or throughout the semester as part of a larger physiotherapy program) focused on the assessment of people with neurological conditions, taught to physiotherapy students.
2. To explore curriculum content of these modules in relation to the assessment of people with neurological conditions.
3. To characterise the teaching and assessment methods (both formative and summative) used to teach physiotherapy students in relation to the assessment of people with neurological conditions.
4. To explore educator perceptions of teaching physiotherapy students about the assessment of people with neurological conditions.

6.2 Methods

The research design adopted a mixed-methods approach, incorporating a web-based curriculum desktop audit and semi-structured interviews with university educators. Interviews were chosen as it allowed the respondents to provide rich, detailed insights into teaching neurology, allowing them to share their views and experiences in their own words without the influence of others in a focus group for example.

Ethical approval was obtained from the Human Ethics Low Risk Panel, Research Development and Support, Flinders University, South Australia (approval number: 4479). The results of this study were reported according to the COREQ checklist (Tong et al., 2007).

Recruitment occurred at two levels using purposive sampling (Rai & Thapa, 2015). This was used to gain a deeper understanding of teaching neurology, based on the experiences of educators teaching neurology to physiotherapy students at university in Australia. Firstly, all universities or institutions of higher education located in Australia offering entry-level pre-registration physiotherapy programs were invited to participate in the study. Physiotherapy programs were contacted by emailing academic leads who were identified through The Council of Physiotherapy Deans Australia and New Zealand (CPDANZ) in June 2021. Following, academic leads identified educators who taught assessment of neurological conditions to physiotherapy students at university. The academic leads then forwarded the contact details of the educators to the lead researcher (JG). Secondly, all identified educators were contacted via email and invited to participate in semi-structured interviews. Institutions only offering postgraduate diplomas, certificates, or higher degrees in physiotherapy post graduate courses were excluded from study invitation.

A web-based audit tool was developed to tabulate quantitative data. This tool was used pre-interview and captured the type of pre-registration degree (i.e., bachelor's, master's by coursework, doctor), units allocated to the modules that teach assessment of people with neurological conditions, learning objectives, and curriculum content. The audit was performed by a researcher (JG) accessing physiotherapy course details pertaining to neurological physiotherapy that were available via the internet. See Appendix I and J for the web-based curriculum audit questions. Next, semi-structured interviews were conducted with educators. The interview consisted of questions to gather participant demographics, to collect complementing information on curriculum content, teaching, and assessment methods (formative and summative) used to teach assessment of neurological conditions (see Appendix L, M, N). In addition, open ended questions to gather educator perceptions of teaching topics relevant in this context were explored. These included: Would you please tell me about your role in teaching neurology to physiotherapy students? Would you please tell me about your teaching methods when teaching neurology. Would you please tell me about assessment of this topic? Would you please tell me about content related to neurological assessment of people with neurological conditions? What facilitates learning neurology, in your opinion? What are barriers to learning in neurological assessment/clinical reasoning in your opinion?

The interviewer (JG) was a female researcher and a PhD student, trained in qualitative research methodology, and known to two of the interviewees. At the time of the study the interviewer was teaching physiotherapy assessment of people with neurological conditions to pre-registration

students as part of her role at university. All interviews were conducted using Zoom version 2.0.6 (Barbu, 2014), a video conferencing platform. Zoom was used as it is relatively easy to use, it is cost effective, has data management features that allow secure storage of data (Archibald et al., 2019) and was recorded by the interviewer.

Data collected through the desktop audit was collated using an a priori developed data-collection form. This collection form was completed by one researcher (JG) and reviewed for accuracy by another researcher (BL). BL was a female researcher and academic with extensive knowledge in qualitative research methodology, and at the time of the study was teaching physiotherapy assessment of people with neurological conditions to pre-registration students as part of her role at university. Textual data from the curricula audit was analysed and descriptively synthesised. Interview recordings were transcribed verbatim using zoom function. The transcripts were cross-checked by the researcher (JG) for accuracy and sent to the interviewees for review to ascertain if the transcript truly reflected their interview; no changes were made. Manifest content analysis (Kleinheksel et al., 2020) was conducted with the assistance of NVivo 12 software for data management and coding. Content analysis was chosen as it was designed to 'identify and interpret meaning in recorded forms of communication' (Kleinheksel., 2020). This methodology identifies data that represents relevant concepts and then organises the data in a way that describes the phenomenon. Manifest content analysis takes the meaning of the transcript at face value. Analysis of the data was based on three phases as described by Elo and Kyngas (2008). The initial phase was the preparation phase. This phase entailed selection of the units of analysis. All the answers from the interviews were reviewed by the interviewer (JG) and reread to familiarise themselves with the data in accordance with the study aims. One research team member (BL), who was not involved in the data collection or analysis, independently read 20% of the interviews. JG and BL met to discuss and understand the material until an agreement was reached on the units of analysis. This was done to ensure coding accuracy and inter-coder reliability within the research team. In the next phase (organising phase) meaning units were developed and confirmed based on the interview questions (Elo & Kyngas, 2008). The highlighted meaning units were then named as codes based on the interview questions. These were used as an initial coding framework (Sandelowski & Barroso, 2006). These codes formed a codebook from which both BL and JG independently coded all the interview data, (Ando et al., 2014; Roberts et al., 2019) see Appendix K. BL and JG met to group together codes into themes, this was further discussed with the research team. In addition, codes that emerged from the process of analysis were created as addenda to capture all findings relevant to the research questions (Lawless & Chen, 2019). This ensured coding accuracy and inter-coder reliability within the research team (BL and JG). When reporting on results of the educator interviews, assessment in terms of neurological assessment will be referred to as clinical assessment. When reporting on results of the educator interviews, to aid in distinguishing between assessment in terms of a clinical skills assessment of a person with a

neurological condition and an assessment at university related to a module or course assessment; the clinical skills assessment will be referred to as examination.

6.3 Results

6.3.1 Participants

Twelve (48%) universities from Australia agreed to participate in the study, out of 25 invited universities currently teaching neurological physiotherapy in pre-registration programmes. However, one university had only recently commenced and was not yet teaching neurological physiotherapy. Thirteen educators were interviewed in the qualitative study and 12 universities supplied their curriculum information for the audit. See Table 6-1 for demographic descriptors of the participating educators.

6.3.2 Learning objectives

The web-based audit gathered descriptions of all modules (n=24), (two modules from each included university) and their learning objectives, focusing on neurological assessment and the clinical reasoning process. In the module descriptions, key words related to assessment (assessment/examination) were found in 9 modules, while reference to the ICF framework was found in 6 modules. However, key terms reflecting clinical reasoning (clinical reasoning, evaluation, management, decision making) were present only in 4 modules, the key word “evaluate” appeared in three modules. Person- centred care and reflection were only included by one of two modules. See Table 6-1 for an overview of web-based audit results. This table shows the frequency of terms reflecting assessment and clinical reasoning in the included module descriptions and learning objectives. See Table 6-2 for demographic descriptors of the participating educators.

Table 6-2 Web based audit of modules related to neurological assessment of the included universities (data from 2021)

Number of Degree programs offered by universities		Frequency of words identified in module descriptions such as assessment and clinical reasoning. (the words are grouped below based on frequency only)		Frequency of clearly documented assessment or clinical reasoning of people with neurological disorders/conditions in the learning objectives	
Doctor of Physiotherapy	4	assessment/examination	9	assessment/examination	8
Master	5	clinical reasoning, ICF framework, evaluation, management, decision making	6	impairments, EBP. ICF Framework	4
Bachelor with honours	8	lifespan, movement, analysis	4	outcomes, assessment tools	3
Bachelor	7	evaluate, safely, EBP	3	person centred, reflect, effectively and efficiently, safely assess, prioritised problem list, analyse	2
		outcome measures, goals	2	apply theoretical clinical reasoning framework, across the lifespan. interpretation, clinical reasoning, risk minimisation, critical thinking	1
		Person centred, interpretation, principles of treatment selection, dysfunction, prioritise	1		

Table 6-3 Demographic descriptors of the participating educators (data from 2021)

Descriptors		*n* (%)
Gender	Female	12 (92.3)
	Male	1 (7.7)
Age	30-39 years	4 (30.7)
	40-49 years	3 (23.1)
	50-59 years	3 (23.1)
	60-69 years	3 (23.1)
Highest level of qualification	PhD	7 (53.8)
	Studying research higher degree	3 (23.1)
	Masters	1 (7.7)
	Grad Dip	1 (7.7)
	BSc	1 (7.7)

6.3.3 Qualitative data from educator interviews

Interviews took place between June and October 2021 and lasted between 30-45 mins. Data from the interviews was analysed and is presented below.

6.3.4 Curriculum content

Interviews revealed that all curriculum content related to neurological physiotherapy was taught within a foundational module, often based on the condition of stroke (n=9, 69%), with an additional, more advanced module including degenerative neurological conditions (n=9, 69%). Educators reported the teaching of the clinical assessment process to be structured. The clinical assessment structures taught to physiotherapy students included functional assessment (n=3, 23%), impairment assessment (n=11, 85%), and assessment based on the ICF framework (n=6, 46%): "When we teach the assessments, we also teach a basic assessment framework. So, we talk about ICF and……. family centred practice and the ICF" (ID9).

The importance of standardised measures and goal setting was also reported, with some educators incorporating standardised measures across all included assessment domains. Additionally, more than three-quarters of the educators reported teaching evidence-based content and learning approaches that align with clinical practice.

6.3.5 Teaching and assessment methods (formative and summative)

All educators utilised university-provided online platforms to host and deliver course content. Educators reported using a combination of teaching formats, including lectures, practicals, and tutorials. Various methods were used to check student understanding after teaching sessions, such as question-and-answer sessions (n=6, 46.1%) or knowledge and skills checks (n=3, 23.1%). A flipped classroom and case-based learning approach was commonly used (69.2%) to teach assessment and clinical reasoning. Practical sessions included: demonstration and observation by five (38.5%) educators, and 'hands on' practice was employed by seven (53.8%) educators to support learning. To develop students' assessment skills 23.1% of educators taught students a method of assessment referred to as 'movement analysis' to assess activity and function.

Access to real patients was noted to be important for teaching neurological assessments and providing context (n=4, 33.3%). To enhance students' learning of neurological assessment educators invited people presenting with neurological conditions into the classroom, or alternatively this was achieved by using patient simulations, patient videos, or students attending clinical settings.

> I like to have real patients … I take the students to the hospital ... to see the real patient or even if we cannot go the best thing is to show them the videos. Showing them [physiotherapists] working with real patients in house (ID5).

Patient videos were developed by educators and physiotherapy clinicians or sourced from online platforms such as YouTube: "Just putting together really simple videos by us, you know, doing a particular skill … can be really, really useful" (ID1).

Using simulation was reported by seven (67%) of the educators. The involvement of actors with physiotherapy experience was suggested to enhance the value of these simulations (n=7, 58.3%). *"*Think it's quite valuable. We have some really good actors, people that are now retired that used to teach into the programme as well. They're excellent" (ID2).

Physiotherapy students took on the role of the patient in the simulation. Students who acted as patients reported gaining valuable learning from the experience*:*

> We used to get actors in for that … last year. And we were just kind of opening up (re Covid-19). But we didn't want to risk our actors as they are usually older people … so we used students and it worked so well … We used second- and third-year students. And it was really great for everyone involved (ID3).

With regards to assessment methods, all educators reported using a summative examination to evaluate students' knowledge of assessment. Most utilised questions in a written assignment or exam format to assess this knowledge:

> Then in our written exam … a problem-based assessment type format. They (students) might watch a video, and it might be on bed mobility, and they have to write down, what am I observing? What and the contributing factors? How would I test for those contributing factors? (ID7).

All educators reported also using a practical exam to evaluate their knowledge of and skills to conduct an assessment. Described methods were practical exam, Objective Structured Clinical Examination (OSCE) and Viva.

Educator perceptions of teaching assessment are presented under five themes: expectations, scaffolding, context, complexity, and clinical reasoning.

6.3.6 Expectations

Educators considered both their own expectations and those of the students regarding what students needed to succeed in the subject. Educators believed that students view neurological physiotherapy as complex, making them apprehensive: "so I think neuro can be quite abstract to a lot of students … but it's a hard module. Students come in a little scared, and think it's really complicated" (ID4).

Educators expected students to come prepared and fully engage with the module. They valued student immersion in neurological content, which included preparing by reading online materials and watching videos: “they can just immerse themselves in neuro and build their skills, and I can just see them really flourish over the semester” (ID1).

Preparations by students for practicals and tutorials were deemed important (n=9, 69.2%). This preparation commonly involved independent learning (n=9, 69.2%), such as viewing videos or reviewing online resources.

6.3.7 *Scaffolding*

The theme of scaffolding referred to the scaffolding of learning, i.e. structured support provided, throughout modules. Typically, each module began with a presentation on a less complex condition, such as stroke. Educators reported that after this initial presentation, ongoing support was provided to help students progressively advance to more complex conditions, thereby scaffolding their approach to assessment: “There’s one neuro module, which is like the fundamentals, and then there’s a second, which is more complex like Parkinson’s and multiple sclerosis” (ID1).

It was reported by educators that scaffolding enabled students to first learn all the essential components of assessment and then apply and modify this acknowledge for a variety of patient presentations.

> I think that's, I guess one of the reasons we scaffold the teaching is to teach them everything in its full form, and then apply it to different populations and conditions, which helps hopefully, the clinical reasoning and interpretation and the selection prioritisation process of different assessments as well (ID9).

6.3.8 Clinical reasoning

Educators mentioned the teaching of clinical reasoning, highlighting components such as evaluation of assessment findings, prioritization these findings, and developing individualized management plans. They reported teaching students how to prioritise clinical assessment findings effectively:

> I might get them to actually interpret what would be the key piece of it (information), which part? Which assessment information do you think is most relevant? So to actually identify what would be the key piece of information for them to, to use (ID8).

Educators referred to the use of movement analysis, and the ability to prioritize assessment findings of movement analysis, allowing students to decide on how to proceed with further testing. This was identified as an essential part of the clinical reasoning process: “Usually starting with movement analysis, which helps direct them to which specific tests they'd use, which helps direct them to which outcome measures” (ID 4).

The identification of specific tests and measures as part of assessment, along with the accurate completion of patient-centred problem lists, was noted as a crucial part of learning about assessment and clinical reasoning.

6.3.9 Context

Educators noted that including contextual information provided students with a deeper understanding of clinical practice with people with neurological conditions, adding additional depth and meaning whilst enriching their overall learning experience. This contextualisation was deemed important as people with neurological conditions clinically present differently from one another. For example, muscle response and tone can vary significantly in people with neurological conditions compared to other conditions. An illustrative example provided was the assessment of tone and spasticity, which are common impairments in neurological conditions:

> Having the patients come in … in second week of their introduction to neuro so that they've got a visual and a practical experience and a holistic representation of what it actually looks like to live for persons who live with stroke, and they can hear their ... personal experience, I think that really sets them up for the rest of the semester … I can then keep saying, well remember this patient remember him (ID2).

All educators described using resources that provided context, such as videos, case studies, and real patients. One educator detailed a method for modifying student experiences to better support learning:

> [students] we thought that when we do our balance assessments, ‘I’ll blindfold them all. So, I would just remove vision, because obviously, that's our main sensory important to balance reactions. And so, we remove vision …. it forces the students to stand a bit closer and think about their handling interpretation (ID9).

Educators reported that a common classroom practice involved students to ‘model’ the neurological condition. Since students often have limited knowledge of how people with neurological conditions may respond in a clinical setting, providing contextual resources is

important for preparing them for clinical placement: “So the videos and getting those real stories of people and how they’ve been impacted by physios, is the most important thing [for learning]” (ID6).

6.3.10 Complexity

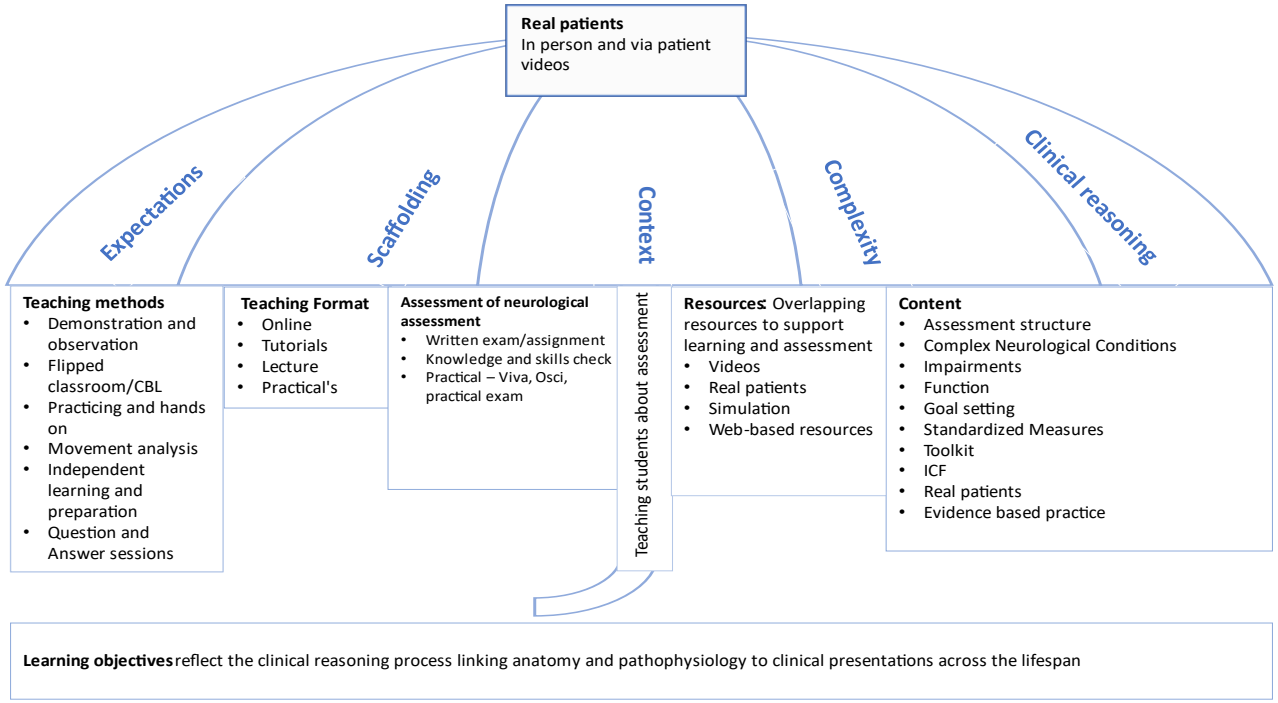
Educators discussed the complexity involved in various aspects of neurological physiotherapy, including anatomy and physiology, patient assessment, patient management, goal setting and managing uncertainty. The concept of ‘uncertainty tolerance’ (Hillen et al., 2017) was identified as a significant complexity inherent to usual healthcare practice, which was also perceived as a barrier to learning neurological physiotherapy.

> We were just talking about uncertainty tolerance. There's a lot of discussion coming out about tolerating uncertainty. And I think that's a real barrier for students is that they want to know the answer…. So if I've got this patient, what do I do you know, what do I say some how do I treat them in that? That uncertainty tolerance of well you'll have to use your clinical reasoning, you know, this is a patient with a stroke, not Parkinson's disease (ID1).

6.3.11 Illustrated integration of findings

To integrate findings from the web-based audit and the interview findings, an illustrated figure was developed (Figure 6.1). This figure illustrates five themes depicted as an umbrella, representing the overarching aspects of teaching the assessment of people with neurological conditions. Beneath the umbrella are categories related to about the teaching of assessment, aligned with the research questions. These themes are supported by the learning objectives from the modules, which form the foundation at the base.

Figure 6-1 Integration of web-based audit and interview findings (data from 2021)



6.4 Discussion

This is the first study to describe how pre-registration physiotherapy students in Australia are taught the assessment of people with neurological conditions and the methods used. All reviewed physiotherapy programs incorporated learning objectives that emphasised clinical reasoning. Curriculum content was introduced through a foundational module, and clinical assessment was taught in a structured manner, covering impairments, standardised measures, goal setting and evidence-based practice. Function or the patients' ability to engage in activities was highlighted as an important inclusion by educators. Teaching methods encompassed both face-to-face and online modalities, with independent learning and a flipped classroom approaches being highlighted. To support the learning experience in clinical assessment, real patients, either in person or through video recordings, and simulated learning were employed. Examination of assessment was primarily in the form of a written and practical exam. Educator perceptions of teaching were organised into five themes: expectations, scaffolding, context, complexity, and clinical reasoning. Below the audit findings (learning objectives, curriculum content, teaching and assessment methods) and the identified qualitative themes are discussed in detail.

6.4.1 Learning objectives

The learning objectives identified from most programs highlighted the connection between assessment, decision making and clinical reasoning. In the module descriptions, only six modules referenced the ICF, this is surprising as this framework has been recommended to guide practice since 2001 (WHO, 2001). Words reflecting clinical reasoning and associated words were only present in four modules possibly suggesting that clinical reasoning although integral to clinical practice maybe more implicit in higher education teaching.

There is a growing body of literature on the use of clinical reasoning by healthcare professionals. (Trede & Higgs, 2019; Edwards et al., 2004; Smith et al., 2008), particularly exploring the differences in approaches used between novice and expert practitioners (Boshuizen & Schmidt, 2018; Jensen et al., 2008; Normann et al., 2007). Physiotherapy, like other professions, involves a significant amount of tacit knowledge, crucial for expert practice (Jamshidi et al., 2018). This knowledge is often based on 'action' rather than 'language' (Langaas & Middelthon, 2020), suggesting that justifying clinical decisions may be challenging for physiotherapists to articulate and might be more easily recognised or observed in practice. Results from a recent survey by Christensen et al. (2019) found that clinical reasoning was explicitly included in the curricula for undergraduate physiotherapy students. Walker (2013), focusing on clinical reasoning in neurology, indicated that teaching

methods are more effective when concrete and conscious learning strategies are combined with practical experiences, such as working with patients and observing peers or qualified physiotherapists. This is supported by Wijbenja et al. (2019) who noted that a significant portion of learning occurs during clinical placements.

The inclusion of safety in the learning objectives highlighted its importance as a foundational component, ensuring that assessment and management practices enable physiotherapy graduates to meet threshold requirements (Phillips et al., 2017). Skill acquisition aimed at neurological impairments is considered essential by the United States Department of Health and Human Services (2010) and the Stroke Strategy 2024 (2022). However, only three of the 12 audited programs specifically identified neurological skill acquisition as part of their module learning objectives. Teaching neurological skill acquisition is common in pre-registration education as preparation for placement. It maybe that this included elsewhere such as individual module handbooks. All audited modules identified learning objectives that considered the person within the ICF framework, which aligns with accreditation standards set by the Australian Physiotherapy Council.

6.4.2 Curriculum content

Designing a curriculum for physiotherapy requires a comprehensive knowledge base or content, effective student learning processes, and the integration of contexts relevant to clinical practice (Broberg et al., 2003). The physiotherapy profession employs a biopsychosocial model for assessment and practice (Fernandez et al., 2020). This model considers the social, environmental, and personal factors influencing physical disability and function. Nearly half of the educators reported teaching the ICF framework as a structure for assessment. The use of the ICF framework as a structure for assessment aligns with the World Health Organization guidelines (2001) and supports neuroplasticity principles that guide rehabilitation (Kleim & Jones, 2008).

Educators in this study highlighted the importance of clinical reasoning as a key component of the curriculum. Teaching the clinical reasoning process involves professional socialization, instilling the values of the profession, and developing the ability to make clinical decisions (Higgs et al., 2020). While the study did not detail specific methods for teaching clinical reasoning, all educators reported using a scaffolding approach, progressing from simpler to more complex presentations throughout the module.

Educators described employing a problem-solving approach and an evidence-based practice (EBP) approach in teaching neurological physiotherapy. Larsen et al. (2019) have highlighted the need for integrating current best evidence to ensure quality

healthcare. Incorporating EBP into healthcare curricula is important for its application in practice (Dang et al., 2021). However, in neurological physiotherapy, there are areas of practice and conditions with limited evidence to support assessment and management (Walker, 2013). This challenge often leads educators, practitioners, and students to extrapolate evidence from other conditions, such as stroke, where there is more robust evidence and guidelines available (Stroke Foundation, 2023).

The content of theoretical approaches was described by some educators as a ‘toolkit’ of methods to help prepare students for a range of therapeutic approaches that they may encounter during clinical placements. Lennon (2004) notes that once qualified, “therapists tend to rely on their preferred approach and their clinical experience to justify the theory and knowledge they use to treat patients”. This reliance on personal experience can pose challenges for students, who are taught the importance of evidence-based practice in the classroom but may find that placement educators justify their decisions based on knowledge of specific approaches (Walker, 2013).

6.4.3 Teaching and examination

Schunk (2012) defines learning as the process by which humans “acquire and modify their knowledge, skills, strategies, beliefs, and behaviours”. The educator’s role is primarily to focus on and facilitate student learning by providing an environment and the resources in which students can learn (Sutherland, 2021, p. 112). There are many factors that influence student leaning involving the student and the educator. Effective teaching at university as described by (Sutherland, 202, p. 112) includes the 4cs of connection, communication, collaboration and consolidation, which can be applied in all teaching environments. In addition, student learning in the classroom is partly influenced by their educators’ teaching methods. Teaching neurological physiotherapy requires approaches that help students grasp the knowledge, skills, and behaviours necessary for making informed clinical decisions about patient care. This depth of understanding is essential for developing the clinical reasoning needed to develop effective treatment management plans (Garner & Lennon, 2018).

Educators in this study reported using case-based learning and the flipped classroom method to teach neurological physiotherapy. Educators in this study reported that neurological physiotherapy was taught together with a foundational module. This allowed students to develop skills that could later be applied to neurological practice. Hudson (2006) integrated patient cases into the curriculum to teach basic neuroanatomy, physiology, and clinical neurology to medical students. The integration of case-based learning enhanced student learning of signs and symptoms, application and interpretation of the information provided. These methods support students to develop clinical reasoning, consolidate

knowledge, and organise information in ways that are relevant to the specific needs of their patients.

6.4.4 Context

Educators in this study identified various resources for providing context in neurological therapy, including videos from websites, clinicians collaborating with individual universities, and real patients from clinics. These resources were used to integrate knowledge and teach clinical reasoning in context. Educators noted that many students lacked experience with people with neurological conditions which could impact learning in certain assessment domains. Simulation-based education (SBE) is used in health professional education to "replace or amplify real experiences with guided experiences and evoke or replicate substantial aspects of the real world in a fully interactive manner" (Prince et al. as cited in Mandrusiak et al., 2014) and Wright et al. (2018). In the study by Wright and colleagues (2018), physiotherapy students completed a simulation-based placement, working in all core areas of practice. Clinical competence was evaluated using the Assessment of Physiotherapy Practice (APP) tool and also their clinical competence was compared to student of the same year who had not participated in the SBE placement. Students who had completed the immersive simulation placement achieved higher APP when evaluated in subsequent placement compared to those who didn't participate in this activity. SBE has been widely adopted in physiotherapy programs due to challenges of incorporating real patient experiences into the classroom setting and to the successes of SBE when compared to real life experiences on traditional placements.

6.4.5 Complexity

Educators in this study reported complexities in teaching the assessment of people with neurological conditions, particularly due to the heterogeneity of the patient cohort. For example, two individuals who have had a stroke may present very differently People living with neurological conditions may also be living with other conditions that impact their activities and participation. Deutsch et al. (2022) in their article presenting a framework for making clinical decisions across the lifespan, suggest interview questions that review other systems as part of the assessment process This aligns with a report by The Australian Institute of Health and Welfare (2024) who reported 38% of Australians were living with two or more conditions in 2022. The complexity of many neurological conditions can be difficult for students to comprehend, as they are seen as integral to the patient's identity and level of disability (First & Fisher, 2015). In interviews with students about neurological physiotherapy (Walker, 2013), they described the challenge of conceptualising new knowledge while lacking relevant prior experience. Walker (2013) further highlighted the difficulty of learning

clinical reasoning particularly when faced with new and complex presentations. This challenge was further exacerbated by students' limited exposure or interaction with real patients with neurological conditions.

6.4.6 Strengths and limitations

This is the first study to explore the teaching of neurological assessment to pre-registration Australian physiotherapy students. The use of open-ended questions allowed the educators to explore their views and perceptions and zoom allowed the researchers to interview educators from multiple states within Australia. A limitation of this study is that less than half of all the university programs teaching neurological assessment to physiotherapy students are represented. Additionally, the web-based audit was only conducted for universities whose educators participated in the study, meaning it does not provide a comprehensive audit of all programs in Australia that teach the assessment of people with neurological conditions. Finally, the audit did not document the placement of neurology within the overall curriculum, including the preceding and following topics, which may have influenced the content.

6.5 Conclusion

All curriculum content related to neurological assessment was taught within a foundational module, utilising varied teaching formats. Educators highlighted the importance of learning from real patients in context. The five identified themes were intrinsically interconnected: the expectations of both staff and students were linked to the complexity of the module, as well as the assessment and clinical reasoning involved. Scaffolding was emphasised as a key strategy to support the learning of assessments and clinical reasoning in neurological physiotherapy. The inherent complexity of the module and the need for developing clinical reasoning skills in this area were also highlighted. This identified complexity maybe further supported by the development of framework or model to better support the learning of assessment and clinical reasoning in neurological physiotherapy for students. The findings from this Chapter provide insights into what and how assessment is taught to pre-registration students at university, informing the next Chapter, which explores students' views and perceptions of the learning gained both at university and through clinical placement experiences.

CHAPTER 7 AUSTRALIAN PHYSIOTHERAPY STUDENTS' PERCEPTIONS OF NEUROLOGICAL ASSESSMENT AND CLINICAL REASONING AFTER CLINICAL PLACEMENT: A QUALITATIVE INTERVIEW STUDY

This chapter builds upon the information gathered in Chapters 4 and 3, which used systematic review and survey methodologies to investigate physiotherapists' assessment and clinical reasoning practises. It also draws on Chapter 6, which examined the educational content provided by university educators and their perceptions teaching assessment and clinical reasoning to physiotherapy students. As a continuation, this chapter explored students' perceptions of neurological assessment and clinical reasoning in the context of their coursework and clinical placement.

7.1 Introduction

The physiotherapy assessment of people with neurological conditions is often complex and dynamic, aimed at informing clinical decision-making and treatment. The assessment process enables the delivery of effective patient-centred care, requiring physiotherapists to employ higher-order thinking, problem-solving, and adaptability (Higgs, 2019). These skills are integral components of the clinical reasoning process (McDevitt et al. 2019) and are utilised routinely to inform patient care (McDevitt et al., 2019).

Clinical reasoning in physiotherapy involves making decisions while considering the individual complexities of patients and the uncertainty of context and outcomes (Huhn et al. 2019; Wijbenga et al., 2019). Physiotherapists often find it difficult to define and articulate how they address complex clinical problems. A recent scoping review presented in Chapter 5, sought to explore and synthesize the available literature pertaining to clinical reasoning in neurological physiotherapy. This review found that the most frequently included components of clinical reasoning were information gathering, evaluation/reassessment, and movement analysis/diagnosis.

In preparation for practice as a qualified clinician, physiotherapy students are introduced to clinical reasoning by university educators across various areas of physiotherapy, including cardiopulmonary, neurorehabilitation, and musculoskeletal physiotherapy. While there are some common principles underlying reasoning across these key areas, it has been suggested that each specialty area may employ different models, terminology, and teaching contexts (Christensen et al., 2017). Students develop clinical reasoning skills in the

classroom which they are expected to apply during placements to achieve competency in analysis and planning.

Teaching neurological physiotherapy, particularly assessment, presents additional complexities compared to other areas of the physiotherapy curriculum (Walker, 2013). The challenging aspects of clinical reasoning in neurological physiotherapy has been linked to increased fear and anxiety among students (Walker, 2013), suggesting that students may benefit from more comprehensive guidance throughout this integrative process.

Huhn et al. (2019) noted limited agreement on how academic institutions in the United States teach clinical reasoning, observing 'highly variable and inconsistent approaches to teaching and assessment within and between programs.' The lack of consensus on teaching, assessment, and research related to clinical reasoning skills result in inconsistent teaching among undergraduate students. Scaffolding assessments has been suggested to aid in the development of clinical reasoning, as learning this skill is not automatic. Ajjawi and Smith (2010) and Rancic et al. (2017) have recommended explicit teaching of the clinical reasoning process, including the skills being assessed and reflected upon by educators, clinicians and students. In Australia, clinical reasoning competency is assessed during placements using the Assessment of Physiotherapy Practice (APP) tool (Dalton et al. 2011).

A recent study by Wijbenga et al. (2019) explored physiotherapy students' experiences of clinical reasoning during clinical placement using focus groups and semi-structured interviews. This study did not specifically address neurology, but three factors were noted to influence the learning of clinical reasoning skill. These were: the environment in which learning took place, clinical supervisors, and the students themselves. The findings suggested that the clinical reasoning skills acquired in the classroom often do not adequately prepare students for clinical practice, highlighting the need for further development of these skills during clinical placements (Wijbenga et al., 2019).

To my knowledge there remain gaps in the literature regarding students' experiences and perceptions of learning to assess people with neurological conditions, and the clinical reasoning process that accompanies this, both in the classroom, and during clinical placement. This study aimed to explore Australian students' perceptions, beliefs, and experiences related to neurological assessment and clinical reasoning within the context of their coursework and clinical placements.

Study Objectives:

1. To explore students' beliefs and experiences regarding assessment processes in neurological physiotherapy.
2. To investigate students' perceptions of their clinical reasoning processes and abilities, and the barriers and facilitators they encounter.
3. To gain insight into how students' neurological assessment practices evolve over the course of clinical placements.

7.2 Methods

7.2.1 Research design

A phenomenological approach was adopted to gain deep insights into the lived experiences of students who participated in the interviews. This methodology was chosen for its ability to capture the essence of individual perceptions and meanings associated with the students' educational experiences. Study findings were reported according to the consolidated criteria for reporting qualitative research (COREQ) checklist (Tong, 2007) (see Appendix P).

7.2.2 Participants and recruitment

Participants were recruited using purposive sampling and snowballing as described by Parker et al. (2019), based on the characteristics and experiences of the participants relative to the research aims. Students were eligible to participate in the study if they had completed coursework on the theoretical aspects of the assessment of people with neurological conditions, or if they had completed both the coursework and a clinical placement in neurology.

Physiotherapy educators were identified by emails to the head of physiotherapy programs across Australia. They were informed about the study via email and asked to distribute a recruitment email amongst eligible students. The researcher (JG) confirmed the eligibility of the students who responded to the email. This recruitment email contained a link to the Qualtrics survey webpage, which contained participant information and the contact details of the lead investigator. Upon agreeing to participate by clicking 'yes' on the consent button, participants were prompted to provide demographic information by answering seven questions (see Appendix Q).

The lead investigator (JG) was a female physiotherapist with a master's degree in clinical rehabilitation, conducting this research as part of her PhD studies. Prior to this study, she had no relationship with the participants. JG contacted physiotherapy students who had consented to participate to schedule interviews. Interviews were completed at two time points. Students who had completed their on-campus neurology subject but had not yet

completed a clinical placement in neurology were offered a pre- as well as a post-clinical placement interviews while students who had already completed their clinical placement in neurology were offered a post-clinical placement interview only. All existing participants were asked to refer other students for the study.

The interview questions were developed by the research team, drawing on findings from Chapter 3 and 4 and were adapted from Wijbenga et al. (2019). Interviews were conducted and recorded using Zoom software. Participants were informed of the purpose of the interviews before they began and the researcher JG introduced herself and gave an overview of her roles at university and in clinical practice to the participants (clinician in neurological rehabilitation in a teaching hospital, lecturer in neurological rehabilitation, experience in regional and metropolitan settings).

The pre-clinical placement interview focused on various aspects of the assessment of people with neurological conditions, including initial steps taken and theoretical approaches. The conversation shifted to explore participants' definitions of clinical reasoning, their learning experiences, and the barriers and facilitators they encountered. Participants were also asked about their confidence in their clinical reasoning abilities, whether they modified their assessment practices at any point in time, and how they used their assessments to inform their clinical decisions, including whether they weighted certain aspects of their assessment (see Appendix R).

At the conclusion of each interview, participants were given the opportunity to add any further comments and to request a review of their transcripts (no participant requested a review) to ascertain if the transcript truly reflected their experiences and views. They were also asked to provide the timing of their five-week clinical placement in neurology, so the researcher could schedule a follow-up interview post-clinical placement. The post-clinical placement interview revisited the same questions as the initial interview and included an additional question prompting participants to reflect on their clinical reasoning skills as part of the assessment process.

7.2.3 Data collection and analysis

Ethical approval was obtained from the Human Ethics Low-Risk Panel, Research Development, and Support, Flinders University, South Australia (approval number: 4997) on 15/12 2021.

Demographic information obtained through the Qualtrics survey was descriptively analysed (measuring frequencies) and tabulated. Recordings from the interviews were downloaded,

and transcriptions generated by the Zoom video conferencing software were reviewed for accuracy. The zoom captured data was stored safely in a password protected university computer.

The interview data was analysed inductively using qualitative thematic analysis with the assistance of NVivo software for data management and coding. This approach developed by Braun and Clarke (2006) was used to identify patterns in the data, using the themes to address the research aims. The semantic themes developed looked to represent what was identified by the respondents. Initial coding of the transcripts was performed by the lead investigator (JG). A total of seven transcripts were independently reviewed, with JG and SL comparing and discussing the codes. Discrepancies in coding were resolved through discussion and the codebook was revised and modified as required to serve as a template for analysis (Wijbenga et al., 2019). Similar codes identified across multiple interviews were compared and grouped to develop themes and subthemes, which were refined until consensus was reached.

Historically, Sandelowski (1985) as cited in Vasileiou et al. (2018) recommended sample sizes that are large enough to allow the development of 'new and richly textured understanding' of the phenomenon under study, but small enough so that the 'deep, case-oriented analysis'. Lincoln and Guba (1985) state that 'sampling can be terminated when no new information is elicited by sampling more units'. Therefore, interviews were conducted until a clear pattern emerged, and no new information or codes were generated from subsequent interviews (Hennink et al., 2017; Nyumba et al., 2018).

7.3 Results

Thirteen Australian physiotherapy students expressed interest in study participation and were contacted by the lead researcher. Nine physiotherapy students responded to the researcher's email and consented to participate in the semi-structured interviews. Of the nine students who participated, four had not yet attended a clinical placement where they had assessed a patient with a neurological condition (P1, P2, P3, P7) while five had (P4, P5, P6, P8, P9). Of the nine participants, three completed both pre- and post-clinical placement interviews (P4, P5, P6). The interviews, which lasted between 10 and 25 minutes, took place between 16th March 2022 and 22nd November 2022.

7.3.1 Participant demographics

Participants, aged between 20 and 44 years and all female, were enrolled in pre-registration physiotherapy courses. One student (11%) was enrolled in a doctor of physiotherapy (n=1,

11.1%), five (56%) in a master of Physiotherapy, and three (33%) in a bachelor's degree. At the time of the interviews, participants were residing in Victoria and South Australia (see Table 7-1).

Table 7-1 Participant demographics (data from 2022)

Participant	Gender	Age	Pre-registration course	Year Level	State
P1	F	26	Master of physiotherapy	1	Victoria
P2	F	20	Bachelor of physiotherapy	3	Victoria
P3	F	21	Bachelor of physiotherapy	3	Victoria
P4	F	44	Master of physiotherapy	1	South Australia
P5	F	25	Master of physiotherapy	1	South Australia
P6	F	24	Doctor of physiotherapy	4	Victoria
P7	F	26	Master of physiotherapy	1	Victoria
P8	F	24	Master of physiotherapy	1	Victoria
P9	F	24	Bachelor of physiotherapy	3	Victoria

7.3.2 Themes

The analysis revealed five major themes: process and components of assessment, treatment planning, patient-centred care, learning clinical reasoning, and assumptions and biases. These themes were derived from 26 codes (Table 7-2). Five codes were reported by more than half of the participants: ‘modify assessment/ first steps’ (n=12), ‘defining clinical reasoning’ (n=9), ‘factors influencing confidence with clinical reasoning’ (n=9), ‘patient choice’ (n=7), and ‘context/patient complexity’ (n=7). For detailed information of the themes, codes, and exemplars see Appendix T.

Table 7-2 Themes and codes (data from 2022)

	Theme	Codes	Number of quotes	Attributed participants
1.	Process and components for assessment	Assessing a domain whilst observing another	6	5
		Choosing appropriate outcome measures	4	4
		Modify assessment and first steps	17	12
		Understanding progression	4	5
		Defining clinical reasoning	9	8
2.	Treatment planning	Don't know what will work	3	2
		Basis for intervention	4	4
		Trial & error	4	4
3.	Patient-centred care	Patient choice	11	7
		Omitted assessment domains based on patients' ability	6	6
		Real-life patients	7	5
4.	Learning clinical reasoning	Context and patient complexity	10	7
		Patient variability	6	4
		Overwhelming knowledge and information overload induces anxiety	6	5
		Observe other clinicians	4	4
		Practice using clinical reasoning forms/problem lists	6	5
		Practice with peers	4	3
		Watching videos during class	6	6
		Real-life patients	7	5
		Clinical reasoning is functional in neuro rather than impairment-focused	5	4
		Clinical reasoning varies according to the 3 core areas	7	4
		Factors influencing confidence with clinical reasoning,	11	9
5.	Assumptions and biases	Blurring of clinical reasoning and clinical decision-making,	11	5
		Missing steps in clinical reasoning, omitted assessment based on patient ability	6	6
		Patterns	3	2

**Note: Figures include data taken from both pre and post timepoints.*

7.3.2.1 Theme 1- Process and components for assessment

Participants shared their approaches, the how, to assessing neurological patients and highlighted what they considered most important. Participants in both pre- and post-clinical placement interviews reported to complete a structured assessment, initially without modifications for different patients: “[when asked: would you modify what you assess and maybe leave things out?] *probably not at the start”* (P5).

Participants reported gathering information while interviewing their patients and also observed how they moved or walked into the room while talking to them. They noted that selecting appropriate outcome measures was challenging due to difficulties with patient communication and tolerance: “also that communication thing, you know, like, do you need something just quick and easy, because they're going to get easily bewildered” (P4).

Participants did not always assess patients using a uniform approach. At times they asked fewer questions if patients presented with more straightforward cases:

> [whilst observing their supervisor during their assessment of a patient] I was just with a supervisor the whole time. It was a lot more succinct I guess than what we learn in um. everything that's possible but like. It was 4 questions in terms of like, I get the idea in terms of the whole angle of discharge, but she was just like that patient was very straight forward like a mild stroke (P5).

Alternatively, if the patient was more severely affected by their condition, participants adapted their approach accordingly: “when you walk into their room. Um, obviously if they're bed-bound, then that's gonna be a little bit different, but yeah, obviously you can still pick up on things that you are doing and you wanna look at” (P8).

Participants reported that patient choice, as demonstrated in the goal setting process, was considered an integral part of the assessment and was valued by the patient. Understanding how to modify or progress the patient during therapy as a part of the evaluation process, was difficult to determine as reported the participants. Patient progress was noted to vary between patients, and it was noted by participants in their final interview that they had learned during the clinical placement to give higher-intensity therapy sessions (P2). When assessing patients on clinical placement, participants often moved straight from a step-by-step approach (in assessment) to focusing on patient goals and function: “a bit more

weighting towards what they need to achieve … more to achieve this sort of goals. This is something for them was to be able to go up free stairs to get into the house" (P2).

Two participants, in post-placement interviews, reported excluding assessment domains that were too difficult for their patient to complete: "Don't want to do an assessment where you are setting them up to fail [too difficult]. Prefer to select an assessment I know they will be able to do" (P6).

When asked to define clinical reasoning, participants reported a range of interpretations such as: "listing what the issues are that you want to work on, maybe seeing how they… interplay" (P4), "clinical reasoning, I guess with neuro it's very much more trial and error. I would say that's the way I would interpret it" (P7), "it's kinda what goes on in your head" (P5).

Participants viewed clinical reasoning as a pathway for identifying the primary issues affecting the patient, which then informed the development of a treatment plan: "clinical reasoning is a way of helping to identify, okay, this is actually what's going on and this is how this is how it's gonna inform my treatment basically" (P5).

7.3.2.2 Theme 2 -Treatment Planning

Participants described how they planned their treatment sessions, and what factors influenced their choice of treatment. "There was definitely no sort of a process whatsoever. It was always just what's going to work for this patient, which is hard at the start" (P4).

They felt unsure about what treatment would work and based their interventions on aspects they believed could be modified:

> What is modifiable? Strength is obviously easier to address than spasticity- I feel like I still don't understand how to treat it strengthen both sides and give Botox … Focus on what you can change, like gait so you strengthen dorsiflexors of stretch under the foot (P6).

7.3.2.3 Theme 3 - Person-centred care

The participants appeared to value the opinions and goals of their patients during the assessment process and using this information to guide decisions regarding treatment: "it depends on what the patient wants to do. If I want to work on rolling and they want to work on sitting, we do sitting and dynamic balance and use outcome measures" (P4).

They wanted to be responsive to each patient as an individual, which often required managing uncertainty:

> She will tell me to come up with a plan [the supervisor] and then you look at the plan and that will not work. Or you have a plan and they [patient] come in a week later and they are like blah blah blah happened, I had a fall and then you have to start again and replan on the spot (P8).

7.3.2.4 Theme 4 - Learning Clinical Reasoning

Participants felt that clinical reasoning in the assessment of neurological patients during clinical placements had a functional focus:

> I feel like when you're out on placement with real people, it's redundant (clinical reasoning). In that sort of subacute stage, because you want to see what they're capable of (the patients), like walking, etc. So, I feel like, yeah, a lot of emphasis was placed on it [clinical reasoning in the classroom], and really didn't use it much on placement (P9).

Participants were asked about the facilitators and barriers to learning clinical reasoning. They reported feeling overwhelmed by the amount of knowledge required to understand patient presentations, which induced anxiety. Clinical reasoning was experienced differently across the various areas of physiotherapy. More than half of the participants identified barriers related to the clinical setting, patient complexity, and variability (n=7). They expressed that the severity of patients' presentations during placement impacted their learning experience: "neurological patients have some quite debilitating symptoms from something like a stroke or spinal cord injury … (these are) more severe and presentations are a bit more confronting" (P6).

Facilitators for learning clinical reasoning included observing other clinicians completing assessments, practicing with clinical reasoning/problem lists, collaborating with other students, watching videos during class, and working with real patients on placement. Watching videos and practicing using clinical reasoning/problem lists were reported as useful in half of the interviews: "based on examples we have problem lists. What is the problem – what are the causes, and why do they have weakness or balance issues? During placements, we get to practice and make as many problem lists as possible" (P4), "so we did

inquiry guides, where we had a case study and we followed the case study, which in hindsight is really good…… we would watch a video of a patient and then come up with questions" (P7).

Factors believed to affect confidence in clinical reasoning included anxiety about the unknown, the complexity of the subject, and expectations surrounding placement experiences:

> Not that confident, I think it is a very complex subject and area and then I didn't expect to see stroke patients, but all the patients I saw were cerebellar ataxia, vestibular, PD, and I or 2 strokes. I felt very thrown in at the deep end. It was great though because it was something I hadn't seen so it was good though but not prepared (P7).

Other participants felt that positive supervisor interactions assisted them with confidence: "Reasonably. I felt good going into the placement at XXXX I mean, obviously I was very lucky to have excellent supervisors and, and yet it was very supported" (P4).

7.3.2.5 Theme 5 - Assumptions and biases

Participants reported on the assessment process from a perspective that was not grounded in theory or evidence-based practice. They also made assumptions as to why assessment domains were included or excluded:

> you have all the knowledge from the topic from the theory, and then you use this when assessing patients, and everyone is different so that makes it hard. Then you try and work it out and if it doesn't work you try something else (P4).

> So you know what you're looking at [the diagnosis of the person with a neurological condition] … from what I know is that you don't really get that so much with neuro so you don't get that kind of thing it's prioritizing right … I don't know my priority until I get to a certain ward where it's like, acute. And I think it's like, they just need to discharge and figure out where they're going. So that's, that's the priority (P9).

7.4 Discussion

This is the first study to explore physiotherapy students' perceptions, beliefs, and experiences regarding assessment and clinical reasoning after completing coursework and clinical placement in neurology in Australia. The findings suggest that elements included in the students' assessment of people with neurological conditions were influenced by factors related to patients' goals and perceived abilities. Students identified the complexity and extensive knowledge required to manage people with neurological conditions during clinical placement as barriers to learning clinical reasoning. Additionally, students reported that learning from others, both in the classroom and through observing qualified health professionals with real patients during placement, was important for developing their clinical reasoning skills.

7.4.1 Learning to implement assessment processes in neurological physiotherapy

Acquiring skills in physiotherapy encompasses various forms of learning, from theoretical knowledge to evidence-based practice, and is a highly individualized experience (Leahy, 2017; Walaker, 2019). The learning approach adopted by physiotherapy students is influenced by theory, context, teaching strategies, the nature of the educational environment, and evaluation methods, all of which shape their learning (Stoikov et al., 2022). These factors differ before and during clinical placements (Murthy et al., 2013). During clinical placement, learning becomes more active than in the classroom setting, with a greater emphasis on problem-based learning, which fosters deep learning and enhances critical thinking. This learning approach is essential when using assessment findings to develop hypotheses and management plans for patients as part of the clinical reasoning process (Walankar, 2019). This study supported this active learning style, as participants reported that interacting with real-life patients or viewing patient videos enhanced their assessment learning. Participants identified domains to consider during the assessment process, such as communication and patients' tolerance for activities, which added complexity. Walker (2013) also identified complexity as a significant factor in learning neurology for physiotherapy students.

Patient choice was highlighted as a key component of assessment, particularly concerning therapy goals and progression. Participants aimed to be responsive to individual patients, which often involved managing uncertainty about how to adjust treatment plans. On placement, participants learned to increase the intensity of interventions, a practice supported by evidence on neuroplasticity principles (Kleim, 2011; Pin-Barre et al., 2017) and stroke rehabilitation (Crozier et al., 2018). Participants valued incorporating patients' goals

and opinions into the assessment process, using this information to guide decisions regarding treatment, as recommended by the Stroke Foundation in the Clinical Guidelines for Stroke Management (2024). Focusing on patient goals during assessment and management can empower patients, positively impacting adherence to physiotherapy exercises, as noted by Karingen et al. (2011).

7.4.2 Learning to implement clinical reasoning processes in neurological physiotherapy

Clinical reasoning is a cyclical process that evolves with experience (Knecht-Sabres, 2013). While expert clinicians typically have highly developed clinical reasoning skills, novice practitioners often find it difficult to grasp (Delaney & Goulding, 2014). This study found that participants used varied definitions of clinical reasoning, encompassing key components of the clinical process, such as compiling a list of problems to inform treatment, in line with Dimitriadis et al.'s (2016) framework for the management of patients with neurological disorders. However, the study also revealed that students miss certain steps in the clinical reasoning process, such as interpretation, and do not always perform clinical reasoning using a sequential approach as described by Dimitriadis et al. (2016). Wijbenga et al. (2019) explored students' experiences of clinical reasoning during placement and found that the environment, clinicians supervising physiotherapy students, and the students themselves were factors influencing learning clinical reasoning skills. The present study identified that clinical reasoning skills acquired in the classroom need to be further developed once on placement. Delaney and Bragge (2009) used student interviews to identify helpful teaching strategies to student learning on placement, reporting educators who modelled good treatment and allowed time for reflection positively impacted on learning. This is supported by our study, in which participants reported that the observation of their supervisor and other clinicians facilitated their assessment and clinical reasoning skills while on placement. They then felt able to use the skills learned through observations to model their practical skills.

7.4.3 Factors influencing confidence with clinical reasoning

This study identified the bridge between theory and practice as a factor influencing confidence in clinical reasoning. Participants reported barriers to clinical reasoning because of the complexity of theoretical knowledge and anxiety of the unknown (when beginning placement). However, complexity is essential for improving the skills of applying knowledge during clinical placement (Sellberg et al., 2022). In preparation for registration, clinical placements provide exposure to various organizations and patients with their associated challenges, including problem-solving (Sellberg et al., 2022). Anxiety has also been identified among students during clinical placement. Physiotherapy students have assigned

theoretical content to be learned, and uncertainty about what is expected of them as factors influencing this (Gallasch et al., 2022). Participants felt that positive supervisor interactions assisted them with confidence, which is in agreement with findings from Wijbenga (2019), who noted clinicians who supervise physiotherapy students were an influencing factor for clinical reasoning confidence.

7.4.4 Assumptions and biases

In a study teaching medical students about implicit bias by Gonzalez et al. (2014). The authors noted the influence of implicit bias on decision making. This is supported by the present study, which identified assumptions and biases related to what were included as assessment domains and treatment planning as part of the decision-making process. The assessment was reported to be not based on theory or evidence, but rather on 'trial and error.' Participants also reported using 'trial and error' to support their treatment choices if the theory did not help them in making clinical decisions. There was a degree of uncertainty about what would be effective considering the complexity of the situation. This disagrees with Hruksa et al. (2016), who found that novice practitioners rely more on theoretical knowledge, and that this changes with experience.

7.4.5 Strengths and limitations

While this study provides valuable insights into the transition from physiotherapy student theory to clinical practice on placement, there were some limitations. The interviews were quite short in length and conducted on Zoom. Participants were students studying in Victoria and South Australia only, and only three participants completed both a pre- and post-clinical placement interview due to the timing of clinical placements with neurological patients and participants' availability. This study did not identify any additional information on participant performance at university or if they had a particular liking for the area of neurology. Students were not asked whether they had been placed in any other area of practice, which may have affected their view of their clinical reasoning ability in people with neurological conditions. Future research in this area could include the use of social media platforms to maximise student recruitment.

7.5 Conclusion

This study identified varying understandings of what clinical reasoning is and revealed that students include limited assessment domains only, mostly guided by patient goals and the perceived abilities of patients. Students reported the value of observing others, whether peers or qualified health professionals interacting with patients to facilitate their learning.

How can students be supported in using and developing their clinical reasoning skills for neurological patients during placement? The barriers of anxiety and feelings of being overwhelmed regarding knowledge and patient complexity and variability, as reported by students in this study, must be addressed. More structured explicit ways of teaching assessment and clinical reasoning and the use of theoretical frameworks (Garner et al., in press) may assist in guiding the clinical process in the classroom and placement. Further research is required to explore the views of clinicians who supervise physiotherapy students on placement to identify effective strategies specifically to employ in order to develop student clinical reasoning skills within the clinical environment in neurology.

CHAPTER 8 DISCUSSION

This thesis aimed to comprehensively explore assessment and clinical reasoning in neurological physiotherapy, in relation to clinical practice and teaching. The research aims were addressed through a series of five complementary studies. This chapter synthesises and discusses the key findings in relation to the thesis' research questions, brings these findings together, contextualising them in the context of the existing literature.

The significance of the findings and their key implications are presented, offering insights into current practices and potential areas for improvement in neurological physiotherapy assessment and clinical reasoning. Additionally, this chapter acknowledges the strengths and limitations of the overall body of work.

Finally, based on the outcomes and identified gaps, recommendations for future research are proposed. These suggestions aim to guide subsequent investigations in the field, fostering continued advancement in neurological physiotherapy practice and education.

8.1 Thesis Research questions and key findings

1. What are the essential domains explored by physiotherapists during the clinical assessment of adults with neurological conditions? (Chapters 3 and 4)

The study findings suggest that the five most frequently included assessment domains in clinical practice are function, postural alignment and symmetry, gait, balance, and muscle strength (Chapter 3) with emerging consensus amongst registered physiotherapists in Australia for the additional domains of falls and safety, goal setting, range of movement, pain, coordination, activity tolerance and upper limb (Chapter 4, Garner et al., 2024). There was variability in assessment in clinical practice (Chapter 4) which was not consistent with expert textbooks (Garner & Lennon, 2018; Porter, 2013) and not supported by the findings in Chapter 6, where a structured assessment was recommended by educators. Goal setting as an included domain was reported in Chapter 4 by over half of the respondents. This was emphasised as a key domain when teaching assessment and highlighted by students in Chapter 7 as influencing their inclusion of assessment domains. This is supported by findings from the scoping review, Chapter 5 which identified collaborative goal setting as a clinical reasoning component in 64% of the included studies and papers.

2. What measures are used as part of the assessment of people with neurological conditions? (Chapters 3 and 4)

The use of outcome measures identified as part of clinical assessment, aligns with recommendations in expert textbooks (Lennon et al., 2023), and study findings including surveys (Van Peppen et al., 2008; Yoward et al., 2008) and an observational study (Tyson et al., 2010). The use of standardised measures was also identified in more than half of the qualitative studies in Chapter 3 finding, linking concepts of familiarity and experience to use in clinical practice. Chapter 4 revealed that respondents employed a wide range of measures beyond standardised tools, including quality of life measures, condition specific measures and self-devised measures. This diversity in measurement approaches concurs with the survey of self-reported measure use conducted by Van Peppen et al. (2008). The breadth of measures utilized reflects the complex nature of neurological conditions.

3. What are the factors that influence physiotherapy assessment of adults with neurological conditions in clinical practice? (Chapters 3 and 4)

In the systematic review (Chapter 3), clinical experience was found to influence assessment and the use of standardised measures. In the survey (Chapter 4) more experienced physiotherapists reported including less assessment domains in their assessment than less experienced physiotherapists. It is generally accepted that clinicians with more experience deliver higher quality care (Choudry et al. 2005) than less experienced clinicians. A systematic review by Choudry et al. (2005) exploring the relationship between physician experience and performance found there was variability in performance with increasing years of experience. This thesis highlights the first research undertaken in physiotherapy that has reported on the influence of clinical experience on assessment practices.

Chapter 4 identified that barriers and enablers to assessment were related to the therapist-case load, knowledge and skills, and intrinsic patient factors such as medical stability and motivation. In the literature, studies have explored barriers and enablers to interventions in physiotherapy but not assessment practices (Dickson et al., 2024; Gleadhill et al., 2022). Severity and complexity of patients were referred to frequently as a barrier to assessment. Complexity of patients influenced time taken to complete an assessment, noting the more complex the patient the more time it took to complete. The complexity of people with neurological conditions compared to people with other medical conditions is well known (Baker et al., 2011; Giles, 2010; Walker, 2013), however no studies have explored the impact of complexity on assessment in physiotherapy.

Therapeutic approaches in neurorehabilitation are based on neurophysiological principles of motor control and recovery (Bhalerao et al., 2016). There often is a dilemma about which approach to use in clinical practice, and this leads to a lot of variation in use of approaches.

Despite evidence that different approaches are used to inform treatment practices, the findings from the survey (Chapter 4) did not reveal any evidence to suggest that therapeutic approach influences assessment practices.

4. Which clinical reasoning frameworks are used in neurological physiotherapy? What is the existing evidence underlying the clinical reasoning process and its components in neurological physiotherapy? (Chapter 5)

A scoping review of the literature identified 25 frameworks developed to guide clinical reasoning (Chapter 5). The most referenced framework was the ICF (Chapter 5), developed by the World Health Organisation (WHO, 2001; Bagraith & Strong, 2013) and included in the Australian and New Zealand Physiotherapy Threshold Standards (Physiotherapy Board of Australia and New Zealand, 2023). The ICF provides a common language to guide interventions, goal setting and evaluation (Nguyen et al., 2018). However, the ICF was not referred to in the clinical practice studies. Spoladore et al. (2021) noted that the ICF framework is not universally adopted in clinical practice due to decreased understanding and operational knowledge. The majority of theoretical frameworks identified in Chapter 5 were designed to provide guiding principles for physiotherapy management in a neurological condition, however as yet there is no literature to support their use in clinical practice. The scoping review identified five key components of clinical reasoning that were consistently cited in over 70% of the studies examined. These components include information gathering, hypothesis formation, collaboration with clients, movement analysis / diagnosis, and evaluation/reassessment. Despite this finding, the review concluded that further research is necessary to develop a comprehensive clinical reasoning framework specifically tailored to neurological physiotherapy to facilitate congruency between education and practice. This finding underscores a significant gap in the current understanding and application of clinical reasoning.

The systematic review in Chapter 3 identified the clinical reasoning components of hypothesis formation and trigger for pattern recognition. Clinical reasoning was linked to concepts of experience which was found to guide prognostication and an in depth understanding of movement behaviours. The findings of the survey in Chapter 4 identified that clinical reasoning skills were found to be an enabler of assessment. In Chapter 5 movement analysis was frequently included in theoretical clinical reasoning frameworks. The inclusion of movement analysis as an important method of assessment is in agreement with expert textbooks (Lennon et al., 2023) and studies linking movement analysis to hypothesis generation (Fisher, 2020; Buckley et al., 2019). The least frequently included components of clinical reasoning were referral/discharge planning and collaboration with patient about

assessment (Chapter 5). This was surprising as collaboration with patients is an essential part of other included domains such as goal setting (Levack, 2024).

6. How is physiotherapy assessment of people with neurological conditions taught to students and what is included in the curriculum in physiotherapy modules that teach the assessment of people with neurological conditions at universities within Australia? (Chapter 5)

All physiotherapy programs audited as part of this research incorporated learning objectives that reflected the development of clinical reasoning (Chapter 6).

All curriculum content for neurology subjects were taught together with foundational modules before commencing the neurological physiotherapy subject. Educators in Chapter 6 reported on teaching more basic conditions such as stroke before more complex conditions later in their subjects. Scaffolding of teaching in this area of practice is important due to the complexity of this area of physiotherapy. Educators reported complexity as a factor to consider when teaching neurological physiotherapy.

The curriculum included a structured assessment, impairments, standardised measures, goal setting, and evidence-based practice. Teaching methods included online and face to face with independent learning and a flipped classroom approach. These teaching methods are indicative of experiential learning methods which has shown to be beneficial for student learning of clinical reasoning (Sikandar, 2015).

7. What are the views and experiences of physiotherapy students pre-and post-clinical placement regarding assessment processes and clinical reasoning abilities? (Chapter 7)

In the final qualitative study, presented in Chapter 7, students identified their assessment to be influenced by intrinsic patient factors such as patient goals, communication, fatigue, and the condition itself (Chapter 7). Focusing on the needs of the patient has been linked in the literature to improved healthcare outcomes (Delaney et al., 2018) and recently understanding the patient's experience has been an increased focus of healthcare (Ferguson et al., 2013) and physiotherapy education (Killingback et al., 2022). In addition to questions about assessment, physiotherapy students in Chapter 7 were asked to define clinical reasoning. The definitions were quite variable amongst the respondents, with a few students not able to answer. This suggests uncertainty regarding what clinical reasoning was in the context of neurological physiotherapy. Wijbenga et al. (2019) explored physiotherapy students' experiences of clinical reasoning during clinical placement. Interviews with

students highlighted feeling of unpreparedness and the need to further develop their clinical reasoning skills once on placement.

8.1.1 Assessment of people with neurological conditions

Physiotherapy assessment typically follows a structured approach, beginning with a subjective examination followed by an objective examination, often incorporating standardised measurement tools (Garner & Lennon, 2018). The ICF (WHO, 2001) provides a comprehensive framework that enables physiotherapists to systematically evaluate and understand a patient's condition beyond just their diagnosis. The ICF allows physiotherapists to identify and contextualize impairments, activity limitations, and participation restrictions, facilitating a holistic understanding of the patient's functional status and goals.

The scoping review highlighted the ICF as the most frequently identified framework, underscoring its significance in guiding clinical reasoning and practice in physiotherapy. However, while the ICF offers a valuable conceptual framework, its full implementation within clinical practice requires further research.

8.1.2 Structure and domains of assessment

The use of a structured assessment was reported by all educators in the educator interviews and web-based audit (Chapter 6). Nearly a quarter of educators reported using a functional assessment, nearly all employed an impairment assessment, and just under half used assessments based on the ICF framework. However, findings from the student interview study (Chapter 7) suggested that assessment approaches are not always structured and may vary during clinical placement. Results from the survey (Chapter 4) revealed that practicing physiotherapists adopt a flexible approach to assessment, which may suggest that assessment may be guided by other factors. The structure of assessment described by Garner et al. (2023), and within the ICF, recommend the inclusion of many domains, as supported by expert textbooks (Lazaro et al., 2019). Interestingly, some recommended domains, such as mental state, communication, sensation, tone, chest status, vision, and reflexes, were not identified as important parts of assessment by the systematic review (Chapter 2) or by physiotherapists completing the survey (Chapter 4). However, assessment of patients' function emerged as a frequently included domain across all studies. The purpose of assessment is to identify modifiable domains that can be addressed and treated in collaboration with the patient (Garner & Lennon, 2018). The assessment of impairments, as identified in chapters 3,4,6 and 7 determines the presence or absence of each impairment and how it may contribute to changes in movement and function (Lang et al., 2013). While the inclusion of standardised measures as part of assessment was identified

across all studies in this thesis, they do not appear to be at the forefront of assessment practices. This is evidenced by students reporting uncertainty about which measures to include (Chapter 7).

The focus on function in physiotherapy assessment as part of rehabilitation is supported by evidence, particularly stroke rehabilitation studies. Research exploring person-centred goal setting in stroke populations consistently demonstrates that patients prioritise regaining functional abilities (Salter et al., 2008; Kristensen et al., 2015). Improving aspects of function, such as transfers, walking and feeding oneself, is very important to patient success in therapy. Walking and mobility have also been identified as predictors of returning to pre-stroke participation levels (Docteur et al., 2012; Singham et al., 2015). These functional aspects of assessment are typically evaluated by observation or movement analysis. The systematic review study (Chapter 3) identified the use of senses as a significant method of assessment. This finding was further corroborated by clinical practice studies and theoretical framework papers examined in the scoping review (Chapter 5). The consistent emergence of sensory assessment as it applies to function across multiple studies and frameworks emphasizes its fundamental role in comprehensive physiotherapy evaluation.

Movement analysis has been identified as an integral component of the assessment process (Wallace et al., 2024) and was consistently reported across all studies in this thesis. Movement analysis uses observation skills to evaluate functional tasks, such as gait, and has been linked to hypothesis formation, informing clinical decision making (Wallace et al., 2024). Chapter 5 highlighted movement analysis as a crucial element of the clinical reasoning process. The assessment process, including movement analysis, forms a fundamental part of clinical reasoning in physiotherapy (Garner et al., 2024). However, this thesis's findings reveal a gap in understanding regarding the frequency and timing of movement analysis re-evaluation during therapy, as well as how it specifically informs ongoing physiotherapy management. It is possible that this re-evaluation is highly individualised to the therapist, particular patient or context. These results lead one to reflect on the teaching of neurological assessment, particularly how movement analysis is emphasised in the educational setting. Methods of assessment, such as movement analysis, is a method of assessing function and a key method that may be used in teaching assessment. When combined with other domain-specific assessment methods, movement analysis enables physiotherapists to develop a ‘picture’ of the status of the patient (Garner & Lennon, 2018). This information can be used as a foundation for developing hypotheses, which is a critical step in the clinical reasoning process (Vignaud et al., 2023). This

underscores the importance of teaching students not only how to perform movement analysis but also how to integrate this information into their clinical decision-making.

8.1.3 Person-centred care

Person-centred care is at the forefront of assessment and therapy. This was supported by free text survey responses in Chapter 4 where goals and strength were the most frequently identified domains, and in the student interviews (Chapter 7) where the respondents chose domains to assess based on their patient goals. However, what appears to be lacking in students' approach to patient assessment is a systematic and comprehensive physical examination that evaluates and analyses information supporting or negating a movement-related hypothesis reflective of the neurological condition (Tan et al., 2022). It is important that patients are listened to, and there should be an additional vital step that brings together the patient's views, beliefs, and goals, with the physiotherapist's knowledge and experience. This integration develops a shared clinically reasoned viewpoint that informs further decision making (Tan et al., 2022). Our studies do not clearly indicate whether students developed such a shared reasoning viewpoint or how they incorporated additional steps in their assessment process. This raises important questions: Could identification of patient goals be at the expense of including other patient related domains, such as sensation or balance? Given that students in Chapter 7 reported only a few identified domains, it remains unclear whether their treatment approach is limited to what was assessed initially in relation to goals, or if other domains are evaluated at different stages of patient management. This gap in our understanding highlights the need for further research into how students integrate comprehensive assessment techniques with patient-centred goal setting.

8.2 Clinical reasoning in neurological physiotherapy

8.2.1 Definition, Perception and Components

Definitions of clinical reasoning in physiotherapy are often based on the work of Higgs et al., (2019) who describe it as a social, cognitive and interactive process. This process is intrinsically linked to assessment and includes 'physical handling' of the patient (Higgs & Jones, 2019). It also involves the therapist interacting with family members and the wider healthcare team.

What is different about applying clinical reasoning in people with neurological conditions? Ansakorpi et al. (2017) explored medical students' perceptions of learning neurology using survey methodology and found that nearly all respondents (95%) reported insecurities about their own performance, along with fear and anxiety. These feelings were preliminary attributed to the added complexities of neurology and challenges in the interpretation of the

clinical findings of people with these conditions, suggesting difficulties with clinical reasoning. This aligns with Walker's (2013) findings on physiotherapy students' experiences in neurology learning. The physiotherapy students interviewed in Chapter 7 were asked to share their definition of clinical reasoning. There was variability in the definitions of clinical reasoning, suggesting that there was a lack of uniformity in their understanding of the process. This conflicts with findings of Cruz et al. (2012) who explored the perceptions of final-year physiotherapy students regarding clinical reasoning in musculoskeletal practice, where understandings of clinical reasoning were clear and focused primarily on diagnostic reasoning. Dimitriadis et al. (2016) expand on the definition provided by Jones and Rivett (2003), linking it to the approach undertaken by the physiotherapist. This connection is supported by the survey results (Chapter 5), where respondents reported using a flexible approach to assessment. This suggests that the clinical approach of the physiotherapist may be linked to their clinical reasoning process, as confirmed by Dimitriades et al. (2016).

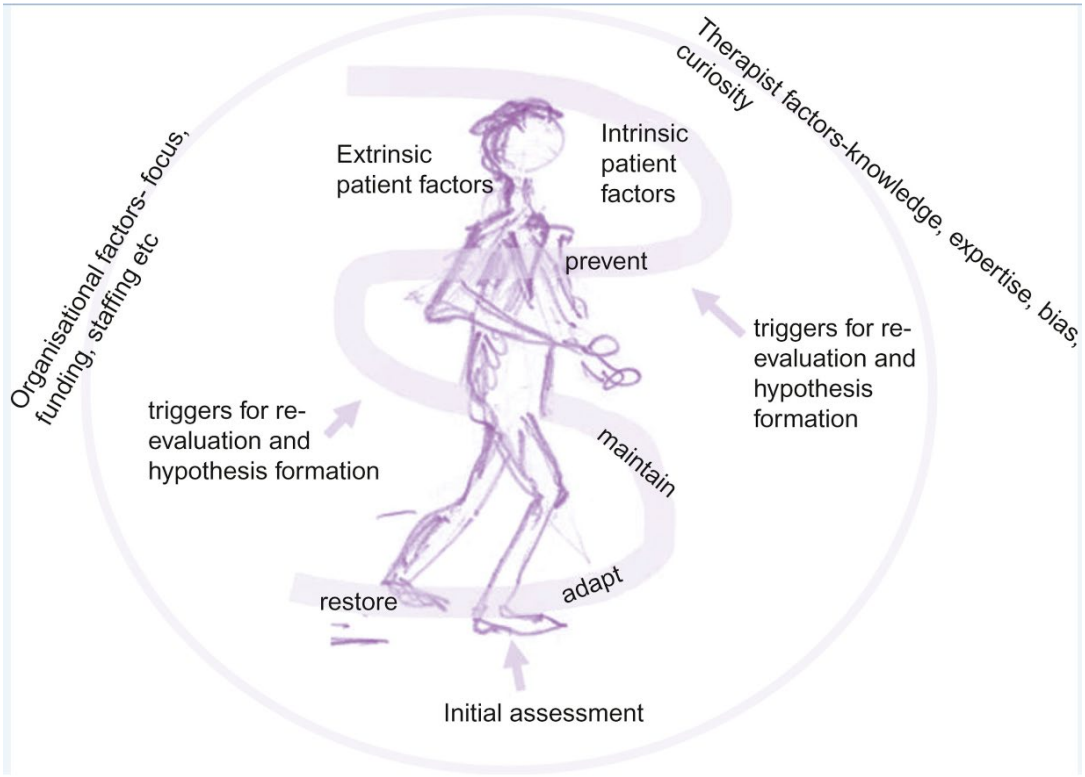
The findings of this thesis suggest a potentially limited understanding of what clinical reasoning is in neurological physiotherapy, with gaps identified in specific components of clinical reasoning as described in Chapter 4. The components of clinical reasoning identified in this thesis align with expert textbooks (Musolino & Jensen, 2024, p. 4-7), literature (Tyson et al., 2008) and practice thresholds (Physiotherapy Board of Australia and New Zealand, 2023). However, some components of clinical reasoning described in the literature were not identified in this thesis, notably awareness and metacognition. Reflection, a component of clinical reasoning included in physiotherapy threshold requirements (Physiotherapy Board of Australia and New Zealand, 2023), was not highlighted as a key component in this thesis. It was not reported by educators (Chapter 6), or students (Chapter 7) during interviews, and was identified in less than a quarter of conceptual frameworks specific to assessment of neurological conditions (Chapter 5). These findings suggest there is insufficient information about reflection as part of the clinical reasoning process, its teaching to students, and its utilisation in clinical practice.

The ICF was the most referenced framework in Chapter 5, recommended to guide physiotherapy clinical practice (WHO, 2001). However, this Thesis and the literature provide little evidence on how and when this framework is used clinically for people with neurological conditions. The primary research papers included in the scoping review in Chapter 5 did not identify components directly related to the ICF framework, highlighting a potential gap between theoretical recommendations and clinical application.

8.2.2 Structure and development

A need for a more structured approach to the clinical reasoning processes was identified by clinicians (Chapter 4), the theoretical framework papers (Chapter 5), and educators (Chapter 6). A suggested structure could be the one offered by Garner et al. (2024, p. 42). This model offers some structure and identifies considerations for clinical reasoning (see Figure 8.1 below). It includes organisational, therapist and patient factors that must be considered and have impact during the clinical reasoning process. It also indicates that throughout the process of clinical reasoning there are extrinsic and intrinsic patient factors that are triggers for reassessment. This may lead to a revision of the most recent movement related hypothesis.

Figure 8-1 Clinical reasoning considerations* (Garner et al., 2024)



* *This figure was published in Physical Management for Neurological Conditions, 5th edition, S. Lennon, G. Ramdharry, & G. Verheyden (Eds.), Clinical Reasoning in Neurological Physiotherapy: Assessment and Treatment Principles. p. 42, Copyright Elsevier (2024).*

Physiotherapy educators (Chapter 6) and students (Chapter 7) reported that practicing clinical reasoning skills aided their development, utilising tools such as problem lists and clinical reasoning forms. This aligns with Furze et al.'s (2015) study, which explored clinical reasoning development in physiotherapy education using clinical reasoning reflection questionnaires and a clinical performance instrument. Their findings suggest that students who can reflect on their progress early in the learning process ('focus on self') are better able

to develop clinical reasoning skills. As learning progresses, the context becomes increasingly important, a notion which is supported by the findings from this thesis.

There is an inevitable link between what university educators teach about clinical reasoning and students' perception of what clinical reasoning is and how to develop it, as one informs the other. The development of clinical reasoning skills begins in the classroom (Christensen et al., 2018; Furze et al., 2015) and is further developed during clinical placements (Furze et al., 2015). Clinicians supervising physiotherapy students, as reported in Chapter 4, identified a few strategies to support students in developing their assessment and clinical reasoning skills whilst on placement. This was not the primary focus of this thesis. There is limited evidence in the literature about clinical supervisor support in neurological physiotherapy areas of practice, which falls outside the scope of this thesis. It has been suggested that development of clinical reasoning skills requires a higher level of cognitive learning (Forehand, 2010). Flew et al. (2013) explored reasons behind failure in international physiotherapists seeking to become accredited physiotherapists in Australia, using a clinical based assessment. The study findings showed that assessment domains that captured skills of assessment, planning, implementation and evaluation had a 77.5% or greater chance of failure across all three core areas of practice (musculoskeletal, neurological, cardiorespiratory), supporting the higher order cognitive skills required for clinical reasoning. The findings form this study may be attributable to the competencies used in non-Australian training models that do not focus on developing 'first contact' practitioner skills, which need highly developed clinical reasoning skills.

8.2.3 Context

Both educators (Chapter 6) and students (Chapter 7) highlighted the importance of exposing students to real patients when learning about assessment and clinical reasoning. This exposure was believed to help students make sense of patient movement and responses, facilitating a comprehensive understanding of all aspects of the neurological patients' presentation and their responses to therapy. Physiotherapy students (Chapter 7) reported several methods that facilitated their learning of clinical reasoning, including observation of clinicians, practice using clinical reasoning forms /problem lists, practice with peers, watching videos during class, and working with real patients. These findings align with a study by Abrandt Dahlgren et al. (2022) which explored understanding of clinical reasoning in physiotherapy students. They found that observing clinicians and their clinical practice during placements was found to facilitate clinical reasoning. This is further supported by Olson et al. (2024), who discussed the inseparability of context and clinical reasoning. Context allows the student to assess individuals with neurological conditions in the clinical

setting, exposing them to the added complexities of communication issues, behavioural challenges, social situations, and fluctuations in medical stability across different settings. Neurological conditions often present with impairments requiring hands-on assessment, as a method to evaluate tone or spasticity, range of movement, and muscle power (Garner & Lennon, 2018). Hands-on assessment provides feedback from the patients/patient's body to the physiotherapist or student, which provides additional information about the clinical situation. The importance of hands-on assessment has been identified in Chapters 3 and 4 and has been confirmed as a method to assist in the incorporation of clinical reasoning skills (Holder et al., 2013).

Chapter 7 identified several barriers to learning clinical reasoning for physiotherapy students, including exposure to the unknown when assessing patients in clinical practice, uncertainty about what to expect from patient interactions, variability in patient presentations, sometimes changing from day to day, and feeling overwhelmed and anxious about how to proceed with assessment and management. These challenges align with the literature reporting the increased complexity associated with learning neurology, whether as a medical student (Jukna et al., 2023) or physiotherapy student (Walker, 2013). These findings suggest that the unpredictable nature of neurological conditions and the diverse presentations of patients can create a steep learning curve for students developing their clinical reasoning skills. The anxiety and uncertainty experienced by students highlight the need for structured support systems and gradual exposure to clinical scenarios.

8.2.4 Clinical decision making and management

The terms clinical reasoning and clinical decision-making are often used interchangeably in the literature. In neurological physiotherapy clinical reasoning skills can be used to form a movement-based diagnosis (Quinn et al., 2021). From this perspective, the clinician, in collaboration with the patient, can progress to clinical decision-making as the final step of the clinical reasoning process (Covington, 2024). However, this thesis did not provide sufficient detail on the specific purposes of assessment and how clinical decisions regarding treatment implementation and ongoing management are made. While evidence can be used to guide treatment options, particularly in stroke rehabilitation where evidence-based interventions are well-established, it remains unclear how this evidence is integrated with the information gathered from assessment to inform clinical decisions. Further research is needed to explore how assessment findings together with the evidence inform clinical decision making.

8.3 Original contribution, Significance and Implication of thesis findings

8.3.1 Original contribution to knowledge

This thesis presents the first comprehensive exploration of physiotherapists' assessment practices for people with neurological conditions. This research has identified five frequently included assessment domains in Australian clinical practice which are approached with flexibility. Goal setting as part of assessment was emphasized when teaching assessment, and as influencing student assessment and as a key component of clinical reasoning.

The study revealed that clinical experience significantly influences assessment practices and the use of standardised measures. Additionally, the severity and complexity of patients were highlighted as barriers to assessment, affecting the time required and serving as important considerations in educators' approaches to teaching clinical reasoning.

Clinical reasoning was found to play a vital role in guiding prognostication and developing an in-depth understanding of movement behaviours. The research identified twenty-five theoretical frameworks used to guide clinical reasoning in practice. However, no single framework was found to comprehensively guide both clinical practice and student teaching of assessment and clinical reasoning while incorporating professional standards.

This research suggests that the teaching of clinical reasoning in neurological physiotherapy may need to be reviewed in light of the findings presented in this thesis. Importantly, the study highlights a significant gap between education and practice in this area, underscoring the need for better alignment between academic preparation and real-world clinical demands.

By providing these novel insights, this thesis makes a substantial contribution to the field of neurological physiotherapy, offering a foundation for improving both clinical practice and educational approaches in assessment and clinical reasoning.

8.3.2 Significance of research findings

The hypothesis presented in the introductory chapter of this thesis, which stated that the content and processes of physiotherapy assessment of people with neurological conditions taught to physiotherapy students in the classroom may not align with what is observed and implemented in various healthcare settings, has been confirmed by the findings of this thesis.

These findings suggest potential considerations for student learning, patient management, and physiotherapy clinical practice in neurological physiotherapy. Our research indicates there may be some discrepancies between university teachings on assessment and clinical

reasoning, particularly regarding timing and choice of assessment domains, and how these processes are structured and implemented in clinical practice. However, it's important to note that these observations are based on limited samples and qualitative studies with acknowledged methodological limitations. Further research with larger, more representative samples would be needed to confirm and generalise these findings. This Thesis has identified many clinical reasoning frameworks to guide practice, suggesting that utilising an evidence-based framework derived from the identified frameworks and components from Chapter 5 could afford a more consistent approach to the clinical reasoning process. Such a framework should reflect the clinical reasoning components outlined in WCPT (2011) and the physiotherapy threshold requirements (Physiotherapy Board of Australia and New Zealand, 2023). Chapter 5 and Chapter 6 revealed a lack of clarity and explicit description of the clinical reasoning process in curricula and practice, highlighting the need for better alignment between university teachings and clinical practice. Knowledge translation approaches could be instrumental in aligning clinical practice more closely with available evidence and threshold standards in relation to assessment and clinical reasoning.

The complexity of neurological conditions, which often affect the whole body, presents unique challenges in physiotherapy education. Many students have little or no exposure to these conditions in the classroom, which introduces challenges learning about these complex conditions without experience or real-world context. This lack of hands-on experience often leads to students only gaining context related to patient conditions during clinical placements or during simulation-based activities. Interestingly, student observations of apparent 'trial and error' practices during placements (Chapter 7) could be interpreted as witnessing the clinical reasoning process at its best. What may appear as ‘trial and error’ to an observer could actually be the clinician rapidly gathering and processing a large amount information, considering the person holistically, and drawing from their ‘toolkit’ to guide possible treatments, whilst taking into account patient impairments, communication, cognitive and functional limitations, as well as patient values. Some studies, such as Kleynen et al. (2017), have adopted think-aloud strategies to make the clinical reasoning process more explicit, although this approach was not observed by students interviewed for this Thesis. This could be a valuable consideration for clinicians supervising physiotherapy students to aid the development of clinical reasoning skills.

Students and qualified physiotherapists are encouraged to implement evidence-based practice as defined by Sackett (1996) which incorporates best research evidence, patient preference, and clinician or educator experience. The role of educators in this process is critical, as they not only provide information but also employ pedagogical principles to

facilitate learning, playing a vital role in the transition from student to new graduate and beyond. It was not possible to recommend a single framework for clinical reasoning in neurological physiotherapy based on the studies conducted. Further research is required to develop a comprehensive clinical reasoning framework in this field.

8.3.3 Key implications for practice

The findings of this thesis highlight several important implications for the assessment and management of patients with neurological conditions in clinical practice. Physiotherapists should consider the following:

1. Assessment domains: ensure the inclusion of key assessment domains including function, postural alignment and symmetry, gait, muscle strength, and balance.
2. Influencing factors: recognise the impact of clinical experience, clinical setting, and geographical location on the selection and inclusion of assessment domains.
3. Information gathering methods: utilise standardised measures and the use of senses, particularly touch and observation as methods of information gathering.
4. Clinical reasoning components: integrate clinical reasoning components including information gathering, objective examination, movement analysis, predicted patient performance, and evaluation/reassessment.

8.3.4 Key implications for teaching

The findings of this thesis also highlight a number of implications when teaching pre-registration physiotherapy students about neurological assessment and clinical reasoning. Educators should consider the following key points.

1. Address common barriers to assessment:
    - Time constraints
    - Patient-centred factors (goals, communication, fatigue, condition complexity)
    - Severity and complexity of patients' conditions
    - Workplace considerations, such as the environment and availability of equipment
2. Highlight enablers for effective assessment:
    - Developing clinical reasoning skills
    - Knowledge of standardised measures
    - Building a strong knowledge base
    - Gaining clinical experience
3. Utilize the ICF framework as a guide for teaching assessment and clinical reasoning.
4. Emphasize key clinical reasoning components:

- Information gathering
- Objective examination
- Movement analysis
- Predicting patient performance
- Evaluation and reassessment

5. Prioritize learning from real patients in context:
    - Provide scaffolding to support learning of assessments and clinical reasoning
    - Encourage observation of peers and registered staff interacting with patients
6. Address the complexity of neurological physiotherapy:
    - Emphasize the importance of developing clinical reasoning skills in both theory and clinical placements
7. Acknowledge and address variable understandings of clinical reasoning among students:
    - Conduct further research to improve teaching methods
8. Implement effective teaching methods:
    - Be explicit in teaching assessment and clinical reasoning
    - Use real cases, videos, and simulation to provide context
    - Encourage application of knowledge across different situations
    - Promote reflection on students' own skills and practice
    - Support knowledge acquisition as a foundation for clinical reasoning
    - Reference threshold requirements from WCPT (2011) and the Board of Australia and New Zealand (2023)
    - Explain different methods of reasoning from novice to expert
    - Inform students about findings from Chapter 4 regarding assessment practices in clinical settings

By incorporating these points into pre-registration physiotherapy education, and educators being more explicit in moving through some of the steps of clinical reasoning (using a framework or other checkbox/guidelines for example), they can better prepare students for the challenges and complexities of neurological assessment and clinical reasoning in practice.

8.4 Personal reflections on my biases

The research findings presented in this Thesis may be influenced by my own biases, given my dual roles as a senior physiotherapist in neurological rehabilitation at a public hospital in Adelaide, Australia, and as a lecturer in neurological physiotherapy at Flinders University from 2013 to 2023.

At the start of my research journey, I undertook a bracketing exercise in which I reflected on my own assumptions and biases related to this area of interest. ‘Bracketing’ can be described as the process of acknowledging preconceived beliefs and opinions about the phenomenon that is being studied (Thomas & Sohn, 2023). In the thesis chapters, especially Chapter 6 describing the findings of the student interviews, my roles as a university lecturer, clinician, and researcher may have impacted the students’ experience in the research. This reflexive aspect should be acknowledged.

With over 35 years of clinical experience assessing individuals with neurological conditions and observing other clinicians in various settings, I have noted a lack of uniformity among physiotherapists within and across different clinical environments, such as inpatient and outpatient settings. It appeared that assessment may be modified based on organizational demands, such as the need to communicate information to other healthcare professionals, for purposes like transfer status or discharge planning.

I assumed that all physiotherapy students possessed the same theoretical knowledge taught at university and that they would eventually need to translate classroom skills into real-world assessment. I reflected on whether theory is very different from practice regarding assessment: What is this assessment based on? and has this changed over the years? What are the influencing factors? How do we adequately prepare students for placement? Prior to conducting this research, students I taught reported not needing to assess certain domains during clinical placements. This raised questions about why this might be the case. Why is this?

I believed that assessment should relate to the diagnosis provided by the medical team. I wondered if certain domains perceived as irrelevant to treatment could be omitted from assessment. For instance, if sensation is not considered or treated, should it be tested? This also applies to testing joint position sense. I pondered whether omitting certain domains prevents obtaining a complete picture or if a complete picture is unnecessary.

I questioned the importance of consistent assessment – whether it has become implicitly integrated into treatment. Perhaps subjective assessment is conducted first, followed by a combination of objective assessment and treatment. I wondered if not all assessment components are completed and reassessment is lacking, how does the physiotherapist know they are effective? Perhaps, it is all about the patient’s perspective? If patients feel better and meet their goals, maybe the specifics of assessment are less critical? These reflections formed the starting point for my PhD journey.

8.5 Strengths and limitations

8.5.1 Thesis strengths

This thesis has made a significant contribution to the body of evidence on physiotherapy assessment and clinical reasoning, particularly in the context of neurological conditions. To the author's knowledge, it represents the first comprehensive exploration of these topics specifically focused on patients with neurological disorders.

Through the application of diverse methodologies, this research has generated new knowledge regarding commonly assessed domains in clinical practice for neurological patients. The Thesis identified 25 theoretical frameworks used to guide practice in neurological physiotherapy. Furthermore, it has elucidated frequently included clinical reasoning components in clinical practice, such as initial information gathering, objective examination, movement analysis/diagnosis, collaborative goal setting, and prognostication. These findings provide a valuable foundation for future research and practice in the field.

The research has also shed light on the nature of teaching assessment and clinical reasoning in physiotherapy education. It revealed that these crucial skills are often taught implicitly, leading to variable understanding among students. This variability highlights the need for more explicit and structured approaches to teaching clinical reasoning in physiotherapy programs.

Moreover, the thesis has uncovered many assumptions about how clinical reasoning is learned, challenging educators and researchers to reconsider current teaching methods and develop more effective strategies for fostering these critical skills in future physiotherapists. This insight opens up new avenues for research into pedagogical approaches that can better prepare students for the complexities of clinical reasoning in neurological physiotherapy practice.

8.5.2 Thesis limitations

The limitations of the thesis are discussed for each individual study. The limitations of this thesis are multifaceted, with each individual study presenting its own set of constraints. In the systematic review (Chapter 3), the diverse range of study types posed a challenge in synthesizing and comparing results across studies.

The survey conducted in Chapter 4 faced limitations in its recruitment strategy and sample representation. By restricting recruitment to physiotherapists who are members of the Australian Physiotherapy Association, the study may have excluded perspectives from practitioners who are not members of this organisation. Additionally, the predominance of

respondents from urban areas, particularly Sydney, raises questions about the generalisability of results to physiotherapists practicing in rural settings. The length of the survey, comprising 39 questions, may have deterred some potential respondents, potentially introducing a bias towards those with more time or greater interest in the topic.

In Chapter 6, the educator interviews and web-based audit were limited by the participation of just under half of all universities that teach pre-registration physiotherapy programs in Australia. This partial representation may not fully capture the diversity of teaching approaches and curricula across the country. The researcher conducting the interviews noted that a focus group approach might have been beneficial, allowing educators from various programs to interact and potentially reveal insights that individual interviews may have missed.

The student interviews (Chapter 7) were constrained by the small number of participants who completed both pre- and post-clinical placement interviews, as well as the limited geographical representation, with participants coming from only two Australian states. This narrow sample may not fully reflect the experiences of students across different regions and educational institutions. For future interview studies, providing questions to students in advance could be beneficial, allowing for more thoughtful and comprehensive responses. This approach might yield richer data and more in-depth insights into students' experiences and perceptions.

Despite these limitations, the multi-method approach employed in this thesis provides a comprehensive exploration of physiotherapy assessment and clinical reasoning in neurological conditions. The diverse methodologies used offer complementary perspectives, helping to mitigate some of the individual study limitations and providing a robust foundation for future research in this area.

8.6 Conclusion

In conclusion, this thesis has enhanced our understanding of the implementation of physiotherapy assessment and clinical reasoning for individuals with neurological conditions in clinical practice. The research comprised five interconnected studies: a mixed-methods systematic review, an online survey, a scoping review, semi-structured interviews with educators (including a web-based audit), and interviews with physiotherapy students. These studies collectively explored assessment and clinical reasoning in neurological physiotherapy from both theoretical and practical perspectives, ultimately leading to an examination of teaching practices and student perspectives.

The findings reveal that physiotherapists' assessment of people with neurological conditions in clinical practice frequently encompasses five essential domains, approached with flexibility. Clinical reasoning was identified as an integral component of this process. However, a notable disparity emerged between what was assessed in clinical practice and what was taught or experienced by students, highlighting a significant gap in the nexus between clinical practice and education in neurological physiotherapy.

The research identified numerous clinical reasoning frameworks used to guide practice. This suggests that utilizing an evidence-based framework derived from these identified frameworks and components could provide a more consistent approach to the clinical reasoning process for both students and clinicians. Such a framework should reflect the clinical reasoning components outlined in the World Confederation for Physical Therapy guidelines (WCPT, 2011) and the physiotherapy threshold requirements set by the Physiotherapy Board of Australia and New Zealand (2023).

This comprehensive exploration of assessment and clinical reasoning in neurological physiotherapy not only contributes valuable insights to the field but also underscores the need for greater alignment between clinical practice and educational approaches. By bridging this gap, we can better prepare future physiotherapists to meet the complex challenges of neurological assessment and treatment, ultimately improving patient care and outcomes.

8.7 Suggestions for future research

To further advance the understanding and practice of clinical reasoning in neurological physiotherapy, the following recommendations for future research are made:

- Investigate the role of clinical supervisors in guiding students during clinical placements, specifically in the assessment of patients with neurological conditions, exploring the difference to other areas of practice
- Examine the effectiveness of scaffolded teaching approaches for clinical reasoning in neurology and assess their impact on student learning outcomes
- Explore and refine existing clinical reasoning frameworks in neurological physiotherapy in order to test an all-encompassing framework in future trials
- Explore the characteristics of expert practitioners in neurological physiotherapy, utilising a framework to understand progression of clinical reasoning skills
- Explore recommendations for teaching neurological physiotherapy assessment and clinical reasoning via a Delphi study with educators from across Australia

APPENDICES

Appendix A: Search strategy

Databases: Ovid MEDLINE, CINAHL, Scopus, web of science and Cochrane Library, Pubmed
Database(s): **Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily** 1946 to January 2023

Search Strategy: (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/)

#	Searches
1	neurological examination/
2	(neurol* adj3 (Assess* or measur* or test* or examin* or evaluat*)).ti,ab,kf.
3	or/1-2
	exp Nervous System Diseases/
5	exp brain injuries/
6	((nervous system or somatosens* or sensor*) adj2 (condition* or disease*)).ti,ab,kf.
7	(stroke or poststroke or multiple sclerosis or parkinson* or guillain barre or polio* or dystonia or brain cancer* or brain neoplasm* or brain tumo* or Glioblastoma or Amyotrophic Lateral Sclerosis or Motor neurone disease or ALS or MND or Spinal cord injur* or brain inj*).ti,ab,kf.
8	or/4-7
9	"Outcome Assessment (Health Care)"/ or "Outcome and Process Assessment (Health Care)"/ or Treatment outcome/ or Disability evaluation/
10	(Assess* or measur* or test* or examin* or evaluat* or domain*).ti,ab,kf.

Appendix B: Quality assessment of quantitative studies (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/)

For each study, if they met the specific McMaster criteria this was indicated by a green triangle in the square if they did not meet the criteria this was indicated by a red triangle. The four McMaster criteria deemed critical by the research team based on answering the research questions for this systematic review were: detailed description of the intervention, detailed description of the sample, appropriate analysis methods, appropriate conclusion. If the study met all four criteria and scored 80% or more on the Mc Master critical appraisal tool for quantitative studies, these were judged as high quality. Studies which met three of the critical criteria and/or obtained an overall score of between 50-79% were judged medium quality. Studies which met two or less of the critical criteria and/or obtained an overall. score of ≤49% were judged low quality.

	Was the study purpose clearly explained	Was relevent background literature reviewed	Was design apporpriae for the question	Biases of the results	Sample described in results	Was the sample justified	Interventio n was desribed in detail	Contaminat ion avoided	Results were reported in terms of statisctial significance	Analaysis methods were appropriate	Clincial importance was reported	Drop outs reported	Conclusions appropriate	Quality asessment
Bailey e tal., 1998														MEDIUM
Blanchette et al., 2017												N/A		HIGH
Cavanaugh & schenkman, 1998												N/A		HIGH
Carr et al., 1994												N/A		HIGH
Checketts et al., 2020														HIGH
Demers et al., 2018												N/A		HIGH
Gervais et al., 2014												N/A		MEDIUM
Houlahan et al., 2023												N/A		HIGH
Lennon & Ashburn, 2001												N/A		HIGH
Lennon, 2001												N/A		MEDIUM
Lennon, 2003												N/A		MEDIUM
Lyon et al., 2023														HIGH
Proud et al., 2013												N/A		MEDIUM
Sackley et al., 1996												N/A		HIGH
Takahashi et al., 2024												N/A		MEDIUM
Wilson et al., 2019														HIGH
Winward et al., 1999														MEDIUM
Yoward et al., 2008														MEDIUM

Appendix C: Quality assessment of qualitative studies (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/)

For each study, if they met the specific McMaster criteria this was indicated by a green triangle in the square if they did not meet the criteria this was indicated by a red triangle. The four McMaster criteria deemed critical by the research team were based on answering the research questions for this systematic review were: procedural rigour, analytical rigour, auditability and theoretical connections (highlighted in yellow). If the study met all four criteria and scored 80% or more on the Mc Master critical appraisal tool for qualitative studies, these were judged as high quality. Studies which met three of the critical criteria and/or obtained an overall score of between 50-79% were judged medium quality. Studies which met two or less of the critical criteria and/or obtained an overall score of ≤49% were judged low quality.

	Was the study purpose clearly explained	Was relevent background literature reviewed	Was design apporpriae for the question	Theoretical persctie indeitifed	Methods congruent with philosphical underpinnings	Purposeful selection	Was sampling done until redundancy	Informed consnet gained	Proceduarl rigour	Analytical rigour	audtiability	Theoretical connections	Quality asessment
Alatawi et al., 2022	▲	▲	▲	▼	▲	▲	▲	▲	▲	▲	▲	▲	MEDIUM
Bainbridge et al., 2023	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	HIGH
McGlynn & Cott, 2007	▲	▲	▲	▼	▲	▼	▲	▼	▼	▲	▼	▲	HIGH
Normann et al., 2007	▲	▲	▲	▲	▼	▼	▲	▲	▼	▲	▲	▲	HIGH
Pattison et al., 2014	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▼	HIGH
Plummer et al., 2006	▲	▲	▲	▲	▲	▼	▲	▲	▼	▲	▲	▲	HIGH
Seale & Utsey, 2020	▲	▲	▲	▲	▲	▼	▲	▲	▲	▲	▲	▲	HIGH
Takahashi et al., 2014	▲	▲	▲	▼	▲	▼	▼	▲	▼	▲	▲	▲	MEDIUM

Appendix D: APA standardised recruitment text (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/)

Dear colleague, we are surveying physiotherapists within Australia to explore current clinical practice, views and perspectives on physiotherapy assessment of people with neurological disorders. We are interested in obtaining perspectives from any physiotherapist who assesses patients with neurological disorders, regardless of their experience or specialty. This study is being carried out by physiotherapist Jill Garner and will contribute to her Masters (Research) in Clinical Rehabilitation at Flinders University. Participation in this survey is entirely voluntary. No personal information will be collected (apart from age and clinical experience) and any data provided by you will be anonymous.

If you decide to participate or would like to read the full participant information form, please click on the link below which will take you to a survey webpage. Before completing the survey, you will be asked to provide consent.

Standardised recruitment text for State-wide emails

To whom it may concern,

With this email I would like to inform you about a research study which aims to explore current clinical practice, and physiotherapists' views and perspectives on physiotherapy assessment of people with neurological disorders.

My name is Jill Garner, I am an Advanced Clinician Neurorehabilitation at Flinders Medical Centre, and a Lecturer and Clinical Educator at Flinders University, in Adelaide. I am working towards a Master by Research in Clinical Rehabilitation with the ultimate aim to develop a clinical framework for the assessment of people with neurological disorders. Currently I am surveying physiotherapists within Australia to assess current clinical practice, with regards to the assessment of people with neurological disorders, as well as their general perspectives on this.

Appendix E: Physiotherapy clinical practice in the assessment of people with neurological conditions (Reproduced with permission under the creative commons license https://creativecommons.org/licenses/by-nc-nd/4.0/)

Please read the 'Participant Information Form' in this embedded link before consenting to complete the survey below.

By clicking the button below, you acknowledge:
Your participation in the study is voluntary. You are 18 years of age. You are aware that you may choose to terminate your participation at any time for any reason.

- ○ I consent, begin the study (1)
- ○ I do not consent, I do not wish to participate (2)

End of Block: Informed Consent

Start of Block: Introduction

Dear colleague, we are surveying the physiotherapy profession in Australia to explore current clinical practice, views and perspectives on physiotherapy assessment of people with neurological conditions. If you decide to participate, you will be asked to complete a survey that will involve answering questions about your thoughts and views of clinical assessment of people with neurological conditions. We are interested in your current practice in this area. This study is being carried out by physiotherapist Jill Garner as part of research to meet the requirements of a Masters (Research) in Clinical Rehabilitation at Flinders University. Jill teaches neurological assessment to undergraduate students and also works clinically in neurology. The outcomes of this study will contribute to the development of a clinical framework for assessment.

The survey is divided into two sections.
Section 1: These questions aim to find out about background information about you (Questions 1-13).
Section 2: These questions aim to find out about assessment content and process (Question 14- 38).
The survey will take approximately 20 mins.
If you have any further questions regarding this survey or would like to view the collated results, please contact Jill Garner: jill.garner@flinders.edu.au.

Q1 Are you currently working clinically with patients with neurological conditions?

- ○ Yes (1)
- ○ No, If you have answered no to this question, please do not complete this survey (2)

Section 1: These questions aim to find out background information about you

Q2 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Other (3)

Q3 What is your age (in years)?

_____

Q4 How many years have you been a qualified physiotherapist? Please state.

_____

Q5 Where did you obtain your primary physiotherapy qualification?

- ○ Australia (1)
- ○ Overseas, please specify (2)

_____

Q6 What is your highest level of professional education?

- ○ Diploma of Physiotherapy (1)
- ○ Bachelor of Physiotherapy (2)
- ○ Bachelor of Physiotherapy, Honours (9)
- ○ Master of Physiotherapy pre-registration (3)
- ○ Doctor of Physiotherapy pre-registration (4)
- ○ Honours (5)
- ○ Master by coursework (6)
- ○ Master by research (7)
- ○ PhD (8)

Q7 Have you attended a neurology related course with a minimum duration of a day in the last two years? If so, please select the number attended. Include those with and without additional qualifications.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ >3 (5)

Q8 Currently, please specify hours per week you are working clinically?

- ○ Hours per week (1)

_____

- ○ Other, if you do not work set hours per week, Please specify (2)

_____

Q9 During the last working month, in which state have you spent the most time working.

- ○ Australian Capital Territory (1)
- ○ New South Wales (2)
- ○ Northern Territory (3)
- ○ Queensland (4)
- ○ South Australia (5)
- ○ Tasmania (6)
- ○ Victoria (7)
- ○ Western Australia (8)

Q10 Below are definitions of work areas. Please choose those areas you have worked in over the last month. Tick all that apply.

Metropolitan (1)

- ○ Regional (4)
- ○ Rural/remote (5)

Q11 In what clinical setting do you work primarily? Please select one only.

- Acute inpatients/public (134)
- Acute inpatients/private (135)
- Inpatient rehabilitation/public (136)
- Inpatient rehabilitation/private (137)
- Outpatient rehabilitation/public (138)
- Outpatient rehabilitation/private (139)
- Outpatients/public (140)
- Outpatients/private (141)
- Residential care (142)
- Home care/community (143)
- Other, please specify (144)

_____

Q12 How many years have you been working with neurological patients?

- ○ (1)
- ○ 1-5 (2)
- ○ 6-10 (3)
- ○ 11-15 (4)
- ○ 16-20 (5)
- ○ >20 (6)

Q13 During your average working week, please specify hours per week spent with patients who have neurological conditions?

- ○ Please specify (9)

_____

Section 2: This section focuses specifically on the content and process of your assessment.

Q14 Considering your neurological patient/patient caseload, how often do you assess each of the conditions below? Please select all that apply.

	Daily/weekly (1)	Often (3)	Sometimes (4)	Rarely (5)	Never (7)
Stroke (1)	•	•	•	•	•
Multiple Sclerosis (2)	•	•	•	•	•
Parkinson's Disease (3)	•	•	•	•	•
Guillain Barre (4)	•	•	•	•	•
Spinal Surgery (5)	•	•	•	•	•
Brain Cancer (6)	•	•	•	•	•
Traumatic Brain Injury (7)	•	•	•	•	•
Spinal Cord Injury (8)	•	•	•	•	•
Motor Neuron Disease/ALS (9)	•	•	•	•	•
Cerebral Palsy (10)	•	•	•	•	•
Other upper motor neuron conditions (11)	•	•	•	•	•
Other lower motor neuron conditions (12)	•	•	•	•	•

Q16 When did you last review resources related to neurological assessment? These include literature, web based information and online videos.

- ○ Within the last 6 months, please specify (27)

_____

- ○ Within the last 12 months, please specify (28)

_____

- ○ When studying as a pre-registration student, please specify (29)
- ○ Other, please specify (30)

_____

Q17 Do you assess **all** neurological patients using the same approach?

- ○ Yes (1)
- ○ No (2)

Q18 Are there certain core domains that you assess in every patient/patient? For the purposes of this survey domains have been defined as: areas covered in assessment such as leg strength or patient goals.

- ○ If yes, please list (1)

_____

- ○ No (2)

Q19 On average, how long does it take you to perform a neurological physiotherapy assessment?

- ○ ≤ 15 minutes (82)
- ○ ≤ 30 minutes (83)
- ○ ≤ 60 minutes (84)
- ○ Other please specifiy (85)

_____

Q20 What influences the amount of the time it takes you to perform an assessment?

- ○ Please specify (1)

_____

Q21 At what point in the patient journey, do you perform an assessment with patients with neurological conditions? Select all that apply.

- On admission (42)
- On discharge (43)
- At set time points ie day 1, day 7, day 14 or half way through therapy schedule- please specify (45)

_____

- Other- please specify (46)

_____

Q22 We would like to know a little bit more about what influences the process of your assessment. Please indicate below which factors influence assessment.

	Barrier to assessment (1)	Enabler of assessment (2)	Does not influence (3)
Time (200)	•	•	•
Space/environment (201)	•	•	•
Peers (202)	•	•	•
Experience (203)	•	•	•
Knowledge (204)	•	•	•
Patient centered factors-intrinsic i.e fatigue, motivation, pain (205)	•	•	•
Patient centred factors-extrinsic i.e environment, family (206)	•	•	•
Clinical reasoning i.e using subjective to inform objective (207)	•	•	•
Standadrised measures (including outcome measures) (208)	•	•	•
Other –please specify (209)	•	•	•

Q23 As part of a recent systematic review exploring current practice in physiotherapy assessment of people with neurological conditions, 55 domains were identified that physiotherapists may assess. These domains have been collapsed together. There is no specific order to these domains.

Please indicate how often you include the domains below in assessment of people with neurological conditions.

	Always (1)	Often (2)	Sometimes (4)	Rarely (5)	Never (7)
10080 (10080)	•	•	•	•	•
Function (e.g bed mobility, transfers, lie to sit, sit to stand), please specify (10081)	•	•	•	•	•
Activities of daily living- please specify (10082)	•	•	•	•	•
Stairs (10083)	•	•	•	•	•
Muscle strength (10084)	•	•	•	•	•
Muscle length (10085)	•	•	•	•	•
Trunk/core (10086)	•	•	•	•	•
Postural alignment and symmetry (10087)	•	•	•	•	•
Somatosensory assessment (e.g light touch, proprioception, pinprick, temperature, pressure, stereognosis, 2 point discrimination, vibration), please specify (10088)	•	•	•	•	•
Pain (10090)	•	•	•	•	•
Vision (10091)	•	•	•	•	•
Perception (10092)	•	•	•	•	•
Neglect (10093)	•	•	•	•	•
ROM (including AROM and PROM) (10094)	•	•	•	•	•
Balance (e.g orientation in space, postural reactions, perturbations, anticipatory movements strategies, sway, static and dynamic balance), please specify (10095)	•	•	•	•	•
Deep Tendon Reflexes (10096)	•	•	•	•	•
Goal setting (10097)	•	•	•	•	•
Gait (e.g speed, distance, endurance, cognitive loading during gait), please specify (10098)	•	•	•	•	•
Activity tolerance (endurance) (10099)	•	•	•	•	•
Cognition (10100)	•	•	•	•	•
Mood (including confidence and anxiety) (10101)	•	•	•	•	•
Co-ordination (10102)	•	•	•	•	•
Selective movement (10103)	•	•	•	•	•
Spasticity (10104)	•	•	•	•	•
Upper limb, please specify (10105)	•	•	•	•	•
Tone (e.g tremor, bradykinesia, dyskinesia) (10106)	•	•	•	•	•
Falls and safety (10107)	•	•	•	•	•

Q24 Are you satisfied that all the essential domains specific to neurological assessment have been identified in Q23?

- ○ Yes (1)
- ○ No, please comment (2)

_____

Q25 This text box is for any additional comments you would like to make regarding assessment domains.

- ○ Additional comments (8)

_____

Q26 This next two questions explore clinical reasoning. Physiotherapists gather and analyse information during the assessment process to inform clinical decisions. The clinical reasoning components below are derived from Higgs, Jones and Loftus (2008); Garner & Lennon (2018). Please select all that components that you use to inform clinical reasoning and comment if needed.

- Evaluation of subjective findings (409)
- Evaluation of objective findings (410)
- Hypothesis formation (411)
- Use of standardised measures (412)
- Goal setting (413)
- Patient's problem list (414)
- Treatment plan (415)
- Clinical pattern recognition (416)
- None (417)
- Other, please specifiy (418)
- Comments (419)

_____

Q27 This next section is related to information gathered as part of the assessment and what it is used for. Please select as many as apply.

- Form hypothesis (1)
- Write a problem list (2)
- Develop patient/patient centred goals (3)
- Plan treatment (4)
- Handover to other physios (5)
- Handover to other Healthcare professionals (6)
- Handover to carers (8)
- Other, please comment (11)

_____

Q15 Do you subscribe to a particular therapeutic approach?

- ○ No (1)
- ○ Yes, please specify (2)

_____

Q28 How do different therapeutic approaches influence the way you assess patients.
An example: I assess patients based on the … approach.

- ○ Please detail how different therapeutic approaches influence your assessment (1) _____

Q29 Does anything else guide your assessment?

- ○ Please comment (1)

_____

Q30 Regarding documentation of assessment. Please select which format applies.

- ○ As per organisational format, please specify (1)

_____

- ○ SOAP format (2)
- ○ Other (3) _____

Q31 This next six questions will explore your approach to using measures as part of assessment. These measurement tools are used for measuring impairments, activity limitations, participation, and quality of life. Those that have had their psychometric properties evaluated are termed standardised measures. Measures that are used to measure the outcome of a treatment are termed outcome measures (Braun et al., 2018).
Do you use any measures as part of your assessment?

- Yes (1)
- No, please continue to question 37 (2)

Q32 Please select all measures that you include as part of your assessment.

- Standardised diagnostic specific measures, please specifiy (84)

_____

- Standardised activity measures, please specify (85)

_____

- Standardised participation/quality of life measures, please specify (86)

_____

- Standardised outcome measures, please specify (87)

_____

- Self- devised measures, please specify (88)

_____

- Other, please specify (89)

_____

Q33 How often do you use standardised measures? Select as many as apply.

- Always (43)
- Often (44)
- Sometimes (45)
- Rarely (46)
- Never (47)
- Other (48) _____

Q34 What influences your choice of standardised measures? Select all that apply.

- EBP (1)
- Familiarity (2)
- Experience (3)
- As directed by organisation (4)
- What will most reflect change in my patient/patient population (5)

Q35 When do you use standardised outcome measures?

- ○ Initial assessment (1)
- ○ Subsequent assessment (2)
- ○ On discharge (3)
- ○ Other, please specify (4)

_____

Q36 Do you use measures of outcome that are not standardised?

- ○ Yes, please specify (1)

_____

- ○ No (2)

Q37 This question is for physiotherapists working clinically who supervise students. Do you supervise students in a clinical setting? If answering no you may continue to question 39.

- Yes (6)
- No, continue to question 39 (7)

Q38 Please share any suggestions you may have about the best way to teach students and /qualified physiotherapists how to perform a neurological assessment:

_____

Thank you so much for taking the time to complete this survey. We welcome any additional comments you have regarding physiotherapy assessment of adults with neurological conditions in the clinical setting.

- Additional comments (1)

_____

Appendix F: Data base search example (data from 2022)

Scopus

TITLE-ABS-KEY (physiotherap* OR "physical
therap*" OR neurophysio* OR neurorehab* OR ((neuro* OR cardiopulmonary OR cardiac* O
R musculoskeletal) W/4 rehabilit*)) AND (TITLE-ABS-
KEY (clinical W/2 (reason* OR competence OR judgement OR "problem solv*" OR "decision
making")) OR "practical reasoning" OR "diagnostic reasoning" OR "critical
thinking" OR (TITLE (assess* OR examin* OR evaluat*))) AND TITLE-ABS-
KEY (model* OR theor* OR framework* OR teach* OR educat* OR student* OR instruct* OR
hypothes* OR reflect* OR "differential
diagnosis" OR (expert W/2 (testimonial* OR opinion* OR focus OR consensus))) AND
NOT TITLE (child* OR paediatri* OR pediatric* OR infant* OR teen* OR adolescen* OR yout
h*)

Appendix G: Clinical reasoning components identified within the Physiotherapy practice thresholds in Australia & Aotearoa New Zealand standards (November, 2023) and enabling components code (data from search, 2024)

Role	Key Competency related to assessment/clinical reasoning and clinical decision making	Enabling components	Clinical reasoning components coupled with Physiotherapy practice thresholds in Australia & Aotearoa New Zealand standards Framework (November, 2023) enabling components
Role 1: Physiotherapy practitioner	1.1 plan and implement an efficient, effective, culturally safe and responsive and patient-centred physiotherapy assessment	1.1A recognise and evaluate the social, cultural, personal and environmental factors that may impact on each patient's functioning, disability and health 1.1E effectively **share information and explanations with the patient** and relevant others about the purpose of physiotherapy assessment, any relevant risks and options 1.1F plan a physiotherapy assessment drawing on applied knowledge of pathology, anatomy, physiology, other core biomedical sciences relevant to human health and **function** and determinants of health relevant to the patient's impairments, activity limitations and participation restrictions **(Use ICF for assessment)** 1.1G collect information about the patient's prior function, physical	ICF- 1.1A Collaboration with patient re assessment findings-1.1E ICF-1. 1F Initial Information gatrhering-1.1G

		abilities and participation and identify the patient's expectations of physiotherapy **(subjective exam)**	
			Standard measures-1.1H
		1.1H incorporate relevant **diagnostic tests, assessment tools and outcome measures** during the physiotherapy assessment	Objective examination including function Diagnostic tests-1.1H
			Referrals /discharge planning-1.1L
		1.1I analyse the patient's response and **information gathered** during the physiotherapy assessment using **clinical reasoning to identify any relationships between assessment findings and modify the assessment appropriately (hypothesis formation)**	Differential diagnosis/Hypothesis formation -1.1I
			Reflection in action -1.1J
		1.1J r**eflect** on the patient's presenting problems and **information gathered** during the physiotherapy assessment and **use clinical reasoning** to explore and **explain the diagnosis** and/or causes of presenting problems	
		1.1K assist and support the patient, other health professionals and relevant others to make **informed health-care decisions** by sharing information and explanations about the **outcomes** of the physiotherapy assessment and diagnosis **(movement related diagnosis/prognostication)** and, where relevant, options for **referral** to other physiotherapists and health	Movement analysis/ diagnosis-1.1K

		professionals for further investigation **(collaborate with patient and other HPs)** 1.1L assist the **patient and relevant others to understand the risks and rationale** for physiotherapy and any referrals to other professionals **(management)**	
	1.2 involve the patient and relevant others in the planning and implementation of safe and effective physiotherapy using evidence-based practice to inform decision-making	1.2A effectively **share information and explanations with the patient**, other health professionals and relevant others about the physiotherapy options available across a range of therapeutic approaches and environments to manage the **patient's presenting problems,** and the benefits and realistic expectations of the risks and outcomes associated with each option 1.2B facilitate discussions with the patient and relevant others to reach agreed goals of physiotherapy that reflect realistic expectations of the risks and likely outcomes **(prognostication)** 1.2C involve the patient and relevant others in **planning** and implementing physiotherapy consistent with the **agreed goals** 1.2D use specific and **relevant measures** to evaluate a patient's response to physiotherapy, and	Evidence based practice BP-1.2 Patient presenting problems-1.2A Prognostication-1.2B Collaborative goal setting-1.2C

		recognise when that response is not as expected **(and review)** 1.2E **share information and explanations with the patient**, other health professionals and relevant others about the patient's response to physiotherapy 1.2F **work collaboratively with the patient,** other health professionals and relevant others to review **agreed goals** and implement appropriate modifications to subsequent physiotherapy to maintain or improve outcomes **(review and modify as nec)**	Evaluate/reassessment-1.2D Prognostication-1.2E Modify plan-1.2F Collaborative goal setting-1.2F
	1.3 review the continuation of physiotherapy and facilitate the patient's optimal participation in their everyday life	1.3A recognise the complex and interrelated factors including social, economic, physical, historical, political, and cultural determinants that may impact on the patient, their needs and response to physiotherapy **(Clinical reasoning and Prognostication)** 1.3B engage with the patient and relevant others to facilitate the patient's optimal participation in their everyday life 1.3C engage with the patient and relevant others to develop an **agreed plan to review** the continuation of physiotherapy, recognize when physiotherapy is not suitable for the patient and	Prognostication- 1.3A ICF-1. 3B Management and treatment planning- 1.3C Monitor effectiveness of therapy 1.3C

		identify and facilitate access to more suitable options, including **referra**l to other professionals 1.3D when relevant, facilitate the patient's transition to a new context, refer for further physiotherapy and link the patient to relevant clinical and non-clinical support services	Referrals /discharge planning- 1.3C Referrals /discharge planning- 1.3D

Appendix H: Frameworks identified in the conceptual framework papers (data from search, 2024)

Framework/s	Number of papers that have included or referenced the framework	Author date
1.International Classification of Function	4	Dimitriadis et al., 2016; Potter, 2011; Schenkman et al, 2006; Sullivan, 2011
2.The Guide to Physical Therapist Practice	3	Dimitriadis et al., 2016; Potter, 2011; Schenkman et al., 2006
3.Hypothesis-Oriented Algorithm for Clinicians (HOAC II)	3	Briggs, 2011, Schenkman et al, 2006, Deutsch et al., 2006
4-7. Concluding Frameworks developed by the authors and influenced by other established published frameworks	3	Potter, 2011; Schenkman et al., 2006; Sullivan, 2011.
8-11. Concluding Frameworks described by the authors not influenced by other established published frameworks	3	Cohen, 2020; Normann, 2015, Oberg et al., 2015
12.An integrated framework for decision making in neurologic physical therapist practice.	2	Schenkman et al., 2006; Dimitriadis et al., 2016
13.Framework for Rehabilitation of Neurodegenerative Diseases	1	Briggs, 2011
14.Framework for Assessment in Oncology Rehabilitation	1	Briggs, 2011
15.Framework for Movement Analysis	1	Gill-body et al., 2021
16.Models of Practice in Palliative Care	1	Briggs, 2011
18. Enablement model	1	Schenkman et al., 2006
19.Neurologic Differential Diagnosis Process	1	Sullivan, 2004
20.Nagi Model	1	Schenkman et al., 2006
21.Framework for Clinical Practice	1	Sullivan, 2000
22.Evaluation and Intervention Models	1	Sullivan, 2000
23.Perry's Model	1	Watson, 1999
24. Model developed by SUnited States of American Ryerson from IBTA-education committee revised with member feedback	1	Michelsen, 2019
25.Systems Framework for Postural Control	1	Gillbody et al., 2021

Appendix I: Audit of web-based curriculum (data from 2021)

Responses to questions scored 0 or 1 (0 = No and 1 = Yes).

2. Are any of the terms – assessment, clinical reasoning and neurological used in the published curriculum?
3. Did the course description use terms such as assessment and neurological, but did not use these terms in the learning objectives?
4. Was there clearly documented assessment or clinical reasoning of people with neurological conditions/conditions in the curriculum?
5. Was a stand-alone neurology course/subject offered?
6. Was there published summative assessment of the student's ability to assess people with neurological conditions?
7. What was the length of the course including how many units? (i.e were aspects run as an intensive).

Appendix J: Interview questions (data from 2021)

Thank you for volunteering to participate in our interview regarding what is taught at university about neurological assessment. We encourage you to respond openly and honestly, in order for us to gain greater understanding of your practises and views on teaching neurological assessment to physiotherapy students. We hope to interview physiotherapists who teach physiotherapy assessment of people with neurological conditions in universities around Australia and also review web-based content. If there are any questions that you do not feel comfortable answering, please let me know. Before we commence, do you have any questions? Are you happy to go ahead?

We would like to begin the interview by asking you some background information.

1. What is your gender? male, female, other
2. What is your age?
3. What state in Australia do you work in?

I'd like to start by asking you some questions about your general experience as a physiotherapist.

1. What qualifications do you have?
2. How long have you been practicing in your profession since graduating?
3. How long have you been teaching assessment of people with neurological conditions?

For this next section, I will be asking questions about teaching neurology to students.

1. What course do you teach into related to neurological assessment?
2. Would you please tell me about your role in teaching neurology to physio students? (prompts: topic co-ordinator, how many hours a week working).
3. Would you please tell me about your teaching methods when teaching neurology (prompts: didactic lectures- recorded or not, workshops, tutorials, PBL, case studies etc).
4. Would you please tell me about assessment **of** this topic?
5. Would you please tell me about content related to neurological assessment of people with neurological conditions?
6. What facilitates learning neurology, in your opinion?
7. What are barriers to learning in neurological assessment/clinical reasoning in your opinion?

Thank you again for all your responses, which are valuable to us understanding what is taught about assessment of people with neurological conditions to physiotherapy students.

Appendix K: Educator Interviews Codebook (data from 2021)

Name	Description
B and F real patients	Barriers and facilitators to having real patients in the teaching environment,
Barriers to learning neurology	Anything identified as a barrier to learning
B amount of content	A barrier to learning neurology can be the amount of content taught
B Clinical reasoning	This barrier is related to clinical reasoning in the neurological population and also how this is different from other topics if it is CR that is being discussed.
B Complexity	Barrier of complexity related to topic content and aspects of teaching neurology
B context	Any barrier related to context - such as not teaching neuro in a clinical setting, no support form clinicians, how hard it may be to give context, difficulties using non impaired models as examples
B knowledge of what neuro PT is	Students not knowing what neurological physiotherapy is
B Prescriptive framework	This barrier is very structured, reproducible framework, words like recipe etc or labelled assessment practices
B realistic practice	This barrier to neurology related to the amount and type of practice and that lack of practice on real people with deficits
B Student expectations	What student expect form learning neurology, reported barriers to this
B supervisor expectations	
B Time	Barrier as amount of time allocated to teaching in the topic
B Uncertainty tolerance	This barrier is related to many areas of neurology have no clear outcome or prognosis related to findings of assessment and then clinical decisions about treatment. So any text that discusses uncertainty and lack of clarity related to patients outcomes
B Videos	Barriers in the use of videos for teaching
Content	
Application for clinical placement	Text that connects what is taught at university with clinical placement preparedness, experience, progress
Assessment framework	Including different frameworks for assessment such as screening, impairment assessment, vestibular etc
Case studies	Content of case studies and how they are used
Clinical reasoning	Aspects of clinical reasoning included as part fof teaching
context	How content is related to patient context
Function	What is included in content
Goal setting	
Interview practice	
Measures	inclusion of measures as part of assessment standardised or otherwise
Movement analysis	
Neurological conditions	
Skill development	
Therapeutic approach	Different approaches t assessment is discussed could be Bobath, motor learning, EBP etc
Topic manual	Contents of
WHO terminology	including ICF framework

COVID	Any text related to changes in teaching contents or format or practicals due to COVID
Examination of assessment	all forms of assessment/exams etc for assessment itself
Osci	What's included in an osci
Practical exam	
Quiz	
Skills check	
Viva	
Written assignment	
Written exam	
Facilitators to learning neurology	
F Clinical Reasoning	
F complexity	
F Context	
F Integrated curriculum	
F Observation	
F student expectations	
F Student immersion	
Resources	Information or people or objects used or created externally for the university
Evidence based practice	
Links with clinicians	
Real patients	
Simulation	
Teaching format	
Demonstration	
Flipped Classroom	An example could be given content as part of preparation and discuss in class
Independent learning	
Lecture	
Observations	
Online	
PBL	
Practicals	
Practice	
Questioning	
Real patients	
Scaffolding	
Simulation	
Touch and feel	
Tutorials	
Videos	
Topic structure	Topic structure refers to number of weeks the topic is run over and whether intensive or not and how the topic is run but no details of lecture or tutorial content or teaching format or methodology

Appendix L: Curriculum content with examples (data from 2021)

Number of teachers that included this content n (%)	Curriculum content	Examples
6 (50)	Application to clinical placement	I went from being concerned about not knowing how to write documentation and not knowing not fully knowing how to put together an assessment and treatment at the start of the semester, to be being able to undertake an entire clinical interaction and effectively document after I feel so much better for placement because of these things. (ID1)
11 (91.6)	Assessment structure	there is a hemiplegia and impairment assessment process (ID 3) using neurological screening process to motor assessment, scale, and all of that kind of thing……. an introduction to functional assessments in another course (ID1)
8 (66.6)	Case studies	So they get a lot of case studies in their practicals. And in the independent learning…….. And that's where we bring in the case studies of well, what would you choose for this patient? And we do a lot of what would you choose under ideal circumstances? And then what would you do? Okay, they now live out in the middle of nowhere. They have no family support. They've, you know, live in a two story home. (ID4)
12 (100)	Clinical reasoning	I guess one of the reasons we scaffold the teaching is to teach them everything in its full form, and then apply it to different populations and conditions, which helps…..the clinical reasoning and interpretation and the selection prioritisation process of different assessments as well (ID9) might get them to actually do interpret what would be the key piece of it what Which part? Which assessment information do you think is most relevant? So to actually identify what would be the key piece of information for them to, to use (ID8).
3 (25.0)	Context	And we have…….. specialists therapist that comes in and teaches them for a week. It really is just a brief introduction, but um, we try to incorporate that as well (ID2) And we use the assessment as a way to give some clinical context to neuroanatomy, so that it's a bit more engaged, learning it. And so we teach it quite structured and not case based initially, because it's purely related to brain function. (ID9)
3 (25.0)	Function	The first one is the fundamental like central components of movement. motor control theory, as motor learning theory , how to teach sit stand so the functional structures (ID6)
4 (33.3)	Goal setting	….we're talking about, you know, family centred practice and the ICF. Goal setting as well. (ID9)
10 (83.3)	Measures	And actually, every lecture, I would say, you know, every lecture on ms or Parkinson's or traumatic brain injury, there would always be a slide on outcome measures (ID1) provide a case study and say, what sort of outcome measures would be appropriate for this patient, so that, you know the theory (ID5) So we do impairment, functional past participation. And then we do assessment in terms of outcome measures that are specific, for example, for stroke, for Parkinson's disease, the TBI and the like, and we train them in those. But say for example, impairments, we look at manual muscle test and dynamometry for strength (ID 12)
7 (58.3)	Neurological conditions	e sort of do our first assessment around stroke (ID 1)

Number of teachers that included this content n (%)	Curriculum content	Examples
		But then we break down assessment according to health condition. So we have a, we have a section on degenerative conditions, we have a section on conditions that can improve with training. So we break down according to conditions we give them, we put assessment within the clinical reasoning process. So we give them assessment. Each time we look at health conditions, we give them assessment, in terms of the impairments that they're following. So they will assess according to the impairment, and these will go across health conditions, but some will be specific to health conditions. (ID 12)
2 (16.6)	Skill development	demonstration of skills and ways of doing thing (ID 10) The videos will teach how to do the skill, but also some considerations of the why we're testing it related to your anatomy or pathophysiology, as well as how we might adapt it for certain populations (ID9)
9 (75)	EBP and Therapeutic approach	And we have …… specialists therapist that comes in and teaches them for a week. It really is just a brief introduction, but um, we try to incorporate that as well. But the foundation of what we teach is based on motor learning (ID 2) We tend to cover it in a toolbox approach. So we teach about what's available, what's been used, how each of them works, what the research is behind each of them. And that it depends on the specific patient as to which one you might pick out for them. (ID4) We're very focused on evidence based practice. So focus really on mercury learning type approach. I often will say, particularly in labs. Now, in my clinical experience, this works well, but there's no evidence for it. So yes, I mentioned various different branches. And I encourage them should not be put off. Because there's no level one evidence. Often there isn't any evidence, because it's too difficult to obtain that data, very encouraged them to take note of single case studies and think about virtually developing lots of single case studies and small groups and that sort of thing. So we can develop a body of data in the way of that practice based evidence as opposed to evidence based practice (ID6)
3 (25.0)	Topic manual	So I have…… a course manual, which is not so much what the content of the lambs, but lots of information about the various outcome measures and how to, to use them (ID6) there's a lot of content about assessment in our prac manuals (ID1)
5 (41.6)	WHO terminology	When we teach the assessments, we also teach a basic assessment framework. So we talk about ICF. And because we do …. we're talking about, …….family centred practice and the ICF (ID9)

Appendix M: Teaching formats and methods of teaching with examples (data from 2021)

Number of teachers that use this format *n* (%)	Teaching format (the means of teaching)	Examples
8 (66.6)	Online	We used to do that tutorial face to face and of course, for the last couple of years have done it online (ID1). So some of those tutorials are via zoom, rather than face to face. And we've also developed a lot of video resources. So we send students off to have a look at things and then we come back on zoom and then discuss them that way (ID2)
7 (58.3)	Tutorials	And then we also have tutorials, which are different videos, where, depending on the content, for example, your gait analysis tutorial (ID1) So that's generally the way we roll and then the tutorial that follows the prac. That's where we really bring the case to get like a case study together. So your practice this week, we worked in, in all of these sort of areas, or we assessed we did assessment in these kind of areas. Now let's look at that in action. Or let's try and think about clinical reasoning around this particular case (ID7)
8 (66.6)	Independent learning	And we use videos quite a lot in that half an hour preparation, so that when they come into the prep room, they're ready to sort of hit the ground running, so to speak. (ID1) And then they have an independent activity workbook that has activities for them to work through. (ID4)
11 (91.6)	Lecture	So, the lectures have all pretty much moved to online recording with q&a sessions. (ID3 o we do all online, pre- recorded lectures. (ID4)
7 (58.3)	Simulation	just reading through the student evaluations…… from a third year student after the end of their unit last year… simulation that is. I went from being concerned about not knowing how to write documentation and not knowing not fully knowing how to put together an assessment and treatment at the start of the semester, to be being able to undertake an entire clinical interaction and effectively document after I feel so much better for placement because of these (ID1)
6 (50.0)	practicals	we will have a much practical class with them for three hours. And then we address all the elements that we have in our lecture about the assessment (ID5).
10 (83.3)	Videos	Then, of course, we have videos or case- based learning, which also involves, you know, assessment because it's presenting an entire case…… I think now even just putting together simple videos of us, you know, doing a particular skill or something can be really, really useful as well (ID)

Number of universities that use this method *n* (%)	Teaching methods (how)	Examples
2 (16.6)	Demonstration	guess demonstration of skills and ways of doing things. Possibly watching, you know, watching patient videos. You know, talking about what people are saying and serving. demonstration and then. Ye (ID 10)
3 (25.0)	Flipped classroom	So they've got that visual, to engage with your phone trying to flip the classroom for practice. So they've got practice stuff they have to access before they come in. And again, that's in the form of videos where, you know, this particular station, this is what you're going to do think about why that's relevant, so that we can, you know, we can come in into scope, wham Here we go, I've got a lot of time to explain it all.(ID7)
3 (25.0)	Observation	I think the observation…..you have to do some observations, …. you can always get your hands on a patient, so you're gonna have to watch them (ID8).
198.3)	Case based learning	Then, of course, we have videos or case based learning, which also involves, you know, assessment because it's presenting an entire case. (ID1).
7 (58.3)	Scaffolding	There's one neuro subject, which is like the fundamentals, and then there's a second, which is a much more complex like parkinsonism, ms. (ID1) 'balances is the obvious one a patient can't even sit, see how then you need to progress your assessment, because then you might have a patient who can run'(ID 10) I think that's, I guess one of the reasons we scaffold the teaching is to teach them everything in its full form, and then apply it to different populations and conditions, which helps hopefully, the clinical reasoning and interpretation and the selection prioritisation process of different assessments as well (ID9)
3 (25.0)	Movement Analysis	so they learn about essential components and analysing normal movement (ID2) usually starting with movement analysis, which helps direct them to which specific tests they'd use, which helps direct them to which outcome measures. (ID 4)
4(I33.3)	practice	We also in the first course, we get patients with who had stroke coming in twice during the semester, once they practice their assessment of people with stroke, and then practice administering all those assessment items (ID 2)
6(50.0)	Questioning	So there's case based learning, there's always a very specific question (ID 1) lectures have all pretty much moved to online recording with q&a sessions. So they watch, you know,……..And then the next day or whatever, we'll have a q&a session(ID3)
4 (33.3)	Real patints	Real patients, They'll probably be two or three, there's usually three a semester. Last year, it was one two online months, and I'm not sure what I'm doing this year. (ID3)
3 (25.0)	Touch and feel	my students have no idea what clonus looks like, I can see it and feel it. And yeah, so it's really, it's really great. (ID2)

Appendix N: Formative and Summative assessment of neurological assessment (data from 2021)

Number of Universities that use this method *n* (%)	Assessment method	Examples
9 (75.00	Written exam- in person or online	Then in our written exam, ……. a problem oriented assessment type format. So again, they might watch a video, and it might be on bed mobility, and they have to write down Well, what am I observing? What am I contributing factors? How would I test for those contributing factors? (ID7)
		The video exam where they use someone doing an activity and have to do a movement analysis of that. And that was done completely online this semester (ID4)
7 (58.3)	OSCI	so we have an assessment station, which will consist of an interview on a physical exam of any number of different presentations (ID1)
4 (33.3)	Practical exam	And then they also do their practical exam where they're asked to do just randomly pick out a bucket, one specific test and one outcome measure (ID4)
		it's broken down into four questions. And those four questions look at their assessed at some form of muscle strength or length assessment, you've got like a tonal based assessment, cranial nerve base assessment. And then you also have usually a functional based assessment (ID 11)
2 (16.6)	Quizzes	most of our we have quizzes and exams, which assess the content and we have the occasional question on what type of assessment would you pick for this condition (ID12)
1 (8.3)	Skills check	we do the skills checks. So asking people to assessment of checking someone to do a certain given the scenario and asking them to assessment (ID10)
1 (8.3)	Written assignment	Whereas a written assignment, which we change every year, but it's usually on looking at the little video reliability of some form of assessment tool in the neurological population. We change that each year. So you might be looking at the most appropriate balance outcome measure and static balance information. poststroke. (ID11)

Appendix O: Resources used to teach assessment with examples (data from 2021)

Number of teachers that use this resource *n* (%)	Resources	Examples
10 (83.3)	Videos/YouTube	We use a lot of videos, we use the ice Learning Centre.It's got some really good videos in clinical settings. (ID3). ‘ just putting together really simple videos of us, you know, doing a particular skill……. can be really, really useful (ID1)
6 (50.0)	Real patients	o first of all, I like to have real patients…..I I'm looking forward to see that I can take the patients, I take their students to the hospital ….. Let me get to the place because they will possibly even before that, to see the real patient or even if we cannot go the the best thing is to show them the videos. Showing them so working with real patient in house. (ID5)
7 (58.3)	Simulation	think it's quite valuable. We have some really good actors, people that are now retired that used to teach into the programme as well. They're excellent (ID2) We have a simulation site. We used to get actors in for that….. Last year, it was November. And we were just kind of opening up. But we didn't want to risk our actors are usually older people. We don't want to risk that. So we used and it worked so well. And I think we'll actually do it again. Because it's also cheaper. We used second and third year students. And it was really great for everyone involved. So cardio is actually doing a project on Peer simulations. So yeah, so we do seem and that's fun. It's hilarious day. It's really, it's really great. Because they kind of thrown in. And, you know, it's an easy teaching day, because I teach them set work, because they've got the case, and then they're, you know, they don't need us as much like for the pre briefing debrief (ID 3)

Appendix P: COREQ (Consolidated criteria for Reporting Qualitative research) Checklist

This checklist has been removed due to copyright restrictions.

Appendix Q: Electronic questionnaire (data from 2022)

Q1	Age
Q2	Gender
Q3	Year Level
Q4	State in Australia in which you study
Q5	For physiotherapy students: physiotherapy undergraduate course enrolled in (e.g., Bachelors or Masters or Doctorate)
Q6	For physiotherapy students: have you completed coursework related to assessment and treatment of people with neurological conditions?
Q7	How many clinical placements have you completed so far?
Q8	Have you worked with any people with neurological conditions to date?
Q8	Please provide contact details, email and phone
Q9	Please provide days and times preferred for the interview

Appendix R: Introduction and Interview questions (adapted from Wijbenga et al., 2019) (data from 2022).

Thank you for volunteering to participate in our interview regarding assessment and clinical reasoning in neurology by physiotherapy students before and after clinical placement in neurology. Just checking you can see and hear me, as we are connecting via Zoom? We will be recording the audio of this sessions via Zoom, please let me know if you are not O.K with this?

As part of this current research, we want to include physiotherapy students before they attend placement and then re interview them after they have assessed and treated patients with neurological conditions on placement. We would like to find out about your views and perceptions of neurological assessment and clinical reasoning. We would also be very interested to know anything else that you want to tell us about this topic.

The conversation is being recorded so the research team can transcribe and look at it later. This information will only be used to help with transcribing as no one will be named in the transcript.

The research team will write up our findings which will hopefully be published at a conference, no one will be named in any of the presentations or publications. If you would like to read the transcription or be made aware of the findings, please let me know via email.

We encourage you to respond openly and honestly, in order for us to gain greater understanding of your practises and views on teaching neurological assessment to physiotherapy students. We hope to interview physiotherapy students who have been educated about physiotherapy assessment of people with neurological conditions in universities around Australia and New Zealand before and after clinical placements in neurology. If there are any questions that you do not feel comfortable answering, please let me know. Before we commence, do you have any questions? Are you happy to go ahead? I will start the recording now.

Initial Interview

I'd like to start by asking a question about assessing people with neurological conditions

How would you proceed when you see a patient with a neurological disorder for the first time? Probe: what would your first steps be?

How has this been approached within your course? Probe: how have you been taught?

In this next section the questions will be about what clinical reasoning is?

How would you define clinical reasoning as applied to the assessment process of people with neurological conditions?

In the next section, I will be asking you questions about learning clinical reasoning

How have you learnt to apply the process of clinical reasoning during your course so far?

How prepared do you feel to integrate your learning of clinical reasoning into practice on placement?

What has facilitated your learning of clinical reasoning?

What has been a barrier to your learning of clinical reasoning?

How confident do you feel with clinical reasoning?

Tell us if and when you modify your assessment (of people with neurological conditions).

Tell us about how you use assessment to make clinical decisions/What parts of assessment has more weighting?

What has facilitated or hindered development of your clinical reasoning abilities?

Final Interview

I'd like to start by asking a question about assessing people with neurological conditions

How would you proceed when you see a patient with a neurological disorder for the first time? Probe: what would your first steps be?

In this next section the questions will be about what clinical reasoning is?

How would you define clinical reasoning as applied to the assessment process of people with neurological conditions?

In the next section, I will be asking you questions about learning clinical reasoning

How have you learnt to apply the process of clinical reasoning during your course so far?

How prepared did you feel to integrate your learning of clinical reasoning into practice on placement?

What has facilitated your learning of clinical reasoning during placement?

What has been a barrier to your learning of clinical reasoning during placement?

How confident do you feel with clinical reasoning?

Tell us if and when you modify your assessment (of people with neurological conditions).

Tell us about how you use assessment to make clinical decisions/What parts of assessment has more weighting?

What has facilitated or hindered development of your clinical reasoning abilities?

On reflection, what are some of the differences in your clinical reasoning before and after clinical placement. Probe: hypothesis formation, development of a problem list, management of the patient, progression of the patient's therapy, re-evaluation.

Appendix S: Student interview codebook (data from 2022)

Code name	Description	No. of participants	No. of quotes
Assessment of other domains while observing another	This describes two domains assessed at the same time, e.g., when a patient is being interviewed, as they walk into the room their ability to walk is being assessed, or when they have their interview and their cognition is being assessed whilst they are talking.	5	6
Basis for intervention	This code indicates what an intervention is based on, such as the assessment or the problems the patient has identified.	4	4
Trial and error	This code indicates where assessment and intervention are based on a 'trial and error' approach rather than evidence of experience.	4	4
Blurring of clinical reasoning and clinical decision-making	This code indicates when the use and meaning of clinical reasoning and clinical decision-making are either not clear or are used interchangeably.	5	11
Choosing appropriate outcome measures	This code indicates when how and what outcome measures are used.	4	4
Context and patient complexity	This code indicates the context of the patient interaction including internal and external factors that may suggest complexity.	7	10
Overwhelming knowledge and information overload induce anxiety	This code suggests the respondent is being given much content and feels overwhelmed by this and this may lead to anxiety.	5	6
Practice using clinical reasoning forms/problem lists	This code indicates the value of using problem lists to help develop clinical reasoning skills.	5	6
Observe other clinicians	Observation of other clinicians during an assessment on placement helps facilitate clinical reasoning skills.	4	4
Practising CR with peers	Practicing clinical reasoning skills such as in the classroom and when on placement.	3	4
Watching videos during class		6	6
Real-life patients	Working with real patients whilst on clinical placements as opposed to observation and no direct interaction.	5	7
CR is functionally focused on neurological physiotherapy rather than impairment-based	When using information from assessment and clinical reasoning skills to develop a movement-related diagnosis leading to a clinical decision the domains included are functional, not impairment-based.	4	5
CR varies according to 3 core areas	This code indicates the description of clinical reasoning according to the three core areas of physiotherapy practice. It includes respondent text that confirms that it is different in the three core areas and also text that confirms that it is both the same.	4	7
Definition of CR	This code indicates what the participants have defined clinical reasoning as.	8	9
CR varies according to 3 core areas		6	7
Don't know what will work	This code indicates that regarding planning treatment the participant doesn't know which treatments will work.	2	3
Factors Influencing Confidence with CR		9	11
Missing steps in CR especially interpretation not using assessment to outline Rx options	This code indicates steps that are missing from the evidence-based suggested steps (Garner & Lennon, 2018) including collecting information from a physiotherapy assessment using this information to form a movement-based diagnosis developing a problem list, and then using this information to make clinical decisions about a management plan in collaboration with the patient.	3	5
Omitted assessment domains based on patient ability	This code indicates when participants have not included a domain because it is too difficult or too easy for the patients/patient to do.	6	6
Modify assessment and first steps		12	17
Patient choice	This code indicates any respondent text related to patient decisions and choices around what is important to them. It can include goals, treatment choices, and priorities.	7	11
Patient variability	This code indicates when a patient may present differently than expected by the respondent, such as day-to-day variability or differently than expected based on their condition.	4	6
Patterns	This code indicates text that indicates clinical patterns, including pattern recognition.	2	3
Understanding progression	This code indicates text related to progressing therapy with patients.	4	5

Appendix T: Themes, codes and examples (data from 2022)

Theme	Codes	Exemplar quotes	No. of quotes	No. participants contributed to codes (pre and post)
1. Process and components for assessment	Assessing a domain whilst observing another	observe when they're walking through the door, ……..What kind of mobility do they have? Do they have any like speaking impairments, all that kind of stuff and you can gauge a lot of that from when they first walk through your door (P5)	6	5
	choosing appropriate outcome measures	which outcome tools you measure…….. think about what level they're already at…….. do you need something just quick and easy because they're going to get easily bewildered (P4)	4	4
	modify assessment and first steps	Because I specifically was with stroke patients, sort of asking you, what were initial things you felt was a weakness, tingling, sort of that. (P2)	17	12
	understanding progression	Some people progress quicker than others, some people progress slower than others. And if you like at uni, we're told to go baby steps, baby steps, part practice. Some of that were in real life. I feel like you are pushing the patients more and they get him to walk a bit quicker. (P2)	4	5
	defining clinical reasoning	but it's just, it's just that way of sort of like listing out what the issues are that you want to work on, maybe seeing how they sort of into, interplay a bit and, you know, looking for some, you know, some interventions that will directly, you know, work on those problems. (P4)	9	8
	don’t know what will work	(regarding proprioception) I still don’t know what would work, I’d want to focus on it but don’t know how to go about it (P6)	3	2
	basis for intervention	Focus on what you can change, like gait so you strengthen dorsiflexors of stretch under the foot. Something makes sense and something you have a solution for. (P6)	4	4
2. Treatment planning	Trial and error	you have all the knowledge from the topic and then you use this when assessing patients, and everyone is different so that makes it hard. Then you try and work it out and if it doesn’t work you try something else. (P3)	4	4
3. Patient-centred care	patient choice	You're just trying to think about how these fit into their life and how, yeah. Your life. (P4)	11	7
	omitted assessment domains based on patients’ ability	If I have a plan in my head – it depends on their presentation. Don’t want to do an assessment where you are setting them up to fail. Prefer to select an assessment I know they will be able to do. (P7)	6	6
	assessed a domain while observing another	asking questions and observing the patient. If they have a hemiplegic arm, you can observe them taking their top off or how they are doing things, or ask them about their problem and experiences. (P8)	5	6
	patient variability	She will tell me to come up with a plan and then you look at the plan and that will not work. Or you have a plan and they (patient) come in a week later and they are like blah blah blah happened, I had a fall and then you have to start again and replan on the spot. (P7)	6	4

Theme	Codes	Exemplar quotes	No. of quotes	No. participants contributed to codes (pre and post)
4. Learning clinical reasoning	context and patient complexity	I wouldn't feel comfortable being left alone with a low-level patient. I feel like if it was a stroke patient or someone, I would also really struggle with someone who can't communicate. (P6)	10	7
	patient variability	I guess it's not so discrete and it's not so discrete in neuro and everybody presents differently. (P5)	6	4
	overwhelming knowledge and information overload induce anxiety	You risk that red hot panic freeze, where you just, which I haven't seen anyone do yet, but everyone's scared (P4)	6	5
	observe other clinicians	actually observing other clinicians, I think everyone has a different way of doing things such as treatment modalities and how to address and do something- that gives you a broader toolbox and think has helped you. (P7)	4	4
	practice using clinical reasoning forms/problem lists	Problem lists are helpful to break down the pathology and understanding why they are presenting that way. (P7)	6	5
	practice with peers	I think another thing another thing at uni is that you are doing all these things on people (other physio students) who don't have these deficits. (P7)	4	3
	watching videos during class	so we did inquiry guides, um, where we had a case study and we followed the case study, which in hindsight is really good…… we would watch a video of a patient and then come up with questions and stuff. (P7)	6	6
	real-life patients	Another thing is to do it in a real-life situation. I will go to my supervisor and be like this is what I want to do with my patients even though I have never met them but have read their file. But you can read your file and not know how specifically they will present. So actually, seeing the patient in real life is really important (P7)	7	5
	clinical reasoning is functional in neuro rather than impairment-focused	(neurological physiotherapy) it's much more focused on what they need to functionally achieve. that's, that's the big distinction that, you know, everyone talks about, you know, when they go from intro to clinical reasoning is the MSK stuff where you're trying to list out sources and stuff, but here it's more about, concentrating on, on just, you know, what daily functions you can either improve or assist, I think, seem to be the big distinction. (P4)	5	4
	clinical reasoning varies according to the 3 core areas	I think the process in which you go about it e.g. the clinic forms that we do is different in the fact that MSK you're looking for actual structures that could potentially be going wrong and working it through that way. Whereas you are looking for more impairment-based stuff in more neuro and cardio, that hospital-based setting, and probably out-patient neuro as well. So yeah, it probably is a little bit different in the way that you do it, but the thoughts behind it in terms of using evidence and experience, I think is the same, if that makes sense. (P5)	7	4
	factors influencing confidence with clinical reasoning	I feel like because I've had a lot of experience with different patients, feel pretty good to do that (clinical reasoning0 as a new grade. (P2) I felt good going into the placement at …….. I mean, obviously, I was very lucky to have excellent supervisors and, yet it was very supported. (P4)	11	9
	patterns	And they're doing it in their head (supervisors), of course. Yeah, they do not have the time to speak through that with us. Like I said, you know when you've got a prompt and here's this person and it's like…… they've just had a stroke with a subluxed shoulder. I'm like, okay, yes, I will position their shoulder. And I'll kind of factor that in. And that is a level of clinical reason. (P5)	3	2

Theme	Codes	Exemplar quotes	No. of quotes	No. participants contributed to codes (pre and post)
5. Assumptions and biases	blurring of clinical reasoning and clinical decision-making	it's (clinical reasoning) just that way of sort of like listing out what the issues are that you want to work on, maybe seeing how they sort of into, interplay a bit and, you know, looking for some, you know, some interventions that will directly, you know, work on those problems so that you sort of keeping it targeted to what they need and also what they want. (P4)	11	5
	missing steps in clinical reasoning, omitted assessment based on patient ability	but then once on placement with my supervisors at my place at my placement, we really did not do any part practice at all. So more, just doing more facilitated more, getting the patient to work, work themselves. I feel like after placement, just not being afraid to be less conservative and, you know, doing part practice when it's sort of indicated, but then aside from that, just seeing what the patient's capable of and then working from there. (P2).	6	6
	patterns	I mean, it is hard to stay how you sort of evolved, but I think you get more and more familiar with how various impairments sort of feed, it becomes very circular, that, that sort of, that interplay of them. You get more and more familiar with that. And I don't know, I think maybe some of the thinking around the goal setting gets a bit clearer. (P4)	3	2
	patient choice	I think actually getting the patient's main problems and understanding that. If you are addressing what they see as the main problem, then you will be getting them on board a little bit more. they will as if they are progressing towards something. If it is their biggest problem it is the highest priority then. (P7)	11	77

REFERENCES

Abasıyanık, Z., Emük, Y., & Kahraman, T. (2022). Attitudes of physiotherapy students toward neurology: Does “neurophobia” exist among physiotherapy students? *Physiotherapy Theory and Practice*, *40*(4), 689–694. https://doi.org/10.1080/09593985.2022.2154627

Abrandt Dahlgren, M., Valeskog, K., Johansson, K., & Edelbring, S. (2022). Understanding clinical reasoning: A phenomenographic study with entry-level physiotherapy students. *Physiotherapy Theory and Practice*, *38*(13), 2817–2826. https://doi.org/10.1080/09593985.2021.1976332

Ajjawi, R., & Higgs, J. (2008). Learning to communicate clinical reasoning. In J. Higgs, M. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions*, (3rd ed., p. 331–328). Elsevier.

Ajjawi, R., & Smith, M. (2010). Clinical reasoning capability: Current understanding and implications for physiotherapy educators. *Focus on Health Professional Education: A Multi-disciplinary Journal*, *12*(1), 60–73. https://search.informit.org/doi/10.3316/informit.575051740584589

Alatawi, S. F. (2022). How can we use the promoting action on research in health services (PARIHS) framework to move from what we know to what we should do for the rehabilitation of a painful hemiplegic shoulder (PHS)? *Journal of Multidisciplinary Healthcare*, *15*, 2831–2843. https://doi.org/10.2147/JMDH.S392376

Alazani, A. (2016). A critical review of constructivist theory and the emergence of constructivism. American Research Journal of Humanities and Social Sciences, 2(1), 1-8. DOI: 10.21694/2378-7031.16018

Al-Ababneh, M. M. (2020). Linking ontology, epistemology and research methodology. Science & Philosophy, 8(1), 75-91. http://dx.doi.org/10.23756/sp.v8i1.500

Alexander, B. (1970). A neurological assessment chart. *Australian Journal of Physiotherapy*, *16*(2), 75–79. https://doi.org/10.1016/S0004-9514(14)61091-6

Allet, L., Bürge, E., & Monnin, D. (2008). ICF: Clinical relevance for physiotherapy? A critical review. *Advances in Physiotherapy*, *10*(3), 127–137. https://doi.org/10.1080/14038190802315941

Anderson, H. D., & Sullivan, J. E. (2016). Outcome measures for persons with acute stroke: A survey of physical therapists practicing in acute care and acute rehabilitation settings. *Journal of Acute Care Physical Therapy*, *7*(2), 76–83. https://doi.org/10.1097/JAT.0000000000000031

Ando, H., Cousins, R., & Young, C. (2014). Achieving saturation in thematic analysis: Development and refinement of a codebook. *Comprehensive Psychology*, *3*, 1–7. https://doi.org/10.2466/03.CP.3.4

Ansakorpi, H., Sumelahti, M. L., & Kaasila, R. (2017). Medical students' experience of emotions and success in neurological studies–What do they tell us? *BMC Medical Education*, *17*(1), 1–10. https://doi.org/10.1186/s12909-017-0905-4

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32.

Archibald, M. M., Ambagtsheer, R. C., Casey, M. G., & Lawless, M. (2019). Using zoom videoconferencing for qualitative data collection: perceptions and experiences of researchers and participants. *International journal of qualitative methods*, *18*, 1609406919874596.https://doi.org/10.1080/1364557032000119616

Ashburn, A. (1982). A physical assessment for stroke patients. *Physiotherapy*, *68*(4), 109–113. https://cir.nii.ac.jp/crid/1573105975811377792

Australian Government, Department of Health and Aged Care. (2020, March 3). *What we're doing about neurological conditions*. https://www.health.gov.au/topics/chronic-conditions/what-were-doing-about-chronic-conditions/what-were-doing-about-neurological-conditions

Australian Health Practitioner Regulation Agency. (2020). *Physiotherapy Board of Australia annual report*. https://www.physiotherapyboard.gov.au/News/Annual-report/2020-annual-summary.aspx

Australian Institute of Health and Welfare. (2024). *Multimorbidity*. https://www.aihw.gov.au/reports/australias-health/multimorbidity

Australian Physiotherapy Council. (2016). *Australian standards for physiotherapy https://cdn.physiocouncil.com.au/assets/volumes/downloads/Accreditation-Standard.pdf*

AVERT Trial Collaboration Group (2015). Efficacy and safety of a very early mobilisation within 24 h of stroke onset (AVERT): a randomised controlled trial. *The Lancet*, *386*(9988), 46–55. https://doi.org/10.1016/S0140-6736(15)60690-0

Bagraith, K. S., & Strong, J. (2013). Rehabilitation and the World Health Organization's International Classification of Functioning, Disability and Health. In H. van Griensven, J. Strong, & A. M. Unruh (Eds.), *Pain: A textbook for health professionals* (2nd ed., p. 339–360). Churchill Livingstone.

Bailey, M. M. J., Mears, M. J., & Riddoch, J. (1998). Is neglect neglected by the physiotherapist? *British Journal of Therapy and Rehabilitation*, *5*(11), 567–572. https://doi.org/10.12968/bjtr.1998.5.11.567

Bainbridge, L., Briffa, K., Burton, E., Hill, K. D., & Fary, R. (2024). Physiotherapists' decision-making about transition to independent walking in hospital after stroke: A qualitative study. *Disability and Rehabilitation, 46*(15), 3323–3331. https://doi.org/10.1080/09638288.2023.2245757

Baker, M. J. (2011). Education requirements for nurses working with people with complex neurological conditions: Relatives' perceptions. *Nurse Education in Practice*, *11*(4), 268–272. https://doi.org/10.1016/j.nepr.2010.11.020

Barbu CM (2014). zoom: A spatial data visualization tool. (Version 2.0.6), https://github.com/cbarbu/R-package-zoom.

Bassile, C, & Lennon, S. (2024). Guiding principles in neurological rehabilitation. In S. Lennon, G. Ramdharry, G. Verheyden (Eds.), *Physical management for neurological conditions* (5th ed., p. 5–19). Elsevier Science.

Beatty, J. E., Leigh, J. S., & Lund Dean, K. (2020). Republication of: Philosophy rediscovered: Exploring the connections between teaching philosophies, educational philosophies, and philosophy. *Journal of Management Education*, *44*(5), 543–559. https://doi.org/10.1177/1052562920912915

Beeston, S., & Simons, H. (1996). Physiotherapy practice: practitioners' perspectives. *Physiotherapy Theory and Practice*, *12*(4), 231–242. https://doi.org/10.3109/09593989609036440

Bhalerao, G., Shah, H., Bedekar, N., Dabadghav, R., & Shyam, A. (2016). Perspective of neuro therapeutic approaches preferred for stroke rehabilitation by physiotherapists. *Indian Journal of Physiotherapy and Occupational Therapy*, *10*(1), 47–50. https://doi.org/10.5958/0973-5674.2016.00011.3

Biesta, G. (2021). Pragmatism and the philosophical foundations of mixed methods research[1]. SAGE *Handbook Of Mixed Methods In Social & Behavioral Research, 95.*

Blanchette, A. K., Demers, M., Woo, K., Shah, A., Solomon, J. M., Mullick, A. A., & Levin, M. F. (2017). Current practices of physical and occupational therapists regarding spasticity assessment and treatment. *Physiotherapy Canada*, *69*(4), 303–312. https://doi.org/10.3138/ptc.2016-54

Boshuizen, H. P., Schmidt, H., Higgs, J., Jensen, G., Loftus, S., & Christensen, N. (2018). The development of clinical reasoning expertise. In J. Higgs, G. Jensen, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (4th ed., p. 57–65). Elsevier.

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology* (Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological (p. 57–71). American Psychological Association. https://doi.org/10.1037/13620-004

Brentnall, J., Thackray, D., & Judd, B. (2022). Evaluating the clinical reasoning of student health professionals in placement and simulation settings: A systematic review. *International Journal of Environmental Research and Public Health*, *19*(2), 936. https://doi.org/10.3390/ijerph19020936

Briggs, R. W. (2011). Clinical decision making for physical therapists in patient-centered end-of-life care. *Topics in Geriatric Rehabilitation*, *27*(1), 10–17. https://doi.org/10.1097/TGR.0b013e3181ff668a

Broberg, C., Aars, M., Beckmann, K., Emaus, N., Lehto, P., Lähteenmäki, M. L., Thys, W., & Vandenberghe, R. (2003). A conceptual framework for curriculum design in physiotherapy education–An international perspective. *Advances in Physiotherapy, 5*(4), 161–168. https://doi.org/10.1080/14038190310017598

Brown, M., Levack, W., McPherson, K. M., Dean, S. G., Reed, K., Weatherall, M., & Taylor, W. J. (2014). Survival, momentum, and things that make me "me": Patients' perceptions of goal setting after stroke. *Disability and Rehabilitation*, *36*(12), 1020–1026. https://doi.org/10.3109/09638288.2013.825653

Buckley, C., Alcock, L., McArdle, R., Rehman, R. Z. U., Del Din, S., Mazzà, C., Yarnall, A. J., & Rochester, L. (2019). The role of movement analysis in diagnosing and monitoring neurodegenerative conditions: Insights from gait and postural control. *Brain Sciences*, *9*(2), 34. https://doi.org/10.3390/brainsci9020034

Carr, J. H., Mungovan, S. F., Shepherd, R. B., Dean, C. M., & Nordholm, L. A. (1994). Physiotherapy in stroke rehabilitation: Bases for Australian physiotherapists' choice of treatment. *Physiotherapy Theory and Practice*, *10*(4), 201–209. https://doi.org/10.3109/09593989409036399

Carr, J. H., & Shepherd, R. B. (2010). *Neurological rehabilitation: Optimizing motor performance*. Elsevier Health Sciences.

Case, K., Harrison, K., & Roskell, C. (2000). Differences in the clinical reasoning process of expert and novice cardiorespiratory physiotherapists. *Physiotherapy*, *86*(1), 14–21. https://doi.org/10.1016/S0031-9406(05)61321-1

Cavanaugh, J. T., & Schenkman, M. (1998). Physical therapy evaluation and treatment in stroke rehabilitation. *Physical Therapy Case Reports*, *1*, 200–209.

Cerniauskaite, M., Quintas, R. U. I., Boldt, C., Raggi, A., Cieza, A., Bickenbach, J. E., & Leonardi, M. (2011). Systematic literature review on ICF from 2001 to 2009: Its use, implementation and operationalisation. *Disability and Rehabilitation*, *33*(4), 281–309. https://doi.org/10.3109/09638288.2010.529235

Checketts, M., Mancuso, M., Fordell, H., Chen, P., Hreha, K., Eskes, G. A., Vuilleumier, P., Vail, A., & Bowen, A. (2021). Current clinical practice in the screening and diagnosis of spatial neglect post-

stroke: Findings from a multidisciplinary international survey. *Neuropsychological Rehabilitation*, *31*(9), 1495–1526. https://doi.org/10.1080/09602011.2020.1782946

Choudhry, N. K., Fletcher, R. H., & Soumerai, S. B. (2005). Systematic review: The relationship between clinical experience and quality of health care. *Annals of Internal Medicine*, *142*(4), 260–273. https://doi.org/10.7326/0003-4819-142-4-200502150-00008

Christensen, N. P. N. (2019). Pedagogies for teaching and learning clinical reasoning. In J. Higgs, G.M. Jensen, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (4th ed., p. 335–344). Elsevier Science.

Christensen, N., Black, L., Furze, J., Huhn, K., Vendrely, A., & Wainwright, S. (2017). Clinical reasoning: Survey of teaching methods, integration, and assessment in entry-level physical therapist academic education. *Physical Therapy*, *97*(2), 175–186. https://doi.org/10.2522/ptj.20150320

Christensen, N., Jones, M. A., & Rivett, D. A. (2019). Strategies to facilitate clinical reasoning development. In M. A. Jones, & D. Rivett (Eds.), *Clinical reasoning in musculoskeletal practice* (2nd ed., p. 562–582). Elsevier.

Cieza, A., Causey, K., Kamenov, K., Hanson, S. W., Chatterji, S., & Vos, T. (2020). Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *396*(10267), 2006–2017. https://doi.org/10.1016/S0140-6736(20)32340-0

Cohen, E. T., Karpatkin, H. I., DiCarrado, S., & Zervas, M. (2020). A clinical reasoning framework for fatigue for neurologic physical therapy. *Physical Therapy Reviews*, *25*(4), 271–282. https://doi.org/10.1080/10833196.2020.1834329

Corrao, S., & Argano, C. (2022). Rethinking clinical decision-making to improve clinical reasoning. *Frontiers in Medicine*, *9*, 900543. https://doi.org/10.3389/fmed.2022.900543

Covington, K. (2024). Clinical reasoning and decision-making: An abridged literature review. In G. Musolino, & G. Jensen (Eds.), *Clinical reasoning and decision making in physical therapy* (p. 57–70). Routledge.

Creswell, J. W., & Plano Clark, V. L. (2017). Designing and Conducting Mixed Methods Research (3rd ed.). The Journal of Positive Psychology, 12(3), 305-306. Sage publication. z01_978-1-4129-7517-9_01.pdf

Crotty, M. (1998). The Foundations of Social Research: Meaning and Perspective in the Research Process. Sage Publications. The Foundations of Social Research : Meaning and Perspective in the Research Process - SAGE Publications Ltd - Torrossa

Crozier, J., Roig, M., Eng, J. J., MacKay-Lyons, M., Fung, J., Ploughman, M., Bailey, D. M., Sweet, S. N., Giacomantonio, N., Thiel, A., Trivino, M., & Tang, A. (2018). High-intensity interval training after stroke: An opportunity to promote functional recovery, cardiovascular health, and neuroplasticity. *Neurorehabilitation and Neural Repair*, *32*(6-7), 543–556. https://doi.org/10.1177/1545968318766663

Cruz, E. B., Moore, A. P., & Cross, V. (2012a). A qualitative study of physiotherapy final year undergraduate students' perceptions of clinical reasoning. *Manual Therapy, 17*(6), 549–553. https://doi.org/10.1016/j.math.2012.05.013

Cruz, E. B., Moore, A., & Cross, V. (2012b). Clinical reasoning and patient-centred care in musculoskeletal physiotherapy in Portugal–A qualitative study. *Manual Therapy*, *17*(3), 246–250. https://doi.org/10.1016/j.math.2012.02.007

Dalton, M., Davidson, M., & Keating, J. (2011). The Assessment of Physiotherapy Practice (APP) is a valid measure of professional competence of physiotherapy students: A cross-sectional study with Rasch analysis. *Journal of Physiotherapy*, *57*(4), 239–246. https://doi.org/10.1016/S1836-9553(11)70054-6

Dang, D., Dearholt, S. L., Bissett, K., Ascenzi, J., & Whalen, M. (2021). *Johns Hopkins evidence-based practice for nurses and healthcare professionals: Model and guidelines*. Sigma Theta Tau.

Delaney, L. J. (2018). Patient-centred care as an approach to improving health care in Australia. *Collegian*, *25*(1), 119–123. https://doi.org/10.1016/j.colegn.2017.02.005

Delany, C. & Bragge, P. (2009). A study of physiotherapy students' and clinical educators' perceptions of learning and teaching. *Medical Teacher*, *31*(9), e402–e411. https://doi.org/10.1080/01421590902832970

Delany, C. & Golding, C. (2014). Teaching clinical reasoning by making thinking visible: An action research project with allied health clinical educators. *BMC Medical Education*, *14*, 1–10. https://doi.org/10.1186/1472-6920-14-20

Demers, M., Blanchette, A. K., Mullick, A. A., Shah, A., Woo, K., Solomon, J., & Levin, M. F. (2019). Facilitators and barriers to using neurological outcome measures in developed and developing countries. *Physiotherapy Research International*, *24*(1), e1756. https://doi.org/10.1002/pri.1756

de Sousa, D. G., Harvey, L. A., Dorsch, S., & Glinsky, J. V. (2018). Interventions involving repetitive practice improve strength after stroke: A systematic review. *Journal of Physiotherapy*, *64*(4), 210–221. https://doi.org/10.1016/j.jphys.2018.08.004

Deutsch, J. E., Gill-Body, K. M., & Schenkman, M. (2022). Updated integrated framework for making clinical decisions across the lifespan and health conditions. *Physical Therapy*, *102*(3), pzab281. https://doi.org/10.1093/ptj/pzab281

Dickson, C., de Zoete, R. M., Berryman, C., Weinstein, P., Chen, K. K., & Rothmore, P. (2024). Patient-related barriers and enablers to the implementation of high-value physiotherapy for chronic pain: A systematic review. *Pain Medicine*, *25*(2), 104–115. https://doi.org/10.1093/pm/pnad134

Dimitriadis, Z., Skoutelis, V., & Tsipra, E. (2016). Clinical reasoning in neurological physiotherapy. *Archives of Hellenic Medicine/Arheia Ellenikes Iatrikes*, *33*(4), 447–457. https://www.mednet.gr/archives/2016-4/447abs.html

Docteur, E., & Coulter, A. (2012). *Patient-centeredness in Sweden's health system--an external assessment and six steps for progress* [highlight report]. The Swedish Agency for Health and Care Services (Vårdanalys) Report Series, 3. https://www.vardanalys.se/wp-content/uploads/2012/10/Rapport-2012-3-Patient-centeredness-in-Swedens-health-system.pdf

Edhlund, B., & McDougall, A. (2019). *NVivo 12 Essentials*. Lulu Press.

Edwards, I., Jones, M., Carr, J., Braunack-Mayer, A., & Jensen, G. M. (2004). Clinical reasoning strategies in physical therapy. *Physical Therapy*, *84*(4), 312–330. https://pubmed.ncbi.nlm.nih.gov/15049726/

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Elsworth, C., Winward, C., Sackley, C., Meek, C., Freebody, J., Esser, P. & Lowe, C. M. (2011). Supported community exercise in people with long-term neurological conditions: A phase II randomized controlled trial. *Clinical Rehabilitation*, *25*(7), 588–598. https://doi.org/10.1177/0269215510392076

Elvén, M., & Dean, E. (2017). Factors influencing physical therapists' clinical reasoning: Qualitative systematic review and meta-synthesis. *Physical Therapy Reviews*, *22*(1-2), 60–75. https://doi.org/10.1080/10833196.2017.1289647

Escorpizo, R., Kostanjsek, N., Kennedy, C., Robinson Nicol, M. M., Stucki, G., & Üstün, T. B. (2013). Harmonizing WHO's International Classification of Diseases (ICD) and International Classification of Functioning, Disability and Health (ICF): Importance and methods to link disease and functioning. *BMC Public Health*, *13*, 1–5. https://doi.org/10.1186/1471-2458-13-742

Eysenbach, G. (2004). Improving the quality of web surveys: The checklist for reporting results of internet e-surveys (CHERRIES). *Journal of Medical Internet Research*, *6*(3), e34. https://doi.org/10.2196/jmir.6.3.e34

Farrance, C., Tsofliou, F., & Clark, C. (2016). Adherence to community-based group exercise interventions for older people: A mixed-methods systematic review. *Preventive Medicine*, *87*, 155–166. https://doi.org/10.1016/j.ypmed.2016.02.037

Ferguson, L. M., Ward, H., Card, S., Sheppard, S., & McMurtry, J. (2013). Putting the 'patient' back into patient-centred care: An education perspective. *Nurse Education in Practice*, *13*(4), 283–287. https://doi.org/10.1016/j.nepr.2013.03.016

Fernandes, J. A. E., Gomes, M. M. F., da Silva Sousa, B., de Faria Fracon e Romão, J., Pinho, D. L. M., & da Silva Marães, V. R. F. (2020). The ICF in the pedagogical projects of physiotherapy courses in Midwest Brazil. *Fisioterapia em Movimento, 33*, e003344. https://doi.org/10.1590/1980-5918.033.AO44

First, M. B., & Fisher, C. E. (2012). Body integrity identity disorder: The persistent desire to acquire a physical disability. *Psychopathology, 45*(1), 3–14. https://doi.org/10.1159/000330503

Fisher, B. E. (2020). Beyond limits: Unmasking potential through movement discovery. *Physical Therapy*, *100*(5), 747–756. https://doi.org/10.1093/ptj/pzaa018

Flew, B., Judd, B., Lange, B., Lee, D., Blackstock, F., Tai, J., Tognon, K., & Chipchase, L. (2023). Understanding underperformance in a high-stakes clinical-based simulation assessment in physiotherapy: A descriptive analysis. *BMC Medical Education*, *23*(1), 676. https://doi.org/10.1186/s12909-023-04649-8

Forehand, M. (2010). Bloom's taxonomy. *Emerging Perspectives on Learning, Teaching, and technology*, *41*(4), 47–56. https://www.d41.org/cms/lib/IL01904672/Centricity/Domain/422/BloomsTaxonomy.pdf

Froment, F. P., Olson, K. A., Hooper, T. L., Shaffer, S. M., Sizer, P. S., Woodhouse, L. J., & Brismée, J. M. (2019). Large variability found in musculoskeletal physiotherapy scope of practice throughout WCPT and IFOMPT affiliated countries: An international survey. *Musculoskeletal Science and Practice*, *42*, 104–119. https://doi.org/10.1016/j.msksp.2019.04.012

Furze, J., Black, L., Hoffman, J., Barr, J. B., Cochran, T. M., & Jensen, G. M. (2015). Exploration of students' clinical reasoning development in professional physical therapy education. *Journal of Physical Therapy Education*, *29*(3), 22–33. https://journals.lww.com/jopte/abstract/2015/29030/exploration_of_students__clinical_reasoning.5.aspx

Galgon, A. K., & Bliss, R. A. (2024). Experienced clinical decision-making in physical therapist management of concussion: A qualitative study. *Physical Therapy*, *104*(5), pzae027. https://doi.org/10.1093/ptj/pzae027

Gallasch, D., Conlon-Leard, A., Hardy, M., Phillips, A., Van Kessel, G., & Stiller, K. (2022). Variable levels of stress and anxiety reported by physiotherapy students during clinical placements: A cohort study. *Physiotherapy*, *114*, 38–46. https://doi.org/10.1016/j.physio.2021.12.002

Garner, J., Lange, B., Lennon, S., & van den Berg, M. (2024). Physiotherapy assessment of people with neurological conditions in Australia: A national survey. *Health Science Reports*, *7*(6), e2117. https://doi.org/10.1002/hsr2.2117

Garner, J., & Lennon, S. (2018). Neurological assessment: The basis of clinical decision-making (Chapter 4). In S. Lennon, G. Ramdharry, & G. Verheyden (Eds.), *The neurological physiotherapy pocketbook* (2nd ed., p. 55–82). Elsevier Science.

Garner, J., Lennon, S., & McLoughlin, J. V. (2024). Clinical reasoning in neurological physiotherapy. In S. Lennon, G. Ramdharry, & G. Verheyden (Eds.). *Physical management of neurological conditions* (5th ed., p. 55–82). Elsevier Science.

Garner, J., van den Berg, M., Lange, B., Vuu, S., & Lennon, S. (2023). Physiotherapy assessment in people with neurological conditions—Evidence for the most frequently included domains: A mixed-methods systematic review. *Journal of Evaluation in Clinical Practice*.1–23. https://doi.org/10.1111/jep.13909

Gervais, T., Burling, N., Krull, J., Lugg, C., Lung, M., Straus, S., Jaglal, S., & Sibley, K. M. (2014). Understanding approaches to balance assessment in physical therapy practice for elderly inpatients of a rehabilitation hospital. *Physiotherapy Canada*, *66*(1), 6–14. https://doi.org/10.3138/ptc.2012-57

Giles, J. (2010). Clinical neuroscience attachments: A student's view of 'neurophobia'. *The Clinical Teacher*, *7*(1), 9–13. https://doi.org/10.1111/j.1743-498X.2009.00330.x

Gill-Body, K. M., Hedman, L. D., Plummer, L., Wolf, L., Hanke, T., Quinn, L., Riley, N., Kaufman, R., Verma, A., Quiben, M., & Scheets, P. (2021). Movement system diagnoses for balance dysfunction: Recommendations from the academy of neurologic physical therapy's movement system task force. *Physical Therapy*, *101*(9), pzab153. https://doi.org/10.1093/ptj/pzab153

Gjelsvik, B. E. B. (2016). *The Bobath concept in adult neurology*. Thieme.

Gleadhill, C., Bolsewicz, K., Davidson, S. R., Kamper, S. J., Tutty, A., Robson, E., Viana da Silva, P., Donald, B., Dooley, K., Manvell, J., Delbridge, A., & Williams, C. M. (2022). Physiotherapists' opinions, barriers, and enablers to providing evidence-based care: A mixed-methods study. *BMC Health Services Research*, *22*(1), 1382. https://doi.org/10.1186/s12913-022-08741-5

Gonzalez, C. M., Nava, S., List, J., Liguori, A., & Marantz, P. R. (2021). How assumptions and preferences can affect patient care: an introduction to implicit bias for first-year medical students.

MedEdPORTAL, 17, 11162. https://doi.org/10.15766/mep_2374-8265.11162Groen, B. E., Weerdesteyn, V., & Duysens, J. (2008). The relation between hip impact velocity and hip impact force differs between sideways fall techniques. *Journal of Electromyography and Kinesiology*, *18*(2), 228–234. https://doi.org/10.1016/j.jelekin.2007.06.002

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of Qualitative Research (p. 105–117). Sage Publications. guba-lincoln-competing-paradigms.pdf

Held Bradford, E., Finlayson, M., White Gorman, A., & Wagner, J. (2018). Maximizing gait and balance: Behaviours and decision-making processes of persons with multiple sclerosis and physical therapists. *Disability and Rehabilitation*, *40*(9), 1014–1025. https://doi.org/10.1080/09638288.2017.1283448

Hennink, M. M., Kaiser, B. N., & Marconi, V. C. (2017). Code saturation versus meaning saturation: How many interviews are enough? *Qualitative Health Research*, 27(4), 591–608. https://doi.org/10.1177/1049732316665344

Higgs, J. (2019). Re-interpreting clinical reasoning: A model of encultured decision-making practice capabilities. In J. Higgs, G.M. Jensen, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (4th ed., p. 13–31). Elsevier Science.

Higgs, J. (2020). Developing clinical reasoning capabilities. In D. Nestel, G. Reedy, L. McKenna, & S. Gough (Eds.), *Clinical education for the health professions: Theory and practice* (p. 1571–1588). Springer.

Higgs, J., & Jensen, G. M. (2019). Clinical reasoning: Challenges of interpretation and practice in the 21st century. In J. Higgs, G.M. Jensen, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (4th ed., p. 3–11). Elsevier Science.

Higgs, J., & Jones, M. A. (2019). Multiple spaces of choice, engagement and influence in clinical decision making. In J. Higgs, G. M. Jensen, S. Loftus, & N. Christense (Eds.), *Clinical reasoning in the health professions* (4th ed., p. 13–32). Elsevier Science.

Hillen, M. A., Gutheil, C. M., Strout, T. D., Smets, E. M., & Han, P. K. (2017). Tolerance of uncertainty: Conceptual analysis, integrative model, and implications for healthcare. *Social Science & Medicine*, *180*, 62–75. https://doi.org/10.1016/j.socscimed.2017.03.024

Herdman, S. J. (2013). Vestibular rehabilitation. *Current Opinion in Neurology*, *26*(1), 96–101. https://doi.org/10.1097/WCO.0b013e32835c5ec4

Holdar, U., Wallin, L., & Heiwe, S. (2013). Why do we do as we do? Factors influencing clinical reasoning and decision-making among physiotherapists in an acute setting. *Physiotherapy Research International*, *18*(4), 220–229. https://doi.org/10.1002/pri.1551

Holder, A. G. (2018). Clinical reasoning: A state of the science report. *International Journal of Nursing Education Scholarship*, *15*(1), 20160024. https://doi.org/10.1515/ijnes-2016-0024

Houlahan, M., Gintings, N., Burdon, M., & Ashby, S. (2023). An exploratory international survey of the assessments and interventions used by occupational therapists and physiotherapists during the hospitalization of people with Guillain-Barré syndrome. *Nursing & Health Sciences*, *25*(3), 302–310. https://doi.org/10.1111/nhs.13022

Hruska, P., Hecker, K. G., Coderre, S., McLaughlin, K., Cortese, F., Doig, C., Beran, T., Wright, B., & Krigolson, O. (2016). Hemispheric activation differences in novice and expert clinicians during clinical decision making. *Advances in Health Sciences Education*, *21*(5), 921–933. https://doi.org/10.1007/s10459-015-9648-3

Hubbard, I., & Parsons, M. (2007). The conventional care of therapists as acute stroke specialists: A case study. *International Journal of Therapy and Rehabilitation*, *14*(8), 357–362. https://doi.org/10.12968/ijtr.2007.14.8.24355

Huber, E. O., Tobler, A., Gloor-Juzi, T., Grill, E., & Gubler-Gut, B. (2011). The ICF as a way to specify goals and to assess the outcome of physiotherapeutic interventions in the acute hospital. *Journal of Rehabilitation Medicine*, *43*(2), 174–177. https://doi.org/10.2340/16501977-0629

Hudson, J. N. (2006). Linking neuroscience theory to practice to help overcome student fear of neurological physiotherapy. *Medical Teacher*, *28*(7), 651–653. https://doi.org/10.1080/01421590600726409

Huhn, K., Gilliland, S. J., Black, L. L., Wainwright, S. F., & Christensen, N. (2019). Clinical reasoning in physical therapy: A concept analysis. *Physical Therapy*. 99, 440–456. https://doi.org/10.1093/ptj/pzy148

Hunt, L., & Chalmers, D. (2021). *University teaching in focus: A learning-centred approach*. Routledge.

Ibeneme, S. C., Anyachukwu, C. C., Nwosu, A., Ibeneme, G. C., Bakare, M., & Fortwengel, G. (2016). Symptoms of poststroke depression among stroke survivors: An appraisal of psychiatry needs and care during physiotherapy rehabilitation. *Scientifica*, *2016*, 5646052. https://doi.org/10.1155/2016/5646052

Jamshidi, E., Nedjat, S., Nedjat, S., Nikooee, S., Rostamigooran, N., & Majdzadeh, R. (2018). How to utilize tacit knowledge in health organizations: An Iranian perspective. *Medical Journal of the Islamic Republic of Iran*, *32*, 116. https://doi.org/10.14196/mjiri.32.116

Jabareen, Y. (2009). Building a conceptual framework: philosophy, definitions, and procedure. International journal of qualitative methods, 8(4), 49-62. https://doi.org/10.1177/160940690900800406

Jensen, G., Resnik, L., & Haddad, A. (2008). Expertise and clinical reasoning. In J. Higgs, M. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions*, (3rd ed., p. 123–136). Elsevier.

Joanna Briggs Institute (2014). *Joanna Briggs Institute reviewers' manual 2014*. The Joanna Briggs Institute.

Jolliffe, L., Lannin, N. A., Cadilhac, D. A., & Hoffmann, T. (2018). Systematic review of clinical practice guidelines to identify recommendations for rehabilitation after stroke and other acquired brain injuries. *BMJ Open*, *8*(2), e018791. https://doi.org/10.1136/bmjopen-2017-018791

Jones, K. (2011). *Neurological assessment: A clinician's guide*. Churchill Livingstone.

Jones, M. A. (2019). Clinical reasoning: fast and slow thinking in musculoskeletal practice. In M. A. Jones, & D. Rivett (Eds.), *Clinical reasoning in musculoskeletal practice* (2nd ed., p. 2–31). Elsevier.

Jones, M. A, Edwards, M., & Jensen, G.M. (2019). Clinical reasoning in physiotherapy. In J. Higgs, M. A. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (3rd ed., p. 245–256). Elsevier.

Jones, M. A., & Rivett, D. A. (Eds.). (2003). *Clinical reasoning for manual therapists E-book*. Elsevier Health Sciences.

Jones, M. A., & Rivett, D. (Eds.). (2019). *Clinical reasoning in musculoskeletal practice* (2nd ed.). Elsevier Health Sciences.

Judd, B. K., Scanlan, J. N., Alison, J. A., Waters, D., & Gordon, C. J. (2016). The validity of a professional competence tool for physiotherapy students in simulation-based clinical education: A Rasch analysis. *BMC Medical Education*, *16*(1), 1–10. https://doi.org/10.1186/s12909-016-0718-x

Jukna, Š., Puteikis, K., & Mameniškienė, R. (2023). Perception of neurology among undergraduate medical students–What can be done to counter neurophobia during clinical studies? *BMC Medical Education*, *23*(1), 447. https://doi.org/10.1186/s12909-023-04405-y

Kapur, N. (2009). On the pursuit of clinical excellence. *Clinical Governance*, *14*(1), 24–37. https://doi.org/10.1108/14777270910933442

Kåringen, I., Dysvik, E., & Furnes, B. (2011). The elderly stroke patient's long-term adherence to physiotherapy home exercises. *Advances in Physiotherapy*, *13*(4), 145–152. https://doi.org/10.3109/14038196.2011.619574

Karvonen, E., Paatelma, M., Laitinen-Väänänen, S., & Piirainen, A. (2017). Clinical reasoning and critical reflection in physiotherapists' examinations of patients with low back pain in its early phase: A qualitative study from physiotherapists' point of view. *European Journal of Physiotherapy*, *19*(4), 185–193. https://doi.org/10.1080/21679169.2017.1316311

Kersten, P. (2004). Principles of physiotherapy assessment and outcome measures. In M. Stokes (Ed.), *Physical management in neurological rehabilitation* (p. 29–46). Elsevier Mosby.

Khan, F., Owolabi, M. O., Amatya, B., Hamzat, T. K., Ogunniyi, A., Oshinowo, H., Elmalik, A., & Galea, M. P. (2018). Challenges and barriers for implementation of the World Health Organization Global Disability Action Plan in low- and middle-income countries. *Journal of Rehabilitation Medicine*, *50*(4), 367–376. https://doi.org/10.2340/16501977-2276

Killingback, C., Tomlinson, A., Stern, J., & Whitfield, C. (2022). Teaching person-centred practice in physiotherapy curricula: A literature review. *Physical Therapy Reviews*, 27(1), 40–50. https://doi.org/10.1080/10833196.2021.2000287

Kleim, J. A. (2011). Neural plasticity and neurorehabilitation: Teaching the new brain old tricks. *Journal of Communication Disorders*, *44*(5), 521–528. https://doi.org/10.1016/j.jcomdis.2011.04.006

Kleim, J. A., & Jones, T. A. (2008). Principles of experience-dependent neural plasticity: Implications for rehabilitation after brain damage. *Journal of Speech, Language, and Hearing Research, 51*(1) S225–S239. https://doi.org/10.1044/1092-4388(2008/018)

Kleinheksel, A. J., Rockich-Winston, N., Tawfik, H., & Wyatt, T. R. (2020). Demystifying content analysis. *American Journal of Pharmaceutical Education*, *84*(1), 7113. https://doi.org/10.5688/ajpe7113

Kleynen, M., Moser, A., Haarsma, F. A., Beurskens, A. J., & Braun, S. M. (2017). Physiotherapists use a great variety of motor learning options in neurological rehabilitation, from which they choose through an iterative process: A retrospective think-aloud study. *Disability and Rehabilitation*, *39*(17), 1729–1737. https://doi.org/10.1080/09638288.2016.1207111

Knecht-Sabres, L. J. (2013). Experiential learning in occupational therapy: Can it enhance readiness for clinical practice? *Journal of Experiential Education*, *36*(1), 22–36. https://doi.org/10.1177/1053825913481584

Knepley, K. D., Mao, J. Z., Wieczorek, P., Okoye, F. O., Jain, A. P., & Harel, N. Y. (2021) Impact of telerehabilitation for stroke-related deficits. *Telemedicine and e-Health*. 27(3), 239–246. https://doi.org/10.1089/tmj.2020.0019

Kristensen, H. K., Lund, H., Jones, D. L., & Ytterberg, C. (2015). Achieving a holistic perspective in stroke rehabilitation: An overview of the use of the ICF by Danish physiotherapists and occupational therapists. *International Journal of Therapy and Rehabilitation*, *22*(10), 460–469. https://doi.org/10.12968/ijtr.2015.22.10.460

Lahelle, A. F., Øberg, G. K., & Normann, B. (2020). Physiotherapy assessment of individuals with multiple sclerosis prior to a group intervention–A qualitative observational and interview study. *Physiotherapy Theory and Practice*, *36*(3), 386–396. https://doi.org/10.1080/09593985.2018.1488022

Lang, C. E., Bland, M. D., Bailey, R. R., Schaefer, S. Y., & Birkenmeier, R. L. (2013). Assessment of upper extremity impairment, function, and activity after stroke: Foundations for clinical decision making. *Journal of Hand Therapy*, *26*(2), 104–115. https://doi.org/10.1016/j.jht.2012.06.005

Langaas, A. G., & Middelthon, A. L. (2020). Bodily ways of knowing: How students learn about and through bodies during physiotherapy education. In D. A. Nicholls, K. Synne Groven, E. Kinsella, & R. Anjum (Eds.), *Mobilizing knowledge in physiotherapy* (p. 29–40), Routledge.

Langridge, N., Roberts, L., & Pope, C. (2015). The clinical reasoning processes of extended scope physiotherapists assessing patients with low back pain. *Manual Therapy*, *20*(6), 745–750. https://doi.org/10.1016/j.math.2015.01.005

Larsen, C. M., Terkelsen, A. S., Carlsen, A. M. F., & Kristensen, H. K. (2019). Methods for teaching evidence-based practice: A scoping review. *BMC Medical Education*, *19*(1), 1–33. https://doi.org/10.1186/s12909-019-1681-0

Law, M., Stewart, D., Letts, L., Pollock, N., Bosch, J., & Westmorland, M. (1998). *Guidelines for critical review of qualitative studies* [Assessment tool]. McMaster University Occupational Therapy Evidence-Based Practice Research Group. https://d1wqtxts1xzle7.cloudfront.net/34413968/Qualitative_research_guidelines_for_optional_points_assignment-libre.pdf?1407761645=&response-content-di

Law, M., Stewart, C., Pollock, N., Letts, L., Bosch, J., & Westmorland, M. (1998). *McMaster critical review form - Quantitative studies* [Assessment tool]. McMaster University Occupational Therapy Evidence-Based Practice Research Group. http://srs-mcmaster.ca/research/evidence-based-practice-research-group/#OIXEXdby

Lawless, B., & Chen, Y. W. (2019). Developing a method of critical thematic analysis for qualitative communication inquiry. *Howard Journal of Communications*, *30*(1), 92–106. https://doi.org/10.1080/10646175.2018.1439423

Lazaro, R. T., Quiben, M. U., & Reina-Guerra, S. G. (2019). Foundations of clinical practice. In R. T. Lazaro, S. G. Reina-Guerra, & M. U. Quiben (Eds.), *Umphred's neurological rehabilitation* (7th ed., p. 1–14). Elsevier Health Sciences.

Leahy, E., Chipchase, L., & Blackstock, F. (2017). Which learning activities enhance physiotherapy practice? A systematic review protocol of quantitative and qualitative studies. *Systematic Reviews*, *6*(1), 1–7. https://doi.org/10.1186/s13643-017-0475-x

Lennon, S. (2001). Gait re-education based on the Bobath concept in two patients with hemiplegia following stroke. *Physical Therapy*, *81*(3), 924–935. https://pubmed.ncbi.nlm.nih.gov/11268157/

Lennon, S. (2003). Physiotherapy practice in stroke rehabilitation: A survey. *Disability and Rehabilitation*, *25*(9), 455–461. https://doi.org/10.1080/0963828031000069744

Lennon, S. (2004). The theoretical basis of neurological physiotherapy. In M. Stokes (Ed.), *Physical management in neurological rehabilitation* (2nd ed., p. 367–378). Elsevier Mosby.

Lennon, S., Baxter, D., & Ashburn, A. (2001). Physiotherapy based on the Bobath concept in stroke rehabilitation: A survey within the UK. *Disability and Rehabilitation*, *23*(6), 254–262. https://doi.org/10.1080/096382801750110892

Lennon, S., Ramdharry, G., & Verheyden, G. (Eds.). (2023). *Physical management for neurological conditions* (5th ed.). Elsevier Science.

Leonhard, S. E., Mandarakas, M. R., de Assis Aquino Gondim, F., Bateman, K., Brito Ferreira, M. L., Cornblath, D. R., Van Doorn, P. A., Dourado, M. E., Hughes, R. A. C., Islam, B., Kusunoki, S., Pardo, C. A., Reisin, R., Sejvar, J. J., Shahrizaila, N., Soares, C., Umapathi, T., Wang, Y., Yiu, E. M., . . . Jacobs, B. C. (2021). Evidence based guidelines. Diagnosis and management of Guillain-Barré syndrome in ten steps. *Medicina, 81*(5), 817–836. http://europepmc.org/abstract/MED/34633957

Levack, W. (2004). The International Classification of Functioning, Disability and Health (ICF)--application to physiotherapy. *New Zealand Journal of Physiotherapy*, *32*(1), 1–3. https://link.gale.com/apps/doc/A160542871/HRCA?u=anon~3fa342a4&sid=googleScholar&xid=66a288ea

Levack, W. M. M. (2023). Goal setting in rehabilitation. In S. Lennon, G. Ramdharry, & G. Verheyden (Eds.), *Physical management for neurological conditions* (5th ed., p. 129–150). Elsevier Science.

Levack, W. M., Dean, S. G., Siegert, R. J., & McPherson, K. M. (2011). Navigating patient-centered goal setting in inpatient stroke rehabilitation: How clinicians control the process to meet perceived professional responsibilities. *Patient Education and Counseling*, *85*(2), 206–213. https://doi.org/10.1016/j.pec.2011.01.011

Lexell, J., & Brogårdh, C. (2015). The use of the ICF in the neurorehabilitation process. *Neurorehabilitation*, *36*(1), 5–9. https://doi.org/10.3233/NRE-141184

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic Inquiry. Sage Publications. ED297007.pdf

Little, T. L., & Davenport, T. E. (2012). Should we be expert clinicians or scholars? The answer is yes. *The Journal of Manual & Manipulative Therapy*, *20*(1), 3. https://doi.org/10.1179/106698112X13231784786132

Lohmann, S., Decker, J., Müller, M., Strobl, R., & Grill, E. (2011). The ICF forms a useful framework for classifying individual patient goals in post-acute rehabilitation. *Journal of Rehabilitation Medicine*, *43*(2), 151–155. https://doi.org/10.2340/16501977-0657

Longo, P. J., Orcutt, V. L., James, K., Kane, J., & Coleman, V. (2018). Clinical reasoning and knowledge organization: Bridging the gap between medical education and neurocognitive science. *The Journal of Physician Assistant Education*, *29*(4), 230–235. https://doi.org/10.1097/JPA.0000000000000224

Luedtke, K., Allers, A., Schulte, L. H., & May, A. (2016). Efficacy of interventions used by physiotherapists for patients with headache and migraine—Systematic review and meta-analysis. *Cephalalgia*, *36*(5), 474–492. https://doi.org/10.1177/0333102415597889

Lyon, M. F., Mitchell, K., Medley, A., Roddey, T., & Gleeson, P. (2023). The impact of standardised balance measurement on physical therapist decision-making in acquired brain injury: A survey. *Physiotherapy Theory and Practice*, *39*(7), 1469–1483. https://doi.org/10.1080/09593985.2022.2040067

Mandrusiak, A. M., Isles, R., Chang, A. T., Choy, N. L., Toppenberg, R., McCook, D., Smith, M. D., O'Leary, K., & Brauer, S. G. (2014). Senior physiotherapy students as standardised patients for junior students enhances self-efficacy and satisfaction in both junior and senior students. *BMC Medical Education*, *14*, 105. https://doi.org/10.1186/1472-6920-14-105

Manikandan, M., Cassidy, E., Cook, G., Kilbride, C., Kerr, C., Walsh, A., Walsh, M., & Ryan, J. M. (2023). Access, use and satisfaction with physiotherapy services among adults with cerebral palsy living in the United Kingdom and Ireland. *Disability and Rehabilitation, 45*(13), 2160–2168. https://doi.org/10.1080/09638288.2022.2087760

Marcum, J. A. (2012). An integrated model of clinical reasoning: Dual-process theory of cognition and metacognition. *Journal of Evaluation in Clinical Practice*, *18*(5), 954–961. https://doi.org/10.1111/j.1365-2753.2012.01900.x

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*,*11*(3). https://doi.org/10.17169/fqs-11.3.1428

McDevitt, A., Rapport, M. J., Jensen, G., & Furze, J. (2019). Utilization of the clinical reasoning assessment tool across a physical therapy curriculum: Application for teaching, learning, and assessment. *Journal of Physical Therapy Education*, *33*(4), 335–342. https://doi.org/10.1097/JTE.0000000000000110

McDonnell, B., Stillwell, S., Hart, S., & Davis, R. B. (2018). Breaking down barriers to the utilization of standardised tests and outcome measures in acute care physical therapist practice: An observational longitudinal study. *Physical Therapy*, *98*(6), 528–538. https://doi.org/10.1093/ptj/pzy032

McGinnis, P. Q., Hack, L. M., Nixon-Cave, K., & Michlovitz, S. L. (2009). Factors that influence the clinical decision making of physical therapists in choosing a balance assessment approach. *Physical Therapy*, *89*(3), 233–247. https://doi.org/10.2522/ptj.20080131

McGlinchey, M. P., & Davenport, S. (2015). Exploring the decision-making process in the delivery of physiotherapy in a stroke unit. *Disability and Rehabilitation*, *37*(14), 1277–1284. https://doi.org/10.3109/09638288.2014.962106

McGlynn, M., & Cott, C. A. (2007). Weighing the evidence: Clinical decision making in neurological physical therapy. *Physiotherapy Canada*, *59*(4), 241–252. https://doi.org/10.3138/ptc.59.4.241

McLoughlin, J. (2020). Ten guiding principles for movement training in neurorehabilitation. *OpenPhysio Journal*. https://doi.org/10.14426/art/1260

McMeeken, J. (2007). Physiotherapy education in Australia. *Physical Therapy Reviews*, *12*(2), 83–91. https://doi.org/10.1179/108331907X175050

Michielsen, M., Vaughan-Graham, J., Holland, A., Magri, A., & Suzuki, M. (2019). The Bobath concept–A model to illustrate clinical practice. *Disability and Rehabilitation*, *41*(17), 2080–2092. https://doi.org/10.1080/09638288.2017.1417496

Mistry, K., Yonezawa, E., & Milne, N. (2019). Paediatric physiotherapy curriculum: An audit and survey of Australian entry-level physiotherapy programs. *BMC Medical Education*, *19*, 1–18. https://doi.org/10.1186/s12909-019-1540-z

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., & Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews*, *4*(1), 1.1–252. https://doi.org/10.1186/2046-4053-4-1

Moore, J. L., Potter, K., Blankshain, K., Kaplan, S. L., O'Dwyer, L. C., & Sullivan, J. E. (2018). A core set of outcome measures for adults with neurologic conditions undergoing rehabilitation: A clinical practice guideline. *Journal of Neurologic Physical Therapy*, *42*(3), 174–220. https://doi.org/10.1097/NPT.0000000000000229

Morgan, S., & Yoder, L. H. (2012). A concept analysis of person-centered care. *Journal of Holistic Nursing*, *30*(1), 6–15. https://doi.org/10.1177/0898010111412189

Moses, L., Rylak, D., Reader, T., Hertz, C., & Ogden, M. (2020). Educators' perspectives on supporting student agency. Theory into practice, 59(2), 213-222. https://doi.org/10.1080/00405841.2019.1705106

Murthy, K. S., O'Neill, P. A., & Byrne, G. J. (2013). The influence of learning styles and personality profiles on undergraduate medical students' clinical performance. *Medical Teacher*, *35*(7), 608–609. https://doi.org/10.3109/0142159X.2013.772972

Musolino, G., & Jensen, G. (2024). Clinical reasoning: Why it matters. In G. Musolino, & G. Jensen (Eds.), *Clinical reasoning and decision making in physical therapy: Facilitation, assessment, and implementation* (p. 3–9). Taylor & Francis.

Neupane, K. (2024). Understanding Pragmatism for Research: Which Pragmatism? In Thinkers: Creating New Ideas of Research (p.562-581). Publisher: Eudoxia Research Centre

Nguyen, T., Stewart, D., Rosenbaum, P., Baptiste, S., de Camargo, O. K., & Gorter, J. W. (2018). Using the ICF in transition research and practice? Lessons from a scoping review. *Research in Developmental Disabilities*, *72*, 225–239. https://doi.org/10.1016/j.ridd.2017.11.003

Nikopoulou-Smyrni, P., & Nikopoulos, C. K. (2007). A new integrated model of clinical reasoning: Development, description and preliminary assessment in patients with stroke. *Disability and Rehabilitation*, *29*(14), 1129–1138. https://doi.org/10.1080/09638280600948318

Nilsson, L. M., & Nordholm, L. A. (1992). Physical therapy in stroke rehabilitation: Bases for Swedish physiotherapists' choice of treatment. *Physiotherapy Theory and Practice*, *8*(1), 49–55. https://doi.org/10.3109/09593989209108079

Norman, G., Young, M., & Brooks, L. (2007). Non-analytical models of clinical reasoning: The role of experience. *Medical Education*, *41*(12), 1140–1145. https://doi.org/10.1111/j.1365-2923.2007.02914.x

Normann, B., Fikke, H. K., & ØBerg, G. K. (2015). Somatosensory impairments and upper limb function following stroke: Extending the framework guiding neurological physiotherapy. *The European Journal of Physiotherapy*, *17*(2), 81–88. https://doi.org/10.3109/21679169.2015.1031175

Normann, B., Sørgaard, K. W., Salvesen, R., & Moe, S. (2014). Clinical guidance of community physiotherapists regarding people with MS: professional development and continuity of care. *Physiotherapy Research International*, *19*(1), 25–33. https://doi.org/10.1002/pri.1557

Nutbeam, D., & Muscat, D. M. (2021). Health promotion glossary 2021. *Health Promotion International*, *36*(6), 1578–1598. https://doi.org/10.1093/heapro/daaa157

Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, *9*(1), 20–32. https://doi.org/10.1111/2041-210X.12860

Øberg, G. K., Normann, B., & Gallagher, S. (2015). Embodied-enactive clinical reasoning in physical therapy. *Physiotherapy Theory and Practice*, *31*(4), 244–252. https://doi.org/10.3109/09593985.2014.1002873

O'Brien, S. R., Durr, K., Laubisch, E., Losi, L., Parrillo, V., Pericozzi, S., Poirier, B., Poirier, L., Ray, K., Sackett, A., & Simoneau, D. (2021). Every person is an individual: Physical therapist clinical reasoning used in inpatient rehabilitation for walking assistive device prescription in patients with stroke and brain injury. *Disability and Rehabilitation: Assistive Technology*, *16*(1), 1–8. https://doi.org/10.1080/17483107.2019.1647568

Olson, A., Kämmer, J. E., Taher, A., Johnston, R., Yang, Q., Mondoux, S., & Monteiro, S. (2024). The inseparability of context and clinical reasoning. *Journal of Evaluation in Clinical Practice*. *30*(4), 533–538. https://doi.org/10.1111/jep.13969

O'Keefe, M., Henderson, A., & Chick, R. (2017). Defining a set of common interprofessional learning competencies for health profession students. *Medical Teacher*, *39*(5), 463–468. https://doi.org/10.1080/0142159X.2017.1300246

Pacheco-Brousseau, L., Stacey, D., Amor, S. B., & Poitras, S. (2022). Shared decision-making conceptual models for physiotherapy: a theory analysis. *Physiotherapy*, *115*, 111-118.https://doi.org/10.1016/j.physio.2022.03.001

Parker, C., Scott, S., & Geddes, A. (2019). Snowball sampling, In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *SAGE research methods foundations*. https://doi.org/10.4135/9781526421036831710

Paterson, C., & Chapman, J. (2013). Enhancing skills of critical reflection to evidence learning in professional practice. *Physical Therapy in Sport*, *14*(3), 133–138. https://doi.org/10.1016/j.ptsp.2013.03.004

Patten, S. B., Marrie, R. A., & Carta, M. G. (2017). Depression in multiple sclerosis. *International Review of Psychiatry*, *29*(5), 463–472. https://doi.org/10.1080/09540261.2017.1322555

Pattison, K. M., Brooks, D., Cameron, J. I., & Salbach, N. M. (2015). Factors influencing physical therapists' use of standardised measures of walking capacity poststroke across the care continuum. *Physical Therapy*, *95*(11), 1507–1517. https://doi.org/10.2522/ptj.20140267

Pernambuco, A. P., de Carvalho Lana, R., & Polese, J. C. (2018). Knowledge and use of the ICF in clinical practice by physiotherapists and occupational therapists of Minas Gerais. *Fisioterapia e Pesquisa*, *25*, 134–142. https://doi.org/10.1590/1809-2950/16765225022018

Peters, M. D. J., Godfrey, C., McInerney, P., Khalil, H., Larsen, P., Marnie, C., Pollock, D., Tricco, A. C., & Munn, Z. (2022). Best practice guidance and reporting items for the development of scoping review protocols. *JBI Evidence Synthesis*, *20*(4), 953–968. https://doi.org/10.11124/JBIES-21-00242

Peterson, K., Anderson, J., Bourne, D., Charns, M. P., Gorin, S. S., Hynes, D. M., ... & Yano, E. M. (2019). Health care coordination theoretical frameworks: a systematic scoping review to increase their understanding and use in practice. Journal of general internal medicine, 34, 90-98.https://link.springer.com/content/pdf/10.1007/s11606-019-04966-z.pdf

Phillips, A. C., Mackintosh, S. F., Bell, A., & Johnston, K. N. (2017). Developing physiotherapy student safety skills in readiness for clinical placement using standardised patients compared with peer-role play: A pilot non-randomised controlled trial. *BMC Medical Education*, *17*(1), 1–10. https://doi.org/10.1186/s12909-017-0973-5

Physiotherapy Board of Australia and New Zealand. (2023). Physiotherapy practice thresholds in Australia and New Zealand. https://cdn.physiocouncil.com.au/assets/volumes/downloads/Physiotherapy-Board-Physiotherapy-practice-thresholds-in-Australia-and-Aotearoa-New-Zealand.PDF

Pin-Barre, C., Constans, A., Brisswalter, J., Pellegrino, C., & Laurin, J. (2017). Effects of high-versus moderate-intensity training on neuroplasticity and functional recovery after focal ischemia. *Stroke*, *48*(10), 2855–2864. https://doi.org/10.1161/STROKEAHA.117.017962

Pinnock, R., Anakin, M., & Jouart, M. (2019). Clinical reasoning as a threshold skill. *Medical Teacher*, *41*(6), 683–689. https://doi.org/10.1080/0142159X.2019.1569754

Plummer, P., Morris, M. E., Hurworth, R. E., & Dunai, J. (2006). Physiotherapy assessment of unilateral neglect: Insight into procedures and clinical reasoning. *Physiotherapy*, *92*(2), 103–109. https://doi.org/10.1016/j.physio.2005.06.003

Pomeroy, V. M., Warren, C. M., Honeycombe, C., Briggs, R. S., Wilkinson, D. G., Pickering, R. M., & Steiner, A. (1999). Mobility and dementia: Is physiotherapy treatment during respite care

effective? *International Journal of Geriatric Psychiatry*, *14*(5), 389–397. https://pubmed.ncbi.nlm.nih.gov/10389044/

Porter, S. (2013). *Tidy's physiotherapy E-book*. Elsevier Health Sciences.

Potter, K., Fulk, G. D., Salem, Y., & Sullivan, J. (2011). Outcome measures in neurological physical therapy practice: Part I. Making sound decisions. *Journal of Neurologic Physical Therapy*, *35*(2), 57–64. https://doi.org/10.1097/NPT.0b013e318219a51a

Proud, E. L., Miller, K. J., Martin, C. L., & Morris, M. E. (2013). Upper-limb assessment in people with Parkinson disease: Is it a priority for therapists, and which assessment tools are used? *Physiotherapy Canada*, *65*(4), 309–316. https://doi.org/10.3138/ptc.2012-24

Quinn, L., Riley, N., Tyrell, C. M., Judd, D. L., Gill-Body, K. M., Hedman, L. D., Packel, A., Brown, D. A., Nabar, N., & Scheets, P. (2021). A framework for movement analysis of tasks: Recommendations from the Academy of Neurologic Physical Therapy's Movement System Task Force. *Physical Therapy*, *101*(9), pzab154. https://doi.org/10.1093/ptj/pzab154

Rai, N., & Thapa, B. (2015). A study on purposive sampling method in research. *Kathmandu: Kathmandu School of Law*, *5*(1), 8–15.

Rancic, J., Trowbridge, R. L., Fagan, M., Szauter, K., & Durning, S. (2017). Clinical reasoning education at US medical schools: Results from a national survey of internal medicine clerkship directors. *Journal of General Internal Medicine*, *32*(11), 1242–1246. https://doi.org/10.1007/s11606-017-4159-y

Roberts, K., Dowell, A., & Nie, J. B. (2019). Attempting rigour and replicability in thematic analysis of qualitative research data: A case study of codebook development. *BMC Medical Research Methodology*, *19*(1), 1–8. https://doi.org/10.1186/s12874-019-0707-y

Rosenbaum, P., & Stewart, D. (2004). World Health Organization International Classification of Functioning, Disability, and Health: A model to guide clinical thinking, practice, and research in the field of cerebral palsy. *Seminars in Pediatric Neurology*, *11*(1), 5–10. https://doi.org/10.1016/j.spen.2004.01.002

Ryan, R. M., & Vansteenkiste, M. (2023). Self-determination theory: Metatheory, methods, and meaning. In R. N. Ryan (Ed.), *The Oxford handbook of self-Determination theory* (p. 3–30). Oxford University Press.

Sackett, D. L. (1997). Evidence-based medicine. *Seminars in Perinatology*, *21*(1), 3–5. https://doi.org/10.1016/S0146-0005(97)80013-4

Sackett, D. L., Rosenberg, W. M., Gray, J. M., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: What it is and what it isn't. *BMJ*, *312*(7023), 71–72. https://doi.org/10.1136/bmj.312.7023.71

Sackley, C. M., & Lincoln, N. B. (1996). Physiotherapy treatment for stroke patients: A survey of current practice. *Physiotherapy Theory and Practice*, *12*(2), 87–96. https://doi.org/10.3109/09593989609036422

Salter, K., Hellings, C., Foley, N., & Teasell, R. (2008). The experience of living with stroke: A qualitative meta-synthesis. *Journal of Rehabilitation Medicine*, *40*(8), 595–602. https://doi.org/10.2340/16501977-0238

Sandelowski, M., & Barroso, J. (2006). *Handbook for synthesizing qualitative research*. Springer.

Schaefer, S. M., Dominguez, M., & Moeller, J. J. (2018). The future of the lecture in neurology education. *Seminars in Neurology*, *38*(4), 418–427. https://doi.org/10.1055/s-0038-1667042

Schenkman, M., Deutsch, J. E., & Gill-Body, K. M. (2006). An integrated framework for decision making in neurologic physical therapist practice. *Physical Therapy*, *86*(12), 1681–1702. https://doi.org/10.2522/ptj.20050260

Schunk, D. H. (2012). *Learning theories: An educational perspective* (6th ed.). Pearson Education.

Scrivener, K., & Shepherd, R. (2022). The importance of kinesiology, biomechanics and motor learning for movement analysis and clinical reasoning in neuromuscular physiotherapy. *Physical Therapy Reviews*, *27*(5), 325–328. https://doi.org/10.1080/10833196.2022.2141529

Seale, J., & Utsey, C. (2020). Physical therapist's clinical reasoning in patients with gait impairments from hemiplegia. *Physiotherapy Theory and Practice*, *36*(12), 1379–1389. https://doi.org/10.1080/09593985.2019.1567889

Sellberg, M., Halvarsson, A., Nygren-Bonnier, M., Palmgren, P. J., & Möller, R. (2022). Relationships matter: A qualitative study of physiotherapy students' experiences of their first clinical placement. *Physical Therapy Reviews*, *27*(6), 477–485. https://doi.org/10.1080/10833196.2022.2106671

Sibley, K. M., Inness, E. L., Straus, S. E., Salbach, N. M., & Jaglal, S. B. (2013). Clinical assessment of reactive postural control among physiotherapists in Ontario, Canada. *Gait & Posture*, *38*(4), 1026–1031. https://doi.org/10.1016/j.gaitpost.2013.05.016

Sikandar, A. (2015). John Dewey and his philosophy of education. *Journal of Education and Educational Development*, *2*(2), 191. https://doaj.org/article/507f524ef88d4b448c05de67582c21a1

Singam, A., Ytterberg, C., Tham, K., & von Koch, L. (2015). Participation in complex and social everyday activities six years after stroke: Predictors for return to pre-stroke level. *PloS One*, *10*(12), e0144344. https://doi.org/10.1371/journal.pone.0144344

Smith, M., Higgs, J., & Ellis, E. (2008). Factors influencing clinical decision making. In J. Higgs, M. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (3rd ed., p. 89–100). Elsevier.

Soares, L. D. S., Silva, N. C. D., & Moncaio, A. C. S. (2019). Active methodologies in higher education: Opinions, knowledge and teaching attitudes. *Journal of Nursing UFPE/Revista de Enfermagem UFPE*, *13*(3). https://doi.org/10.5205/1981-8963-v13i03a236317p783-795-2019

Sole, G., Skinner, M., Hale, L., & Golding, C. (2019). Developing a framework for teaching clinical reasoning skills to undergraduate physiotherapy students: A Delphi study. *New Zealand Journal of Physiotherapy*, *47*(1), 49–58. https://pnz.org.nz/Folder?Action=View%20File&Folder_id=454&File=NZJP%20Volume%2047%20Number%201%2006.pdf

Spoladore, D., Mahroo, A., & Sacco, M. (2021). Fostering the collaboration among healthcare stakeholders with ICF in clinical practice: EasyICF. In L. M. Camarinha-Matos, X. Boucher, & H. Afsarmanesh (Eds.), *Smart and sustainable collaborative networks 4.0: 22nd IFIP WG 5.5 Working Conference on Virtual Enterprises* (p. 623–631). Springer International Publishing. https://doi.org/10.1007/978-3-030-85969-5

Steiner, W. A., Ryser, L., Huber, E., Uebelhart, D., Aeschlimann, A., & Stucki, G. (2002). Use of the ICF model as a clinical problem-solving tool in physical therapy and rehabilitation medicine. *Physical Therapy*, *82*(11), 1098–1107. https://pubmed.ncbi.nlm.nih.gov/12405874/

Steinmetz, J. D., Seeher, K. M., Schiess, N., Nichols, E., Cao, B., Servili, C., ... & Atalell, K. A. (2024). Global, regional, and national burden of disorders affecting the nervous system, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. *The Lancet Neurology*, *23*(4), 344-381. https://doi.org/10.1016/ S1474-4422(24)00038-3

Stern, C., Lizarondo, L., Carrier, J., Godfrey, C., Rieger, K., Salmond, S., Apóstolo, J., Kirkpatrick, P., & Loveday, H. (2021). Methodological guidance for the conduct of mixed methods systematic reviews. *JBI Evidence Implementation*, *19*(2), 120–129. https://doi.org/10.11124/JBISRIR-D-19-00169

Stoikov, S., Maxwell, L., Butler, J., Shardlow, K., Gooding, M., & Kuys, S. (2022). The transition from physiotherapy student to new graduate: Are they prepared? *Physiotherapy Theory and Practice*, *38*(1), 101–111. https://doi.org/10.1080/09593985.2020.1744206

Stroke Foundation. (2023). *Clinical guidelines for stroke management*. https://informme.org.au/guidelines/living-clinical-guidelines-for-stroke-management

Stroke Foundation. (2024). *Stroke strategy 2024*. https://strokefoundation.org.au/About-us/Strategies

Stucki, G., Cieza, A., Ewert, T., Kostanjsek, N., Chatterji, S., & Üstün, T. B. (2002). Application of the International Classification of Functioning, Disability and Health (ICF) in clinical practice. *Disability and Rehabilitation*, *24*(5), 281–282. https://doi.org/10.1080/09638280110105222

Stucki, G., & Sigl, T. (2003). Assessment of the impact of the disease on individuals. *Best Practice & Research Clinical Rheumatology*, *17*(3), 451–473. https://doi.org/10.1016/S1521-6942(03)00025-1

Sullivan, J. E., Andrews, A. W., Lanzino, D., Peron, A., & Potter, K. A. (2011). Outcome measures in neurological physical therapy practice: Part II. A patient-centered process. *Journal of Neurologic Physical Therapy*, *35*(2), 65–74. https://doi.org/10.1097/NPT.0b013e31821a24eb

Sullivan, K. J., Hershberg, J., Howard, R., & Fisher, B. E. (2004). Neurologic differential diagnosis for physical therapy. *Journal of Neurologic Physical Therapy*, *28*(4), 162–168. https://www.proquest.com/trade-journals/neurologic-differential-diagnosis-physical/docview/213734315/se-2

Sullivan, P. E., & Markos, P. D. (2000). Applying the framework of clinical practice to a patient with Multiple Sclerosis. *Journal of Neurologic Physical Therapy*, *24*(1), 10–16. https://journals.lww.com/jnpt/fulltext/2000/24010/applying_the_framework_of_clinical_practice_to_a.5.aspx

Sutherland, K.A. (2021). The four Cs of effective classroom teaching. In L. Hunt, & D. Chalmers, *University teaching in focus: A learning-centred approach* (2nd ed. p.112-135). Routledge. https://doi.org/10.4324/9781003008330

Takahashi, A., Kitsunai, S., Kawana, H., Saito, N., Yoshihara, A., & Furukawa, K. (2024). Physiotherapy management focusing on proprioceptive impairment in a patient with gait and balance impairments following stroke: A case report. *Physiotherapy Theory and Practice*, 1–15. https://doi.org/10.1080/09593985.2024.2332792

Takahashi, J., Takami, A., & Wakayama, S. (2014). Clinical reasoning of physical therapists regarding in-hospital walking independence of patients with hemiplegia. *Journal of Physical Therapy Science*, *26*(5), 771–775. https://doi.org/10.1589/jpts.26.771

Tan, A., Copley, J., & Fleming, J. (2022). Decision-making aids for upper limb interventions in neurological rehabilitation: A scoping review. *Disability and Rehabilitation*, *44*(18), 5291–5309. https://doi.org/10.1080/09638288.2021.1924881

Te, M., Blackstock, F., & Chipchase, L. (2019). Fostering cultural responsiveness in physiotherapy: Curricula survey of Australian and Aotearoa New Zealand physiotherapy programs. *BMC Medical Education*, *19*, 1–12. https://doi.org/10.1186/s12909-019-1766-9

Teherani, A., Nishimura, H., Apatira, L., Newman, T., & Ryan, S. (2017). Identification of core objectives for teaching sustainable healthcare education. *Medical Education Online*, *22*(1), 1386042. https://doi.org/10.1080/10872981.2017.1386042

Thackray, D., & Roberts, L. (2017). Exploring the clinical decision-making used by experienced cardiorespiratory physiotherapists: A mixed method qualitative design of simulation, video recording and think aloud techniques. *Nurse Education Today*, *49*, 96–105. https://doi.org/10.1016/j.nedt.2016.11.003

Thomas, S. P., & Sohn, B. K. (2023). From uncomfortable squirm to self-discovery: A phenomenological analysis of the bracketing experience. *International Journal of Qualitative Methods*, *22*, 16094069231191635. https://doi.org/10.1177/16094069231191635

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, *19*(6), 349–357. https://doi.org/10.1093/intqhc/mzm042

Trede, F., & Higgs, J. (2019). Clinical reasoning and models of practice. In J. Higgs, M. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (3rd ed., p. 31–42). Elsevier.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., Lewin, S., … Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

Tyson, S. F., & DeSouza, L. H. (2003). A clinical model for the assessment of posture and balance in people with stroke. *Disability and Rehabilitation*, *25*(3), 120–126. https://doi.org/10.1080/0963828021000013944

Tyson, S., Greenhalgh, J., Long, A. F., & Flynn, R. (2010). The use of measurement tools in clinical practice: An observational study of neurorehabilitation. *Clinical Rehabilitation*, *24*(1), 74–81. https://doi.org/10.1177/0269215509341527

Tyson, S. F., Hanley, M., Chillala, J., Selley, A. B., & Tallis, R. C. (2007). The relationship between balance, disability, and recovery after stroke: Predictive validity of the Brunel Balance Assessment. *Neurorehabilitation and Neural Repair*, *21*(4), 341–346. https://doi.org/10.1177/1545968306296966

Tyson, S., Watson, A., Moss, S., Troop, H., Dean-Lofthouse, G., Jorritsma, S., Shannon, M., & Greater Manchester Outcome Measures Project (2008). Development of a framework for the evidence-based choice of outcome measures in neurological physiotherapy. *Disability and Rehabilitation, 30*(2), 142–149. https://doi.org/10.1080/09638280701216847

United Kingdom Health & Care Professions Council. (2023). *Standards of proficiency: Physiotherapists*. https://www.hcpc-uk.org/standards/standards-of-proficiency/physiotherapists/

United Nations (2015). *Transforming our world: The 2030 agenda for sustainable development*. United Nations. https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-17981

United States Department of Health and Human Services. (2010). *Multiple chronic conditions—A strategic framework: optimum health and quality of life for individuals with multiple chronic conditions*. Washington, DC: US Department of Health and Human Services, 2. https://www.hhs.gov/sites/default/files/ash/initiatives/mcc/mcc_framework.pdf

Unsworth, C. A. (2011). The evolving theory of clinical reasoning. In E. Duncan (Ed.), *Foundations for practice in occupational therapy*, (5th ed., p. 209–231). Elsevier.

van de Port, I. G., Kwakkel, G., Schepers, V. P., & Lindeman, E. (2006). Predicting mobility outcome one year after stroke: A prospective cohort study. *Journal of Rehabilitation Medicine*, *38*(4), 218–223. https://doi.org/10.1080/16501970600582930

van Duijnhoven, H. J., Heeren, A., Peters, M. A., Veerbeek, J. M., Kwakkel, G., Geurts, A. C., & Weerdesteyn, V. (2016). Effects of exercise therapy on balance capacity in chronic stroke: Systematic review and meta-analysis. *Stroke*, *47*(10), 2603–2610. https://doi.org/10.1161/STROKEAHA.116.013839

van Peppen, R. P., Hendriks, H. J. M., Van Meeteren, N. L., Helders, P. J., & Kwakkel, G. (2007). The development of a clinical practice stroke guideline for physiotherapists in The Netherlands: A systematic review of available evidence. *Disability and Rehabilitation*, *29*(10), 767–783. https://doi.org/10.1080/09638280600919764

van Peppen, R. P., Maissan, F. J., van Genderen, F. R., van Dolder, R., & van Meeteren, N. L. (2008). Outcome measures in physiotherapy management of patients with stroke: A survey into self-reported use, and barriers to and facilitators for use. *Physiotherapy Research International*, *13*(4), 255–270. https://doi.org/10.1002/pri.417

Vasileiou, K., Barnett, J., Thorpe, S., & Young, T. (2018). Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC medical research methodology*, *18*, 1-18.https://doi.org/10.1186/s12874-018-0594-7

Vaughan-Graham, J., Patterson, K., Zabjek, K., & Cott, C. A. (2017). Conceptualizing movement by expert Bobath instructors in neurological rehabilitation. *Journal of Evaluation in Clinical Practice*, *23*(6), 1153–1163. https://doi.org/10.1111/jep.12742

Vignaud, H., Molins, C., Legaux, C., Slusznis, A., Sarhan, F. R., & Demont, A. (2023). Description of the abilities of physiotherapists in terms of diagnostic hypothesis and management decision for self-referred patients with musculoskeletal disorders in France using clinical vignettes: A cross-sectional survey. *Musculoskeletal Care*, *21*(4), 1592–1600. https://doi.org/10.1002/msc.1836

Voss, P., Thomas, M. E., Cisneros-Franco, J. M., & de Villers-Sidani, É. (2017). Dynamic brains and the changing rules of neuroplasticity: Implications for learning and recovery. *Frontiers in Psychology*, *8*, 274878. https://doi.org/10.3389/fpsyg.2017.01657

Wainwright, S. F., Shepard, K. F., Harman, L. B., & Stephens, J. (2010). Novice and experienced physical therapist clinicians: A comparison of how reflection is used to inform the clinical decision-making process. *Physical Therapy*, *90*(1), 75–88. https://doi.org/10.2522/ptj.20090077

Wainwright, S. F., Shepard, K. F., Harman, L. B., & Stephens, J. (2011). Factors that influence the clinical decision making of novice and experienced physical therapists. *Physical Therapy*, *91*(1), 87–101. https://doi.org/10.2522/ptj.20100161

Walankar, P. P., Panhale, V. P., & Situt, S. A. (2019). Evaluation of learning approaches in physiotherapy students: A valuable insight. *Journal of Education and Health Promotion*, *8*(1), 25. https://doi.org/10.4103/jehp.jehp_254_18

Walker, K. (2013). *University students' perceptions of neurology and experiences of learning neurological physiotherapy* [Doctoral dissertation, University of East Anglia]. UEA Digital Repository. https://ueaeprints.uea.ac.uk/id/eprint/49593/

Wallace, A., Cassidy., & Bunn, L. (2024). Observation and analysis of movement. In S. Lennon, G. Ramdharry, G. Verheyden (Eds.), *Physical management for neurological conditions* (5th ed., p. 71–112). Elsevier Science.

Walmsley, C., Taylor, S., Parkins, T., Carey, L., Girdler, S., & Elliott, C. (2018). What is the current practice of therapists in the measurement of somatosensation in children with cerebral palsy and other neurological disorders? *Australian Occupational Therapy Journal*, *65*(2), 89–97. https://doi.org/10.1111/1440-1630.12431

Wasserman, T., & Wasserman, L. D. (2017). *Neurocognitive learning therapy: Theory and practice*. Springer International Publishing.

Watson, M. J. (1999). Clinical reasoning in neurology: Perry's model. *Physiotherapy*, *85*(5), 281–288. https://doi.org/10.1016/S0031-9406(05)61451-4

Wiegand, N. M., Belting, J., Fekete, C., Gutenbrunner, C., & Reinhardt, J. D. (2012). All talk, no action? The global diffusion and clinical implementation of the international classification of functioning, disability, and health. *American Journal of Physical Medicine & Rehabilitation*, *91*(7), 550–560. https://doi.org/10.1097/PHM.0b013e31825597e5

Wijbenga, M. H., Bovend'Eerdt, T. J., & Driessen, E. W. (2019). Physiotherapy students' experiences with clinical reasoning during clinical placements: A qualitative study. *Health Professions Education*, *5*(2), 126–135. https://doi.org/10.1016/j.hpe.2018.05.003

Wikström-Grotell, C. (2021). Physiotherapy and physiotherapy education–From an international to a global and value-based perspective. *European Journal of Physiotherapy*, *23*(3), 133–134. https://doi.org/10.1080/21679169.2021.1907967

Wikström-Grotell, C., & Eriksson, K. (2012). Movement as a basic concept in physiotherapy–A human science approach. *Physiotherapy Theory and Practice*, *28*(6), 428–438. https://doi.org/10.3109/09593985.2012.692582

Williams, M. K. (2017). John Dewey in the 21st century. *Journal of Inquiry and Action in Education*, *9*(1), 7. https://files.eric.ed.gov/fulltext/EJ1158258.pdf

Wilson, T., Martins, O., Efrosman, M., DiSabatino, V., Benbrahim, B. M., & Patterson, K. K. (2019). Physiotherapy practice patterns in gait rehabilitation for adults with acquired brain injury. *Brain Injury*, *33*(3), 333–348. https://doi.org/10.1080/02699052.2018.1553067

Winward, C. E., Halligan, P. W., & Wade, D. T. (1999). Current practice and clinical relevance of somatosensory assessment after stroke. *Clinical Rehabilitation*, *13*(1), 48–55. https://doi.org/10.1177/026921559901300107

World Confederation of Physical Therapy. (2011). WCPT guidelines for standards of physical therapy practice. WCPT, London, UK. https://world.physio/sites/default/files/2020-07/G-2011-Standards-practice.pdf

World Health Organization. (2001). *International classification of functioning, disability, and health (ICF)*. World Health Organization. https://www.who.int/classification/icf

World Health Organization. (2006). *Neurological conditions: Public health challenges*. World Health Organization. https://www.who.int/publications/i/item/9789241563369

World Health Organization. (2012). *Health education: Theoretical concepts, effective strategies and core competencies: A foundation document to guide capacity development of health educators*. World Health Organization. https://iris.who.int/handle/10665/119953

World Physiotherapy. (2011). *World physiotherapy standards*. https://world.physio/guideline/standards.

World Physiotherapy. (2021). *Physiotherapist education framework*. World Physiotherapy. https://world.physio/sites/default/files/2021-07/Physiotherapist-education-framework-FINAL.pdf

Wright, A., Moss, P., Dennis, D. M., Harrold, M., Levy, S., Furness, A. L., & Reubenson, A. (2018). The influence of a full-time, immersive simulation-based clinical placement on physiotherapy student confidence during the transition to clinical practice. *Advances in Simulation*, *3*(1), 1–10. https://doi.org/10.1186/s41077-018-0062-9

Yardley, S., Teunissen, P. W., & Dornan, T. (2012). Experiential learning: AMEE guide No. 63. *Medical Teacher*, *34*(2), e102–e115. https://doi.org/10.3109/0142159X.2012.650741

Yazdani, S., & Hoseini Abardeh, M. (2019). Five decades of research and theorization on clinical reasoning: A critical review. *Advances in Medical Education and Practice*, 703–716. https://doi.org/10.2147/AMEP.S213492

Young, M., Thomas, A., Gordon, D., Gruppen, L., Lubarsky, S., Rencic, J., Ballard, T., Holmboe, E., da Silva, A., Ratcliffe, T., Schuwirth, L., & Durning, S. J. (2019). The terminology of clinical reasoning in health professions education: Implications and considerations. *Medical Teacher*, *41*(11), 1277–1284. https://doi.org/10.1080/0142159X.2019.1635686

Yoward, L. S., Doherty, P., & Boyes, C. (2008). A survey of outcome measurement of balance, walking and gait amongst physiotherapists working in neurology in the UK. *Physiotherapy*, *94*(2), 125–132. https://doi.org/10.1016/j.physio.2007.08.005